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ABSTRACT

This proceedings volume includes the following 29 papers: Session 1--(1) "Technology for Learning: The Present and Future in the United States" (Thomas Owens, Carolyn Cohen); (2) "Computer Systems Technology Programs at the British Columbia Institute of Technology (Canada). A Technology-Based Model for Information Technology" (Ken Takagaki); (3) "The University Level Training Program of the Information Technology" (Phan Dinh Dieu); (4) "Using the World Wide Web in Education and Training" (James Kow Kim Song); Session 2--(5) "Multimedia Education" (Tran Van Hao, Ngo Huy Hoang); (6) "Educational Multimedia in a Networked Technology" (Antony Bates); (7) "Production of Interactive Multimedia Packages" (Tran Minh Phuong); (8) "Digital Signal Processing Applied in Multimedia" (Tran Cong Toai, Tran Hoang Buu, Dang Xuan Hieu); Session 3--(9) "Courseware Engineering" (Nguyen Thanh Son, Ngo Ngoc Bao Tran, Quan Thanh Tho, Nguyen Hong Lam); (10) "Machine Discovery Theorems in Geometry: A Helpful Tool in Teaching Geometry" (Hoang Kiem, Vu Thien Can); (11) "Model of Problems in Analytic Geometry and Automatically Solving" (Do Van Nhon); (12) "Heuristic Based Scheduling in High School" (Nguyen Duc Thang); (13) "A Model of Knowledge of Analytic Geometry" (Do Van Nhon); Session 4--(14) "Impacts of Information Technology in Education and Training" (Vuong Thanh Son); (15) "Management Changes in the Information Age" (Pattrick Tantribeau); (16) "Restructuring the University for Technology Change" (Antony Bates); (17) "Interactive Multimedia Technology Contributing in Solving the Problem of National Education" (Tran Ha Nam); (18) "Information Technology Will Transform the University" (Wm. A. Wulf); Session 5--(19) "Distance Education at University of Hawaii" (David Lassner); (20) "An Approach to Distance Education by Using Network Technology" (Dam Quang Hong Hai); (21) "About the Ways To Solve Shortage of IP Address" (Phan Cong Vinh); (22) "Introduction to a Very Large Database" (Do Hoang Cuong); Session 6--(23) "Knowledge Based Approach for English Vietnamese Machine Translation" (Hoang Kiem, Dinh Dien); (24) "A Learning Algorithm for Feature Selection Based on Genetic Algorithms Approach" (Nguyen Dinh Thuc, Le Hoai Bac); (25) "Artificial Neural Network

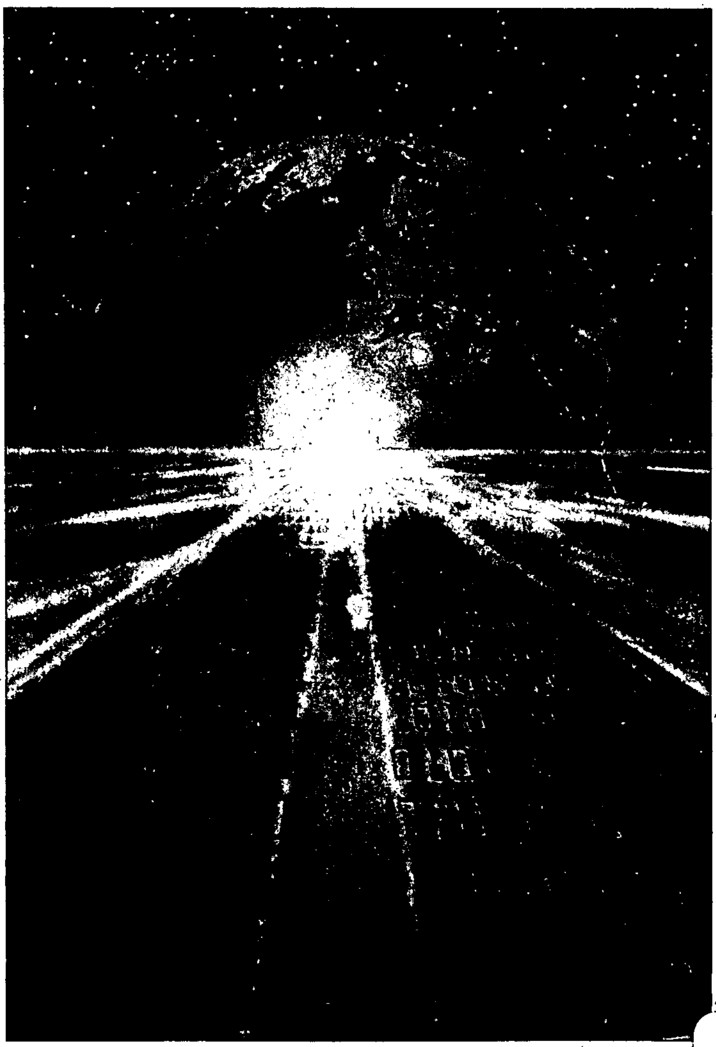
for Color Classification" (Tran Cong Toai); (26) "Synthesizing and Recognizing Vietnamese Speech" (Hoang Kiem, Nguyen Minh Triet, Vo Tuan Kiet, Luu Duc Hien, Bui Tien Leu); (27) "On-line Character Recognition" (Nguyen Thanh Phuong); (28) "Data Mining and Knowledge Acquisition from a Database" (Hoang Kiem, Do Phuc); and (29) "Genetic Algorithm for Initiative of Neural Networks" (Nguyen Dinh Thuc, Tan Quang Sang, Le Ha Thanh, Nguyen Thanh Son). (SWC)

IT@EDU98

INFORMATION TECHNOLOGY

IN

EDUCATION AND TRAINING



Ho Chi Minh City
15-1-1998 to 20-1-1998

PROCEEDINGS

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INFORMATION TECHNOLOGY
IN EDUCATION-TRAINING

January 15-16,1998
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SECRETARIAT

Do Phuc, Le Hoai Bac

PREFACE

IT@EDU98 conference is held in Ho Chi Minh City, Vietnam on January 15-16/1998 in the context of the explosion of Information Technology and the high demand of human resources for the industrialization, modernization of Vietnam. The main aim of the conference is to create a link between the Education and Industry into an action program for developing the Human Resources and Information Technology of Vietnam.

The IT@EDU98 received 30 papers from the Vietnamese and overseas professors, researchers, educators which are divided into 4 topics:

1. *Multimedia technology in Education- Training.*
2. *Educational software.*
3. *Computer-Network based training.*
4. *Machine Learning- Vietnamese based human and machine interface.*

These Proceedings contain all papers to be presented in the conference. We would like to express our thanks to all the speakers and sponsors for their contribution in the success of the conference and have great pleasure to introduce these Proceedings to the readers.

HCM City, January 14, 1998

The organization and program committee

IT@EDU98

SESSION 1

Thursday, 15 January 1998

Session 1: Keynote address

Chair:
Dr. Dong Thi Bich Thuy, University of Natural Sciences, HCMC, Vietnam

1-1. **Technology for learning: The present and future in the United States**
Dr. Thomas Owens, Carolyn Cohen, NWREL, USA

1-2. **Computer systems technology programs at the British Columbia Institute of Technology (Canada). A technology-based model for Information Technology**
Dr. Ken Takagaki, BCIT, Canada

1-3. **The University Level Training program of the Information Technology**
Prof. Phan Dinh Dieu, HNU, Vietnam

1-4. **Using the World Wide Web in Education and Training**
Mr.James Kows, Informatics College, Singapore

TECHNOLOGY FOR LEARNING:
The Present and Future in the United States

Thomas Owens, Carolyn Cohen
Northwest Regional Educational Laboratory, USA

"I suspect that we fail to recognize the real depth and breadth of the ongoing and potential impact of technological change on learning in America."

Participant Larry Frase, Research Director
Educational Testing Service

"Technology should be infused into curriculum so it is like a latte. It can't be just integrated; it has to become a whole different flavor and look with the coffee and milk inseparable."

Participant Cathy Parise, Technology Supervisor
Office of Superintendent of Public Instruction, state of Washington

On August 11, 1997, a group of 28 futurists from the Northwestern part of the United States congregated for a three-day meeting in Oregon. Ourpurpose was to learn from each other and to expand our thinking on the implications of technology for learning. Our group included business people, educational policymakers, teachers and administrators in the K-12 system, and representatives of higher education. This conference was sponsored by the Education and Work Program of the Northwest Regional Educational Laboratory (NWREL).

During the three days, we rotated through small and large discussion groups to address these questions:

- How do we learn? What strategies work best in teaching and learning?
- What are the current uses of technology in learning? What will they be in the next 30 years?
- What are the issues and opportunities in the use of technology for learning and teaching?
- How do we go about creating a preferred future for learners?

In this paper we focus on how technology is changing learning; the most promising opportunities as well as our concerns; and describe implications for the use of technology in improving educational outcomes. Input for this paper came from the collective thinking of the participants at the NWREL conference and experiences we have had regarding technology and learning over the past 20 or more years.

How Will Technology Change Learning?

"We always underestimate the long-term impact of new technologies. When radio first came out, they just read the newspaper to us on the radio; when television came out, the first shows were basically adapted radio shows," noted participant Neil Evans, Executive Director, Northwest Center for Emerging Technology. As a group, we tried to envision education outside the parameters of our current way of thinking. We talked about the learning implications of simulations, artificial intelligence, access to on-line experts, and distance learning. We also

noted that technology doesn't just mean computers, but also includes laboratory science equipment, video, and other media tools. We identified seven broad areas where we have already seen technology change education. We expect further evolutions in each of these areas.

1. **Use of technology is changing both student and teacher roles.** Students will take more responsibility for their own learning. The teacher will facilitate the learning process, rather than serving as the sole source of information. This step is critical in preparing students for the workplace, where they will need to be skilled in seeking out answers and solving problems. However, teachers will still need to be well-grounded in subject areas. Also, technology will provide more opportunities for individualized instruction, and allow students to learn at their own pace and in various locations.

2. **Students will access information in new ways.** Participant Myrtle Mitchell, dean at Seattle Central Community College, pointed out that use of information will, in many cases, supplant textbooks. She gave the example of information from the recent Mars exploration, which was beamed back every eight minutes and available to anyone with Internet access. Science information that is current will, of course, never be available in classroom textbooks. So, for certain areas, there will be more reliance on alternative ways of gathering information. Also, learners can access information without the constraints of time or place: there is no waiting for materials to be checked in or for the library to be open.

3. **More students, and those of all ages, will fully participate in the learning community.** We anticipate expanding opportunities for many students who have not been fully served by education systems. For example, a community college administrator related how deaf students can participate in courses and communicate with faculty without relying on signing and interpreters. Another example is that adult learners who are balancing work, school, and family will be able to use technologies such as distance learning to participate in courses at times convenient for them.

4. **Students will work together with their communities in new ways.** For example, students can collaborate on projects with students and/or faculty at other schools

anywhere in the world. They can also work with community members, such as the model piloted by the Hewlit-Packard company that allows employees to mentor students through on-line communication.

5. **Teachers will use technology to improve efficiency.** We have seen several examples of teachers using e-mail and the Internet to conduct assessment and tracking, communicate with students, and provide syllabi and resources, all on-line. Another benefit of this technology is that students can access some resources on their own that they are used to getting from teachers or counselors. For example, students seeking career guidance can get information on-line. One high school teacher noted that this capability is a significant improvement in his school where, because the school counselor/ student ratio is 400:1, students find it difficult to meet with their counselor. This teacher also cautioned that while teachers must use technology effectively as a tool, it does not replace the interpersonal connections that are critical to a learning experience, and does not replace the role of personal interaction at the K-12 level in developing young people as responsible citizens.

6. **Institutions of learning will restructure.** Technology provides schools with restructuring opportunities. In fact, the very idea of a "school building" may change. We expect to see "colleges without walls," and accreditation of on-line programs. In the near future, colleges may become the brokers of courses and teachers, reaching and competing for students regardless of boundaries. As one community college administrator said, "Our students will be the world." This restructuring would have a profound policy impact, particularly if the outcome is the demise of state-based or nation-based college boundaries. If that happens, colleges will need to employ new strategies to compete for students across the globe, and policy makers will need to rethink state financing of higher education.

7. **Schools will have new opportunities to serve parents and communities.** Large segments of the adult population who did not grow up using computers and other technology are eager for access and instruction. This provides an opportunity for schools to share equipment and instructional expertise with their community, and to provide family learning. For example, some schools have implemented programs that provide computer courses for parents and community members in the evenings, or weekend opportunities where families learn together. Others offer families on-line opportunities to access information about curriculum, homework assignments, and student progress. In a recent visit to one inner city high school in Seattle we talked with a Hispanic student who came to school early every morning to use the Internet to download the Spanish language newspaper to copy articles for his family to read that evening at home.

Challenges All of the opportunities cited above have multiple consequences. The NWREL conference participants were selected because of their interest and involvement in the world of education and technology. We see the use of technology as a powerful

learning tool, whose potential even the most technically knowledgeable of us may barely perceive. However, we did not all agree with each other on several issues. We debated where technology funding fits in as an educational priority, and some of us expressed other concerns that are described below. These concerns are not over the importance of using technology; they are, rather, issues that are raised by many educators and can be thoughtfully addressed by those concerned with education policy.

Equity Issues. For example, technology has the potential to provide an opportunity for more equal access to educational experiences, particularly for those who are educationally disadvantaged. At the same time, if access to technology is dependent on factors such as social class, the gulf between the "haves" and the "have nots" will increase. Appropriate use of technology to further educational outcomes. One community college faculty member warned, "Don't embrace technology just for its own sake. As with any instructional strategy, teachers must be clear about their learning objectives, and then evaluate whether, and which use of, technology enhances those objectives."

School funding priorities. Participants reviewed an article published in a recent copy of the Atlantic Monthly, "The Computer Delusion." The author raises concerns over expenditures on computers at the expense of other educationally sound programs and questions the learning outcomes of classroom computer use. In our discussions, concern was voiced over funding priorities in general, particularly regarding the decline in funding for art and music. Some noted that we know that art and music, which have been significantly cut in many public schools, have great developmental value if taught early. We don't know if the same is true for technology.

Faculty/staff support. Effective technology implementation requires significant staff support. Faculty and staff should be provided ample training, with home access to technology and time to learn. Such training has to be related to ways of improving curriculum and instruction and to the existing knowledge level of individual teachers.

Internet literacy training. Some participants were concerned over youth having access to pornography, violence, and other inappropriate materials. These participants were also concerned about the "garbage" and misinformation on the Web that is portrayed in very credible ways. Students at all grade levels will need to be taught specific skills in assessing and evaluating information.

Ethical issues/Student Privacy. Technological changes are occurring faster than our ability to think ethically about their consequences. Every day we read about new developments, such as the ability to clone, prolong or end life with medical equipment, and access others' personal health and financial records. These changes will be part of our students' lives, and they will be the ones making ethical decisions about how to develop and use these capabilities. As a result, we must keep our focus on the essentials of learning: critical thinking and problem solving, character development, and understanding one's rights and responsibilities as a citizen must be the building blocks of education. Some

participants voiced concerns that access to student data be safeguarded, and privacy maintained.

Developing Our Preferred Future. Schools face many complicated issues when determining how best to infuse technology into education. Several participants noted that we need more solid research on where technology is best used. We need information on how using technology for learning affects the development of cognitive strategies. We want to maintain the fundamental principles of education, which one participant defined as "civility, intelligence, and humanness, and another added "creativity, and passion." We want to see technology as a tool, but not necessarily as its own subject. For example, we would expect spreadsheets to be incorporated appropriately into existing coursework, rather than a class taught in using spreadsheets. Implications for Education and Training . The issues raised and debated in this NWREL conference are of concern to the education and business communities across the country (and perhaps the world). As evidence, nearly all of the challenges we identified are also noted in the recent publication Plugging In: Choosing and Using Educational Technology, published by the Council for Educational Development and Research of the North Central Regional Educational Laboratory. This document identifies the need for equity of access for all students and all schools; teacher support and professional development; high standards for student achievement; new solutions in school finance; integration of technology curriculum with other subjects particularly school-to-work; and working in partnership with the parent community. A few of the implications are listed below: How do we build on existing and develop new education-business partnerships so that we can work together to bring the best learning opportunities to our students, workers, and citizens? Many states in the United States are emphasizing comprehensive school reform efforts including statewide standards setting, testing, and evaluation. How will we incorporate technological literacy into these standards? How will we use technology to improve learning for all? As more and more schools are using technology in their classrooms, we need to find ways to identify best practices in infusing technology into education and disseminate such practices worldwide. Staff development is a key in using technology effectively in our classrooms. We found teachers in many schools encountered similar problems in use of technology in classrooms. There need exists to proved, through existing or new technologies, staff development which are accessible to more teachers, particularly those in remote or rural areas.

Access to technology increases the volume and flow of information. Our students, teachers and business members are often inundated with information. To help people use critical thinking skills to make a sound judgment based on relevant information will remain a challenge to all of us.

COMPUTER SYSTEMS TECHNOLOGY PROGRAMS AT THE BRITISH COLUMBIA INSTITUTE OF TECHNOLOGY (CANADA) A TECHNOLOGY-BASED MODEL FOR INFORMATION TECHNOLOGY TRAINING

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Abstract

The High Technology and Software sectors in British Columbia are among the fastest growing in the provincial economy and must be supported by an effective educational and training system in order to maintain and increase their presence in the global IT economy. The current system in B.C. consists of three major components: traditional degree programs in Computer Science offered by the universities, two-year diploma programs in Computing Technology offered through regional community colleges, and the diploma and technology degree programs offered by the British Columbia Institute of Technology (BCIT). Graduates of the two-year Diploma programs are well accepted by high technology employers and in some cases, even preferred to graduates from traditional degree programs. BCIT pioneered many of the concepts underlying the Diploma and Technology Degree models. This paper describes some of these underlying concepts and how they result in distinct and viable job entry and career advancement credentials. The paper concludes with some comments how these programs are expected to evolve in order to keep pace with the rapid changes in technology faced by this industry.

Introduction

The High Technology sector in British Columbia is one of the fastest growing in the province and a focus of increasing interest for government economic policy and private investment. In 1995, the last year for which complete statistics have been gathered [1], this sector earned in excess of CDN $5.1 billion with an annual growth of well over 30% compared to a 5% overall growth in the British Columbia Gross Domestic Product. There are some 5,500 high technology companies in the province and this number is steadily growing by about 10% per year. In 1995, direct employment in this sector was about 41,000 workers in 1995 with a growth rate of 20-25% per year. By comparison, the total provincial workforce grew 4% during this period. In addition, there are significant numbers of programmers, systems analysts and other Information Technology-related staff employed by firms in the other industry sectors of the province. With respect to employment related specifically to Software Technology, there are approximately 21,000

software workers and professionals in B.C. [2] most of whom are trained at the post-secondary level in computer science, programming and software engineering.

The B.C. software industry is now participating in the global high technology economy and the rapid growth in this sector has created enormous opportunities. As in many other parts of the world, however, B.C. also faces a chronic shortage of qualified software technology workers. Recent estimates suggest that in 1996, 5-7% of the required software positions in B.C. remain unfilled [2], thus hampering the potential growth in this industry sector. Thus, the province is faced with some major challenges in supplying a well-trained, highly motivated, and effective workforce to ensure the ongoing success and well being of its software industry.

Over the years, British Columbia has been evolving a sophisticated and effective public educational system to support this industry sector with world class human resources and to provide opportunities for the many thousands of men and women interested in seeking careers in the software industry. Through provincial legislation, this system is divided into three major components: (1) the *Universities* offering Bachelor, Masters and Ph.D. programs in Computer Science; (2) regional *Community* or *University Colleges* offering two year Diploma and one year Certificate programs; and (3) the *Institutes*, specifically the *British Columbia Institute of Technology* offering Bachelor of Technology, Diploma and Certificate programs.

Altogether, this system delivers annually some 600-700 graduates with the appropriate post-secondary training necessary (i.e. at degree or diploma levels) to effectively enter this industry [Table 1]. Graduates from two-year Diploma programs are well accepted by the B.C. high technology and software industry and, in some cases, preferred to more traditional four-year degree programs. The B.C. Institute of Technology (BCIT) originally pioneered the concept of the two-year Diploma program in Computer Technology as a distinct and viable alternative to university degree programs for both employers and for students seeking training options. More recently, BCIT also pioneered the concept of the technology degree, the *Bachelor of Technology*, which effectively builds upon Diploma programs and offers professional development and career advancement opportunities to IT practitioners.

	Graduates (1995/96)
Degree Programs	294
Diploma Programs	298
Certificate and Others	101

Table 1. Graduates from Job Entry level programs [3]
(Undergraduate degree and diploma programs)

BCIT – A Technology-Based Training Institute

1. The B.C. Institute of Technology

BCIT is a publicly supported post-secondary Institute established by provincial legislation to provide technological training programs to support the industry sectors important to the B.C. economy [4]. As such, BCIT offers one year (or less) Certificate Level, 2 year Diploma Level, and 4 year Bachelor level programs related to Business, Engineering and Health. In addition, BCIT has mandates to pursue applied research and to facilitate and encourage entrepreneurial activities. BCIT also has one of the largest Part Time Studies and Continuing Education programs in the province with courses and programs designed specially for individuals already working in industry and wishing to upgrade and advance their careers.

BCIT is located over several campuses including the main campus in Burnaby B.C., a campus in downtown Vancouver, an Airport Campus, and the Pacific Marine Campus in North Vancouver.

2. School of Computing and Information Technology

BCIT has established a School of Computing and Information Technology offering a variety of programs in Computer Programming, Systems Analysis and Software Development. The School is composed of three major program areas: Diploma Programs, Continuing Education and Professional Programs, and the Bachelor of Technology Program.

The Diploma programs are two-year programs with a total enrolment of 400 students per year, 200 in 1st Year and 200 in 2nd Year. These are designed as *job entry* programs into the Computing industry. The majority of applicants to the program are individuals from the workforce who are seeking a major career change. The remaining are equally divided into direct applicants from the High School system and applicants with degrees or other post-secondary credentials seeking entry into the computing field.

The Continuing Education and Professional programs provide training to over 6,000 students per year in over 500 different courses, mainly to individuals who are already working and wish to enhance their existing skills or advance their careers. The level of this training ranges widely, from introductory courses in computer literacy to very advanced and highly specialized and technical topics. Often, these courses can be packaged as specialized Certificate programs in focused areas such as Office Automation, Network Administration, or Internet Support.

The Bachelor of Technology program provides advanced, degree level training to students who already possess a job entry qualification such as the 2 year Diploma or in some cases, a conventional university degree. This program is designed specifically to meet the needs of individuals already employed in the IT industry and is offered primarily

in evenings, weekends or in other formats which provides full-time employees access to this type of ongoing education.

In addition, the School offers many professional seminars, short programs, customized training and other products as the demand arises.

Curriculum Design

The overall curriculum design for the *Computer Systems Technology (CST)* Diploma program is shown in Table 2 and the *Bachelor of Computer Systems Technology* Degree program in Table 3.

1. Diploma Program

	Term 1	Term 2	Term 3	Term 4
Communication Skills	• Technical Writing & Speaking	• Technical Writing & Speaking		
Mathematics	• Applied & Discrete Math	• Statistics	• Decision Systems	
Business	• Economics • Accounting	• Marketing • Accounting	• Org Behavior	• Computer Law
Programming	• Programming Methodology • C Language	• Visual Programming • C++/JAVA	• Advanced C++/JAVA	• O-O Design
Systems	• Computer Applications	• Systems Analysis & Design		• Software Engineering & CASE
Technical		• Computer Architecture	• Data Base • Data Comm	• Advanced Op Sys
Project Work			• Industry project	• Industry project
Specialization			• 2 Specialty Courses	• 2 Specialty Courses

Table 2. Two-Year CST Diploma Program – Curriculum Map

As can be seen from the Curriculum Map, all students receive courses in the three foundation areas: Communication Skills, Mathematics and Business. This provides students with basic employability and business context skills. All students are required to take Programming, Systems and Technical courses to an advanced level. Industry projects

are also required of all students in their third and fourth terms. These projects are sponsored by local firms and organizations and are considered a major "capstone" experience for the students.

A unique feature of the BCIT CST Diploma program is the ability for students to major in one of several specializations, each of which are targeted to a specific market segment. These specialties will vary according to trends in industry. Currently, these specializations include:

- Applied Artificial Intelligence (Expert Systems)
- Data Communications & Networking
- Data Base
- Technical Programming
- Client-Server Systems
- Multi-Media Software Development
- Management Information Systems.

Students take the equivalent of 4 courses in their specialization area.

The program puts a heavy emphasis on teamwork, communications and other employability skills. While much of the curriculum is delivered by conventional lectures, lab assignments, and examinations, a very substantial percentage of the students' learning, often 50% or more, is based upon group projects and teamwork activity. The curriculum also provides many opportunities to interact with industry and potential users through industry sponsored projects, guest lectures, and special arrangements with numerous vendors and suppliers of hardware and software.

Altogether, graduates of the BCIT Diploma program receive a total of about 2400 hours of in-class instruction during their studies or about 1200 hours per year. This can be compared to the 450 to 750 hours of classroom instruction per year found in typical undergraduate university programs. This is accomplished by an extended school year (average 17 weeks per term) and 7 hours of classes over 5 days each week. There are no general education or liberal arts requirements and students are able to focus solely on curriculum related to employability in the IT industry.

2. Bachelor of Technology

The Bachelor of Technology is a practitioner-oriented degree program specifically designed for the career enhancement and professional development of individuals already working in the software industry. As such, the prerequisite to the program is the BCIT CST Diploma or its equivalent, as well as two years of relevant work experience.

As can be seen from Table 3, the curriculum is structured into four major components: core courses, technical courses, a formal practicum, and a liberal education requirement.

The core courses are designed to give students exposure to advanced issues in the management and technology relevant to intermediate and senior IT practitioners. These courses are also designed to help develop the management maturity and critical thinking skills of students.

The technical courses are designed to permit substantial depth in an area of the student's choice.

The practicum is a project or other activity, preferably in a workplace setting that involves applied research or technology transfer and produces an outcome that is innovative, experimental or exploratory in nature. A formal process for project proposal, defining formal deliverables, and presenting the final report is required. The practicum is supervised and reviewed by a formal review committee consisting of academics and industry representatives. In most cases, the practicum emanates from a major project or assignment in the student's workplace.

The liberal education component requires courses in Arts, Social Sciences, History, Language Studies or other areas unrelated to the computing field. This constitutes the breadth component of the degree.

As indicated in the Curriculum Map, the degree requires 60 credits of work. Most courses in the degree program are offered in evenings and weekends, making them accessible to working professionals with full-time jobs. Candidates have considerably flexibility in how they progress through the program but are required to maintain a minimum load of 3 courses per year. All candidates are required to complete the program within 6 years.

Degree Component	Admission to Program	Level 1	Level 2	Before Graduation
Prerequisite	BCIT CST Diploma or equivalent			
Work Experience	2 years related experience			
Core Courses (15 Credits)		• Management issues in IT • Technical issues in IT • Applied Research Methods • Advanced Management Electives		

Advanced Technical Specialties (15 Credits)			• Data Base • Data Comm • Computer Graphics • AI • Electives	
Practicum (18 Credits)			• Major formal practicum	
Liberal Education (12 Credits)				• 12 University Credits in approved courses

Table 3. CST Bachelor of Technology– Curriculum Map

Non-Curriculum

1. Faculty

The minimum standard for regularized faculty is Master's degree in Computing Science or related field and 5 years significant industry experience. Since these programs are heavily career-oriented, faculty are expected to maintain industry currency and professional contacts within the profession.

2. Facilities

These programs are supported by a variety of hardware and software resources. They include an IBM mainframe, SUN and SGI UNIX systems, and some 30-40 networked PC labs under Novell and Windows NT.

3. Advisory Committee and Industry & Academic Liaison

Both the Diploma and Degree programs are supported by an Advisory Committee consisting of senior managers, executives, and officials representing different industry segments including large corporations, major consulting firms, high technology companies, independent software developers, and academics. In addition, faculty and student involvement with local, provincial, national and international industry and professional organizations are encouraged. The programs are, where appropriate, accredited by relevant industry accrediting bodies (in Canada, this is the *Canadian Information Processing Society*).

4. Student Recruitment & Job Placement

While the B.C. post-secondary system allows open access to all qualified applicants, every effort made to ensure candidates make appropriate career choices and are highly motivated to complete the program. There is a heavy emphasis on student

recruitment activities such as detailed orientation sessions for applicants, aptitude testing, and career counseling.

Graduates from this program have traditionally shown excellent job placement rates. Follow-up surveys indicate that around 95% of graduates from the Diploma find employment within 3 months of graduation.

5. Applied Research

Teaching faculty do not have a research requirement as part of their duties. However, opportunities for conducting applied research are available through a separate department at BCIT, the Technology Centre, that has the mandate for applied research. A special research division, the Applied Research in Computer Systems (ARCS) Laboratory specializes in computing and IT applied research projects.

Summary

Table 4 attempts to summarize some possible differences between the BCIT and typical Computer Science degree programs. It is difficult to generalize, however, since there is much variation between the Computer Science undergraduate degree programs offered through difference universities.

Program Component	BCIT Approach	Computer Science Degree Approach
Employability	• Team work skills • Technical Writing, Speaking and Communications skills • Industry related Project experience required for graduation	• Some universities offer Co-Op programs
Overall Curriculum	• Two step credentials (Diploma for job entry, Degree for Career Enhancement) • No liberal arts or general education requirement in Diploma programs, graduation requirement for Degree • Applied mathematics only (Discrete Math foundations, Statistics, Decision Systems) • Formalisms only as required	• One step credential • Liberal art and general education typically satisfied early in program • Emphasis on mathematics topics • Formalisms often required in program
Domain Knowledge	• Business foundations (Accounting, Marketing,	• Normally not part of typical CS degrees (except for

	Economics, Organizational Behaviour, Computer Law)	combined CS/Commerce degrees)
Programming	• Exclusive use of industry standard languages, otherwise similar to University programs	• Teaching languages are often used
Systems	• Emphasis on industry practice, especially practical issues (user interfacing, interview techniques, expectations management, end-user training, etc)	• Often more emphasis on Software Engineering and formal techniques
Technical Topics	• Heavy emphasis on applications and industry-specific products, otherwise similar to University Programs	• Less emphasis on product-specific applications

Table 4 : BCIT and Computer Science Curricula

It is usually acknowledged that the BCIT programs are specifically designed for employment into the workforce or for upgrading the skills of workers already employed in the industry. Unlike Computer Science programs, the curriculum has no provisions for leading to careers in academic research or typical graduate programs in Computer Science. The BCIT curriculum contains less mathematics and formal theory. On the other hand, it puts significantly more stress on employability skills, product-specific knowledge and practical issues (e.g. interfacing with users and managing user expectations).

Future Issues

As a primarily practitioner-oriented training and educational organization, the School of Computing and Information Technology puts a premium on its ability to respond quickly and effectively to technology trends and new product releases. Major curriculum changes in the diploma program have been implemented in as little as three months or less through an on-going and continuous curriculum review process. In the future, mid-term and "on-the-fly" response cycles of as little as 2-3 weeks to rapid changes in technology may be needed.

Trend	Planned Response	Examples
Increasing consumerization and diversity in the IT sector. Demand for more cross-trained and multi-skilled individuals. Skills gaps in project management, marketing & distribution,	Wide diversity in programming, including new specializations, cross-disciplinary programs, and partnerships with other private and public organizations	• Joint CST/Marketing Diploma • Joint CST/EE Diploma • Collaborative Multi-Media Diploma with Emily Carr (BC Art Institute) • New specializations e.g.

and leadership.		Games programming Internet
Shortage of qualified IT workers – short term	Encourage increased support in this industry sector from government. Seek alternatives to public funding. Explore alternate training formats as well as mentorship, job incubation, and work experience programs	• Cost-recovery programs in specific areas as specified by industry (e.g. Microsoft and Novell) • More short certificate programs in specific areas (e.g. LAN Admin, Windows NT support, etc) • Student projects under paid work conditions
Shortage of qualified IT workers – longer term	Provide special programs and improved access to new and under-represented learner groups	• Special programs for women, immigrants, and talented high school graduates • Provide special cross-training programs for individuals qualified in other fields (business, engineering, health) • Formally recognize prior training and work experience toward credentials

Table 5. Future Trends and Responses

In the near term, the School has identified a number of overall trends and developed some possible responses to these trends. A brief summary of these is presented in Table 5. The School also constantly monitors industry change, both through its own industry and market surveys and by reference to government and industry surveys and statistics.

Trend	Planned Response	Examples
Growing importance of industry specific credentials for job entry and career development (e.g. Microsoft and Novell certificates)	Curriculum designs permitting the co-existence of private and traditional academic credentials. Articulation, bridging	• Cost-recovery programs in specific areas as specified by industry (e.g. Microsoft and Novell) • Embed private credential opportunities within Diploma

	and laddering among the two sets of credentials:	and Degree programs • Recognize private credentials as prerequisites to programs or equivalents to conventional courses
Internationalization of IT industry	Develop international oriented programs	• Pacific Rim Computing Diploma/Degree • NAFTA Computing Diploma/Degree • Programs designed for immigrants to Canada • Articulation, exchanges and other collaborations with foreign universities
Growing complexity and specialization of IT industry	Increased use of Educational Technology and Internet-based resources. Increase resources for competency *assessment* (relative to conventional curriculum *delivery*)	• Web-based curriculum support • Computer-Based Training • Use of vendor-supplied tutorials and training materials

Table 5. Future Trends and Responses – cont'd

Table 6 summarizes some specific generally acknowledged issues, technology needs and skills gaps which are factored into the program design of the School [2]. Speaking very broadly, the following overall factors are likely to heavily influence the directions of future programs.

Increased consumerization and diversification of the IT industry. As this industry evolves and matures, it will demand increasingly more diverse skill sets, talents and aptitudes within its workforce. This is both a challenge to academic institutions and an opportunity for many new learner groups to enter and benefit from employment in this industry.

Critical skill gaps in <u>both</u> technical and non-technical areas. These include skills shortages in project management, marketing and distribution, leadership and administration. There is increasing attention to the concept that software development is very labour intensive and that the optimization of human resources is a necessity. Thus, the balance between technical and non-technical components is a significant challenge in human resource planning for this industry,

Worldwide worker shortages in IT. The skills and worker shortages in this industry have been widely documented. In British Columbia, however, as in many other parts of Canada and the U.S., public funding for post-secondary education is not keeping pace with the training need. In addition, academic institutions are also suffering from a shortage of qualified faculty to teach and conduct research programs. In the long term, there is also a need to encourage more individuals with the right talents and abilities to enter this field. Finding alternatives to both the short-term and the long-term skill shortage problem will remain a challenge for the foreseeable future.

Rapid change and growing complexity/ specialization in the IT industry. The growing complexity and rapid change of this industry makes it increasingly difficult for any one department, school or institution to fulfill the market demand. Conventional curriculum change processes cannot keep pace with much of this technological change. Alternatives to traditional curriculum delivery, program planning, and credentialling need to be considered in order to meet these challenges.

Global nature of IT industry. The software industry in B.C. and in most other parts of the world is global in nature. Markets are worldwide and software workers are highly mobile. Increasingly, therefore, training programs for this industry must look beyond local conditions and factor in considerations that are more global and international in scope.

Category	Issues and Concerns
Top 4 Industry Concerns	1. Recruiting quality people 2. Customer satisfaction 3. Delivery schedules 4. Managing growth
Top 3 Software Development Problems	1. Schedule overruns 2. Shortage of skilled staff 3. Poorly defined requirements
Top 4 Technology Change Concerns	1. Internet and information publishing 2. Development tools and languages 3. Client/server & distributed computing 4. Desktop operating systems
Top Software Industry Needs (1996)	1. Written/Verbal Communications 2. C++ 3. NS Windows NT 4. Technical Leadership 5. Team skills

Top Skills Gaps	1. Technical leadership 2. Domain knowledge 3. Object-oriented methods 4. C++ 5. MS Windows NT

Table 6. Technology Needs and Skills Gaps

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[2] "Technology and Skills Gap Analysis: B.C. Software Industry", Software Productivity Centre, 1997. (www.spc.ca)

[3] British Columbia Ministry of Education, Skills and Training; Universities, Colleges and Institutes Branch

[4] British Columbia Institute of Technology. (www.bcit.bc.ca)

Biography

Ken Takagaki

Ken Takagaki is Dean of the School of Computing and Information Technology at the British Columbia Institute of Technology (Canada). Dr. Takagaki received his Ph.D. in Information Systems from the University of British Columbia and has 25 years of experience in the Computing, Software Development and IT industries, both in private industry and the academic sector. He is a member of the Canadian Information Processing Society (CIPS), ACM, and IEEE Computer Society and is also a licensed Certified Accountant. He ~~has been~~ a director of the boards of Software B.C. and the Technology Industries Association of B.C. (TIA-BC), chair of the B.C. Computers in Education Council (BCCEC), and chair of the CIPS National College Accreditation Council. He has been involved in numerous IT related activities for both industry and public sector organizations, including the B.C. Science Council, TIA-BC, CIPS and most recently, the Minister's Task Force on the B.C. Software Industry Skills Shortage.

In his current position, Dr. Takagaki is responsible for the development and delivery of Computing and IT programs at the B.C. Institute of Technology. He has been directly responsible for the development of the Bachelor of Technology (Computer Systems) degree and the Diploma programs in Multi-Media, Technical Programming, Data Communications, Data Base and Client/Server.

USING THE WORLD WIDE WEB IN EDUCATION AND TRAINING

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Introduction

Distance learning is not a new subject, but it recently has come in vogue again. With the advent of new educational and training technologies and the need to meet the needs of students in a fast-paced world, distance learning is becoming a necessity. In its best sense, it can help educate more people anywhere at any time.

Distance learning is a challenge, for those who create the programs and those who participate in them. It offers us the potential to provide ongoing education to more people, but is also requires us carefully to evaluate our instructional methods and the technologies to establish communication among learners and educators/trainers.

Distance learning can be much more than this simple definition indicates. It can involve the use of new technologies, innovative materials, and interactive instructional methods. It can reach people of all ages and abilities who might otherwise find it difficult to further their education or get the training they need. It can help students realize the importance of lifelong education, whether for personal interest or career preparation and enhancement. Distance learning is not a panacea for all educational or training ills, but it does offer additional possibilities for educating and training more people than can be easily and efficiently accommodated in more traditional settings, such as in-house corporate training programs, public schools, and universities. In the broadest sense, distance learning can be very private or it can be highly formalized.

The Internet and the World Wide Web

With the constantly increasing popularity of the internet, distance learning has taken on new meaning. The Internet is an international network that links one computer to another. Unlike a LAN, the Internet is a wide area network (WAN), one so large that virtually any computer anywhere in the world can be linked to others.

Once learners have subscribed to, or signed up for, an Internet provider, they gain access to the educational materials and services designed for the Internet and World Wide Web (WWW), E-mail, or electronic mail, allows one person to write messages to an individual or a group; this tool can be used to update the "correspondence" part of the correspondence courses. Electronic bulletin boards and mailing lists link individuals to

more information and other people interested in similar topics. Online chat rooms promote discussions. Very simply, primarily written communication tools can enhance distance learning programs.

Perhaps the most exciting part of the Internet is its multimedia and hypertext capabilities. The Web provides information in many different formats. Of course, text is still a popular way to transmit information, but the Web also presents information in sound bites, such as music, voice, or special effects. Graphics may be still photographs, drawings, cartoons, diagrams, tables or other artwork, but they also may be moving, such as animation or video.

Because of the interactive, multimedia capabilities of the Internet, and especially the Web, distance learning is gaining popularity with new groups of learners, educators, and trainers. Educational and training materials can be stored on a Web site so that learners anywhere have access to the information at any time. There is a greater potential for sharing information through the Internet than through other means of transmitting and receiving information.

When the Internet is used in distance learning courses, learners can also gain that personal touch by sending e-mail messages to their instructor or to other learners. Chat rooms and mailing lists can connect groups of learners to discuss a topic and share ideas. Assignments can be sent electronically instead through the mail and feedback can be provided more quickly. Materials from learners can be added to the Web site to share with others taking the same course and new information can be added quickly to the Web site.

Internet-based education overcomes the stumbling blocks of time and distance. The internet is opening new ways of studying, allowing schools to become "virtual universities". It gives student remote access to research and study materials. Online education holds an irresistible appeal on three fronts: convenience, encourages active learning, access to wide cultural and knowledge base of faculty and students. Interacting with virtual classmates and lecturers in remote locations with different time zones, forces one to be creative and thoughtful. Students assert that taking part in an Internet-based course program engenders a higher set of skills, particularly the ability to communicate and respond in real-time.

Informatics1

Informatics through its team of R & D professionals began exploring the use of the Internet to enable group-based reporting, discussion, workshops and dissemination of course materials. The company is currently developing its Internet Online Services titled *Informatics1* for students and to provide learning accessible anytime and anywhere. It will be an innovative approach that provides distance learning programs to the growing audio-visual presentation industry - it effectively overcomes the limitations of time and travel. Moreover it will keep students' attention to this dynamic learning environment.

Informatics1 is a world class Cyber Campus of tremendous magnitude. It consists of various state-of-the-art components such as video conferencing, automated online test, mock exams, resources, chat-rooms for group discussions and others that provide a true interactive environment for users as well as for our students.

Because today's students often have full-time jobs while pursuing professional and personal development, working and learning are no longer mutually exclusive activities; *Informatics1* incorporates the richness of group learning with the flexibility support individual learning, all enabled by collaborative technologies. It is an unique approach that allows new and rich forms of education to be offered by corporations and higher education institutions to a diverse and distributed population of learners. Distributed learning uniquely responds to the needs of these learners for flexible, collaborative learning which can be accessed anytime and anywhere through distance learning.

Changes in technology have spawned new ways of working, new business processes, and new ways of delivering education. Within the context of rapid technological change, training and education is seen as an ongoing necessity, enabling workers to remain current with required skills and knowledge.

A number of underlying social, economic and technological forces are coming together to drive demand for continuing education and training.

While individuals are motivated to learn from personal and professional development, the logistics of attending classroom education are increasingly difficult to manage. To respond to this situation, Informatics are looking to:

- Increase the speed, flexibility and reach of training and education
- Reduce costs associated with offering classroom training as the only delivery vehicle.
- Leverage instructors' expertise to a broader population of participants.
- Leverage team learning and collaboration for performance and productivity.

The growing market for continuing education and the market conditions described above have fueled the growth of "distance learning" options. These new modes of learning are designed to meet the demand for continuing education while providing a range of flexible delivery choices.

To stretch dollars, Informatics is turning to technology for assistance in distributing more flexible educational experiences. Technology can deliver learning experiences directly to learners desks or workstations, eliminating travel and related expenses. Learning becomes available when as learners need it, not merely when it is scheduled.

The cost of technology has at times prohibited widespread use of distance learning, but recent reductions in the cost of hardware and software have lowered that barrier. The huge growth in the installed base of networked and inter-networked computers presents an

opportunity now to create an electronic environment for learning any time and any place by Informatics.

Creating a Virtual Classroom within *Informatics1*

A virtual classroom should not be much different from a real classroom or training room. An effective classroom does the following:

- It provides the tools that learners need when they need them. If it's not possible to have all the tools in the classroom, an effective educator/trainer explains where the tools can be easily located.
- It creates an expectation for and an environment conductive to learning.
- It brings together educators/trainers and learners to share information and exchange ideas.
- It allows learners the freedom to experiment, test their knowledge, practice completing tasks, and apply what they've discussed or read about.
- It provides mechanisms for evaluating performance.
- It provides a safe haven in which learning can take place.

Providing Tools for Learners

The virtual classroom must contain the tools needed for the course and the ability to receive and send information among learners and educators/trainers. For example, if learners will read documents, the documents should be accessed online from the Web site. If learners need additional documents that can't be placed online within the course's Web site, educators/trainers must provide links to other sites where the information is stored.

Taking a distance learning course in Iformatics1 which involves a teleconference, any materials referenced during the teleconference should have send to learners seeing the teleconference from another site. The teleconference room itself must be equipped with the necessary technology to make sure that all learners, whether in a remote location or at the originating site of the teleconference, can receive all the information.

Creating an Expectation for Learning

Distance learning courses can be as difficult, important, and effective as in-person classes or training sessions. But to receive the same status as in-person courses, distance learning classrooms like those found in *Informatics1* must create within learners and educators/trainers the same expectation that learning will occur and that the course is serious business. "Serious" doesn't mean dull or uninteresting; it does mean that learners will complete the course work and meet their responsibilities with the same intensity that they would in a regular classroom. Educators/trainers treat the distance learning course with the same amount of preparation and treat individual learners with the same degree of courtesy and interest that they would in a regular classroom.

Setting course objectives, explaining the purpose and design of the course, developing high-quality materials, and making sure that learners and educators/trainers can communicate with each other at certain points in the course are important ways of creating an expectation for learning.

Bringing Together Learners and Educators/Trainers

Learners and educators/trainers may seldom (or never)see each other during the course; they may never have the opportunity to meet in person. Nevertheless, an effective classroom is the place where learners and educators/trainers create a community of sharing. Writing e-mail messages back and forth can establish a personal link among participants in a course, as can participation in a mailing list, a newsgroup, pr a multiple-user domain (MUD). Through a teleconference or a desktop video conference, participants can see and/or hear and/or speak with each other, to create a more personal form of communication.

When educators/trainers use more than one medium to create a virtual classroom, the sense of community among learner and instructors is enhanced. The more ways to communicate with each other and develop a sense of the people behind the programs, the more personal the education or training.

Creating the Space for Experimentation and Application

Education and training involve more than listening to someone talk about subject or reading and discussing materials. Theoretical background is important, but so is application. In effective classrooms, learners have the opportunity to apply what they learn. In a regular classroom, they may complete workshop activities, conduct an experiment in a lab, demonstrate the correct way to complete a task, or make a group presentation to express their ideas.

The virtual classroom should be designed to allow learners similar types of practice and sharing activities. For example, a teleconference or a desktop video conference can be used for group or individual) speeches and presentations. An online simulation, with appropriately designed feedback for acceptable and incorrect actions or choices, can allow participants to act out what they've learned, role play, conduct an experiment, or complete a task.

Virtual classrooms should provide activities as well as referential information. They should help learners develop both skills and knowledge appropriate to the course.

Evaluating Performance

In addition to the immediate feedback provided through simulations, for example, other ways of evaluating learners' performance should be built into the course. The classroom environment within *Informatics1* include sites where learners can ask questions and receive answers, take practice or real examination and receive comments about the accuracy of their responses, and otherwise measure how well learners are doing. Some forms of feedback can be very personal; educators/trainers may write e-mail messages,

add comments to assignments and return them to learner, discuss performance on the phone or during a teleconference or video conference, and so on. Whatever evaluation methods are included in the course design, learners should always have an objective measure of their progress.

Creating a Safe Haven

Learners need the freedom to experiment, to make incorrect assumptions and choices, to success and showcase what they've learned, and to interact with others, free of anxiety. An effect classroom is the place where learners feel free to express themselves in appropriate ways, to take risks so that they can learn more, to share their ideas, and to ask questions. The virtual classroom can provide the safe haven for learners to interact with each other and take the risks they need to learn more. It should allow them the opportunity to question instructors and other learners, and to test their ideas and skills in non-threatening ways.

Educators/trainers who develop a virtual classroom can create a "safe" atmosphere in several ways. They can establish protocols for using the technology (e.g. providing equal access to resources, ensuring that no one can tamper with another learner's or the educators'/trainers' materials) and for communicating with each other. Through their instructional materials, educators/trainers can encourage questions and comments. Creating a safe haven involves establishing and maintaining professionalism among all the course's participants and valuing the contributions of each member of the virtual class.

Who participants in distance learning through *Informatics1*?

Participants in distance learning through Informatics include the people who create and disseminate the learning materials and the students.

Distance learning is even more important today, when society is changing rapidly. Students need to meet ongoing needs for education and training. As society becomes technologically more sophisticated, the knowledge base changes; what is considered a "well-rounded education" changes with and expanded knowledge base.

Learners who take distance learning courses

Adults whose work and personal schedules don't permit them to attend classes scheduled by a university in their area can take distance learning courses offered within *Informatics1* at their convenience. Adults or youth who suffer from a temporary or permanent illness or condition that prevents them from participating in other types of education programs can receive similar instruction at home or in another setting. People with different abilities, which may make it difficult to participate at the same pace or in the same way as other students in a classroom, may participate fully by using specially designed materials that enhance their learning. In short, distance learning can be an effective method of education or training. In short, distance learning can be an effective method of education and training for almost everyone. It promotes the sharing of

information and experiences, so that people who design and provide the materials and the people who use them can learn from each other.

What are the benefits of distance learning on *Informatics1*?

Learn at their own pace

Learners can take a course during a traditional term or training sessions, or they can take their time to complete learning activities. They can go over materials many times or proceed quickly and use materials during the day, after work, during breaks, in the middle of the night, or at regularly scheduled intervals- whenever is convenient for them and the provider of the information. They can learn during predetermined time segments (such as an hour-long discussion or a 15-minute teleconference) or participate for as long or as little as they need, for as many times as is appropriate for them to gather information or master a skill or concept.

Learn in a Convenient Location

Depending upon the medium or media being used to provide materials or experiences, distance learning can take place in many convenient locations. Learners at home or at work can access *Informatics1* web-based information. This form of distance learning media helps to ensure that people who want to take a course can take one conveniently, wherever they are located. Because distance learning spans many technologies that can reach virtually nearly everyone in the world, learners may find that anyplace can be a learning environment.

Participate in the programs of universities, colleges and other groups that offer high-quality programs without having to relocate.

Within each discipline or profession, some institutions are noted for their high-quality training or educational programs. Participating in high-quality, specialized programs through distance learning can enhance learners' professional standing and provide them with exactly the type of training or education they'll need on the job.

Learners who want to "attend" an university whose name is instantly recognized as a prestigious institution now can take at least some courses without having to relocate near the institution. For example, learners who want to take a course from University of Leicester may be able to participate through courses offered on *Informatics1*.

Learn according to learners' preference mode of learning

Everyone has a learning preference. Some people are active learners, while others are more passive. One benefit of *Informatics1* is the variety of materials available to meet everyone's learning preference.

Some people are hands-on learners, who learn best by doing, Hands-on learners might prefer using online, CD, or interactive video simulations of tasks they'll need to complete later. Virtual reality may be a big part of their educational experience.

Some people learn best by discussing their ideas with peers, to sort through the information and get feedback from other people. Discussion (chat-rooms) and news group probably will be preferred by learners who need to discuss their ideas or findings within a group. These learners might enjoy e-mail, as well as teleconferences or inactive broadcasts over the Internet, to help discuss materials with others.

Other, more traditional learners may prefer lecture and notetaking methods for learning. They may prefer to read and think about material before applying it, and prefer to work with an instructor who provides lectures, notes, handouts, and reading assignments. These group of learners participate in teleconferences, read information stored on Internet, search resource databases online and download their assignments to a printer.

For learners who prefer graphics to prose, the Internet, as well as video, offers a wealth of diverse materials. Movie clips, animation, sound effects, music, voiceovers, photos and 3-D environments are some formats through which they might learn best.

The degree of interactivity required by individual learners can be matched with the type of technology and course. Some media are more interactive, and some subject areas require more direct learner involvement. Distance learning courses, such as that offered on *Informatics1*, if they're well designed, offer learners a wide range of options, so that they can find the right mix of interaction and learning style to enhance their individual capacity to learn or be trained.

Practice working with different technologies

As learners work with *Informatics1* educational technologies, they not only learn about their subject areas, but also have practice working with a variety of interactive technologies. They become fluent with rapidly changing technical environment and receive a broader picture of the many media and technologies that are used to provide them with materials and learning experiences. One of the great benefits of distance learning through *Informatics1* is that learners not only gather information and experiences relating to their primary area of study, but also pick up additional skills and knowledge related to the technology.

Direct their learning

One of the most important benefits may be that learners can direct their learning. As learners have more materials made available to them in exciting, innovative ways, they're more likely to want to learn more and learn on their own. Instead of having an instructor tell them where to access information, what to do, learners are more likely to share with instructors what they've found and how much information is available. They're also more likely to continue their education and training on their own through *Informatics1*.

Conclusion

Today, the quality of distance education depends on technology. Recently improvements in the costs and capabilities of hardware and software, combined with the

growth of the World Wide Web and connectivity, encourage the development of new teaching environments. To provide a flexible, collaborative learning experience requires tools that allow learners to access various sources of information in a variety of media and work at their convenience.

Distributed learning allows students to manage their time and learn while interacting with other students and instructors. Students are now presented with new opportunities for professional and personal development.

We believe *Informatics1* and its vast potential services in the near future are significant steps towards realizing Informatics' commitment to current and new customers and learners. These are first steps as we pursue partnerships with institutions of higher education to achieve the shared vision of enabling learning through technology.

Informatics acknowledge that these students within *Informatics1* would be an entire breed of people operating in a global, multimedia world where convenience, accessibility, and real time response are the norm. Such an environment has considerably increased the importance of international business relationships, team-based processes, and networking.

A dedicated team of professionals from Academical, Technical and Business will support the site and provide the online "live" contents. Informatics will further develop Internet resources to reduce operational cost, improve productively and better learner's services & training.

SESSION 2

Thursday, 15 January 1998

Session 2: Multimedia

Chair:
Dr. Luu Tien Hiep, Lotus College, Vietnam

2-1. **Multimedia Education**
Prof.Tran Van Hao, University of Education, HCMC,Vietnam
Ngo Huy Hoang, University of Technology, HCMC,Vietnam

2-2. **Educational Multimedia in a networked technology**
Prof.Tony Bates, UBC, Canada

2-3. **Production of interactive Multimedia packages**
Tran Minh Phuong,SCITEC , Vietnam

2-4. **Digital signal processing applied in Multimedia**
Tran Cong Toai,Tran Hoang Buu, Dang Xuan Hieu, University of Technology, HCMC, Vietnam

MUTIMEDIA EDUCATION

Tran Van Hao
University of Education, HCMC, Vietnam
Ngo Huy Hoang
University of Technology,HCMC, Vietnam

1. Introduction of Product

The introduction of computers into the schools in many countries of the region has been carried out en masse in many popular ways. Until 1995 the Ministry of Education and Vocational Training had made a big investment in the information cause: 02 US million dollars were spent on computer equipment for Elementary and Secondary schools.

Therefore the formation and development of a model for complete educational tools to help the Vietnamese students to get access to one of the most up todate learning equipment in a fast and easy way has made it a tendency to develop software.

As a result a new educational model "Multimedia Education" has been created. We have made this tool with researching and referencing a number of documents both domestic and abroad issued in the year 1995 and have initial success to apply this new topic. The version 1.0 entered the competition "Young Professional Talents of 1995" and won the first prize. We sincerely hope in the years to come new versions of this first educational tool will be available popularly throughout the country as survey has shown that this new tool has proved to be more interesting, more attractive and effective than those that used to be applied by the older generations.

This tool is made based on the several other educational software such as Just for Kids (Quantum Inc. USA), Computer Assisted Learning (Singapore), Kidware for Education (Germany) and Living Books (Broder Bun - USA, World Class 1995).

Just imagine to learn mathematics without having to learn by rout the Multiplication Tables. Through the games with colorful pictures and sound the children can fast grasp the four calculations, can learn how to read Vietnamese words or learn by heart a poem with the computer.

2. The software Demand

During a survey early 1995 we interviewed with about 50 students of the pedagogical college in Hochiminh City and their same answer is that they all liked the lessons on the computer. We all know that Video games or TV in general have great attraction for the children and we have now turned their interest into something more useful: To play and at the same time learn via the computer. When we asked if the equipment can be furnished at home too most of the students' parents agreed they should.

Before 1995 no such software was made in Vietnam for the children in the elementary schools whilst in other countries in the region such as Singapore and the Philippines a complete set has been introduced into education and successfully applied. In Hochiminh City today many schools have been furnished with computers, even with modern serials but still have got no appropriate software. The majority are still not utilised or just available for games! This is due to the fact that no software was made until then and this was quite a problem not only for those who work in the educational field but also those who work in computer sciences.

3. Objectives

The demands as can be seen are great but the supplies are so scarce. Why? The problem is what is appropriate for the children and in what way. When we finished with this product a number of other programmers started to make their own without much success. The cause for their failure might be the same problem.

Our main objective is to make a accessory tool for the teaching and learning at elementary schools. It could by no way replace the teachers. It carries almost no theory or can't it be seen as school book but just a helping tool. The students before or after the class can have some ideas with new lessons or can revise what they have learned. The software is made into small games which are educational-oriented and/or inducing creativeness. Once they get tired of a certain game they might turn to other ones. However, they should at first be given guidance and later on they can start the games themselves.

4. The Pedagogical Approach

In order to make it appropriate for the elementary levels and to abide ourselves with pedagogical requirements we made a thorough research of school books on Mathematics and Vietnamese. Also Teachers' books concerning the children's psychology.

Many parents have expressed the negative side of pictures and games which are non educational and time consuming. So why not turning them into the positive side, why not bring to them the lessons in the way they like to deal with, the lively, colourful, natural way. This is the right psychological theory in education of the children which says we should bring the children "from lively realistic objectives gradually to the abstract thinking".

Therefore we have chosen the best approach for this topic to put games within the educational model of feedback in order to get the required results / evaluation.

It is commonly known that the children get tired of a game so quickly therefore we organise the games in various levels to match with the their progress. Most of the educational games in the world are being made the same way.

5. Technical Approach

To build up the programme we have taken into account the strong characteristics as well as the weak characteristics of the machine in comparison with man in the field of education. That is way not everything to teach in class can be applied in the machine.

Although being a two-way educational tool, i.e. to get impact on the learners and receive feedback so as to correct their possible mistakes, the ability of the machine is by far poorer than man (the teacher). For example, the machine cannot be able to identify the right speaking of the learner, or the precise spelling of the Vietnamese dictation, etc.

We should therefore try to minimize the weal points of the machine, which does not mean we just avoid them. To correct the mistakes of the learners is a very important point in education, which many software writers often ignore. So we should work out more exercises and never forget the correction parts. This can be done, if necessary with the help of the teachers.

The strong points of the machine, which we all know are the lively pictures and sound it can create so we must exploit the utmost of this multimedia characteristic.

6. Multimedia Education

The following are the complete parts which we have finished in the version 1.0 introduced in 1995 plus the revision.

The set consists of various smaller programmes, each being an educational game. The total version 1.0 are stored in three (3) 1.44 MB floppy discs. In the coming version 2.0 there will be more, which will be available in the year 1998.

The programme in version 1.0 was written with Microsoft Visual Basic 4.0. The programme in version 2.0 will be written with Borland Delphi & Borland C++ Builder.

The programme requires simple configuration: Minimal 386 with Sound Card.

The programme can run in Window 3.1 or later environments.

Installation for version 1.0 is simple:

Insert Disc 1, run SETUP and then follow instructions on the monitor until all is recorded onto hard disc. Then you can start the programme.

Version 2.0 is planned to release on CD-ROM and can be used direct from the disc.

Following are the contents of the programme

Educational Games Available in Version 1.0

1. I Learn How to Count

The objective is to help the child to learn how to count from 1 to 10 by "counting fingers"

2. I Learn How to spell

The objective is to help the child to learn to how to spell basic sounds and sound clusters.

3. I Learn How to Calculate

The objective is to help the child to learn calculations of Adding and Subtracting (+ and -) with cute living beings.

4. I Learn Mathematics with Fun

The objective is to help the child to learn calculations by objective tests with the four basic calculation of Adding, Subtracting, Multiplying and dividing (+, -, x and /)

5. I Learn Mathematics on Blackboard

The objective is to help the child to check their tests of calculations with the help of the familiar "Blackboard". This game creates confidence in the learners and their excitement when the learners volunteer to work out the problems "on blackboard"

6. I Learn Fractions

The objective is to help the child to get familiar with notions of fractions, to identify the fractions, to compare the fractions and the calculation of them

7. I Learn the Sets

The objective is to help the child to get familiar with notions of sets and the simple calculations with setting

8. I Learn the flags

The objective is to help the child to learn Geography and basic information of the large countries in the world

The following are being written in Version 2.0

1. I Learn Poems

The objective is to help the child to how learn by heart poems. The words will be accompanied with pictures and sounds. Sentences are repeated time and again. Words will be erased until the child can learn by hear t the whole poem.

2. I Learn How to Spell 2.0

In version 2.0 the child will be given more sound clusters, how to spell them, how to articulate them and the photos will help them to mimic.

3. I Learn how to Arrange

The objective is to help the child how to arrange the things in logical orders, from small to large or vice versa.

4. I Learn how to Pronounce the Words

The objective is to help the child how to combine the sound clusters to make up the right words that are illustrated with the photos.

5. I Play Football with Subasa

The objective is to help the child to learn the multiplying Charts by funny way *Goals against Subasa.*

6. I Learn How to Make Sentences

The objective is to help the child to learn how to make up the correct sentences with the help of photos

7. I Learn Traffic Rules

The objective is to help the child to learn the traffic rules when going on the roads

EDUCATIONAL MULTI - MEDIA IN A NETWORKED SOCIETY

Antony Bates UBC, Canada

The Technical And Economic Revolution

Multi - media in education is seen by many primarily as an extension of computer - based learning. This is understandable, as some of the main constraints on computer - based learning have been the high cost of incorporating good graphics and video materials, and the restricted sensory stimulation for learners from screen - based text. The addition of high quality graphics, audio, and video to text, and more powerful editing and authoring software, provide a major enhancement of computer - based learning. The costs of hardware and the cost of producing multi - media materials are also dropping rapidly. "Stand - alone" computer - based learning will become even more powerful as artificial intelligence and virtual reality develop.

However, while 'stand - alone' applications of multi - media will continue to be important in education, a much more significant development will be the application of high - speed multi - media networks for educational purposes. As well as the convergence of different media networks for educational purposes. As well as the convergence of different media within a common computer platform, we are also seeing the convergence of the previously separate technologies and industries of computing, telecommunications and television. For instance, in April of this year, Stentor, an alliance of Canadian telephone companies, announced an $8 billion, 10 year initiative, called BEACON, that will bring broadband, multi - media services to 80% - 90% of all homes and businesses in Canada by the year 2004. The social and educational impact of this convergence, and the speed with which it will be implemented, will be revolutionary and deeply challenging to established educational institutions.

At the same time as this technological revolution (and partly because of it), the needs of the workforce are also rapidly changing. In 1993, 78% of all jobs in the USA were in service industries, and the trend is likely to continue (Economist, 1994). Microsoft's annual revenues are greater than Sony's and Honda's combined, but they employ 100 times fewer workers. Most new jobs are being created in Canada by companies with less than 20 workers; indeed, the trend to both self - employment and working from home is likely to grow (StatsCan, 1992).

The wealth of nations will depend increasingly on knowledge - based, high - tech industries. but if every worker currently in the workforce was sent back to college for three months training every five years, we would have to increase the post - secondary education system in Canada 50%.

The wealth of nation will depend increasingly on knowledge - based, high - tech industries, in the areas of bio - technology, environmental products and services, computer software, financial services, and entertainment (particularly film and television). Furthermore, these are highly competitive, global industries. Keeping even a few months ahead of the competition, in terms of innovation and knowledge, are critical to survival, as is the quality of product and service. This means that education and training, not just in the pre - work years, but throughout a lifetime, are essential elements of a successful work - force. However, if every worker currently in the workforce was sent back to college for three months training every five years, we would have to increase the post - secondary education system in Canada by 50%. In practice, of course, the political trend is to reduce or limit public expenditure, to make schools and colleges more cost - effective, to take greater numbers for less cost.

Multi - media and modern telecommunications do offer an opportunity to meet these lifelong learning needs of the work - force in a cost - effective manner. This will not happen though without thinking very differently about how education and training will be organized, in order to serve the needs of the work - force.

Learning in the 21st century

Modem learning theory sees learning as an individual quest for meaning and relevance. Once learning moves beyond the recall of facts, principles or correct procedures, and into the area of creativity, problem - solving, analysis, or evaluation (the very skills needed in the work - place in a knowledge - based economy - see Conference Board of Canada, 1991), learners need inter - personal communication, the opportunity to question, challenge and discuss. Learning is as much a social as an individual activity. However, for someone working in a small company, the nearest person with similar interests and expertise may be somewhere on the other side of the country, particularly in leading 0 edge technologies.

Learners will need to access, combine, create and transmit audio, video, text, and data as necessary. If we take this as the design requirement, there is then a need to build a systems that support this form of learning, both for formal and informal learning.

Work and learning will be inseparable. Most learning will be informal and lifelong. It is not difficult to build a convincing portrait of learning at the work - place. We can envisage a computer software designer or television animation artist, called Wayne, probably working from home, needing information on a certain technique or approach, or advice on how best to create a certain effect. From previous experience and contacts, or on the advice of a colleague, he has the name of someone half - way across the country (Sue). From his work - station, Wayne calls Sue, talks about the problem, and Sue loads up some software which she 'shares' with Wayne via the network. Wayne asks a few questions, tries a couple of things on - line while Sue watches and comments, then

downloads the software. Sue and Wayne are both registered with an educational institution that has been set up to enable the exchange of commercially sensitive material for learning purposes. Wayne's work - station has automatically displayed the cost per minute of consulting Sue, and the cost of rights for downloading the software. However, Wayne was also able to give Sue some information, and this is charged back to Sue's account. Wayne now not only has the software she needs, but also can contact Sue (on a chargeable basis) any time he has a problem with the software. The learning context has been established. Note it is fragmented, on demand, and charged at cost.

Learners will interact with their desk - top or portable workstations in a variety of ways, determined by the nature of the learning task, and their preferred style of learning in the work situation, These preferred styles will vary considerably, both within a single person, depending on the task, and, for the same task, between different individuals.

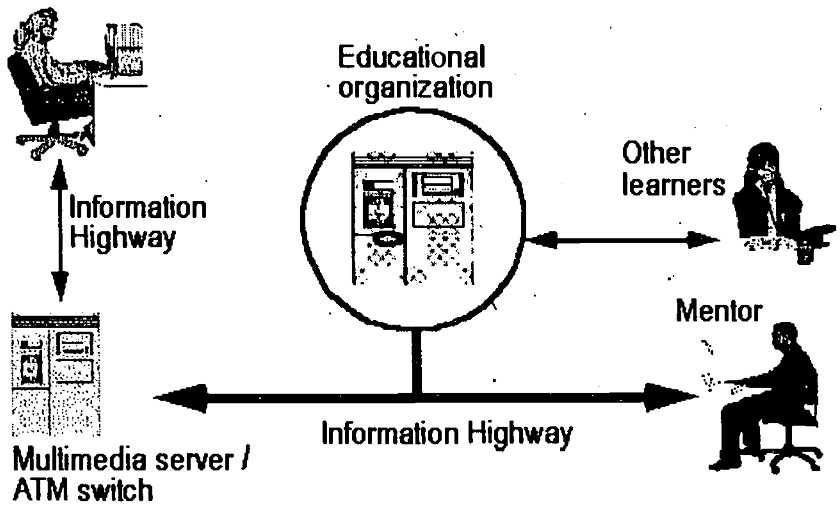
The learning context will need to encompass the following :

- working alone, interacting with learning material (which may be available locally or remotely);
- working collaboratively (and in an equal relationship) with fellow workers at different remote sites, either synchronously or asynchronously : both these modes are likely to be multi - media;
- as an 'apprentice' or 'student', working with a more experienced worker, supervisor, or instructor;
- as an instructor, supervisor or more experienced colleague for other less experienced colleagues.
- The same person may find themselves in each of these roles within a single working day. Learners will also need to be able to work from home, or from a work - site, or while in transit. They will need the following :
- access to information (searching, downloading) from multiple sources in multiple formats;
- selection, storage and re-ordering/re - creation of information;
- direct communication with instructors, colleagues, and other learners;
- incorporation of accessed/re - worked material into work documents;
- sharing and manipulation of information/documents/projects with others.

Learners will need to access, combine, create and transmit audio, video, text, and data as necessary. If we take this as the design requirement, there is then a need to build system that support this form of learning, both for formal and informal learning. I give my

own personal 'vision' of how such a system would provide the kind of educational experiences I would like to see. This is summarized in Figure 1.

Figure 1 : A networked educational multi - media system



The work - station

The work - station of the future will be a multi - purpose machine, probably in modular form, including input (voice, pen, keyboard, gestures) and display (screen, sound, printer) devices, telecommunications, computing and television. It will be at least in part portable.

Key features will be the interface between the user, the tools available to the learner within the workstation, and a range of remote services, both educational and non - educational, that can be accessed remotely via the work - station.

The interface

Design work has already begun on building interfaces for educational services on the information highway. The Virtual Interactive Environment for Workgroups (VIEW) is one such system currently in the initial stages of development in Canada by MPR Teltech, the Open Learning Agency, Simon Fraser University, Science World (British Columbia), the British Columbia Educational Technology Centre, and Stentor. The VIEW system will provide tools for creating and using 'multimedia conferences', and for enabling users to engage in individual and collaborative group activities using information from diverse sources and in a variety of media formats, operating either in synchronous or asynchronous modes (Teles and Laks, 1993).

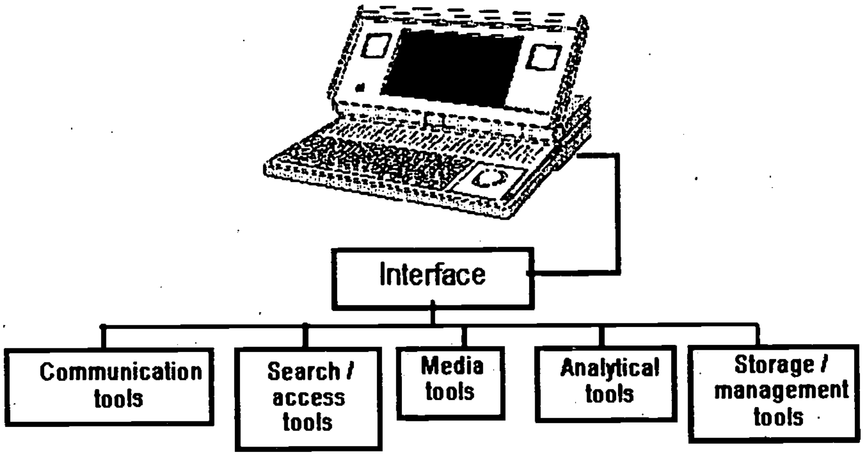
In essence, when learners switch on their work - station, there is a window with a choice of services. One of the choices (others may be films, home shopping, financial services, messages, etc.) will be education and training. When the learner chooses education and training, VIEW will provide a new window, with a choice of educational

services, and a choice of a range of software tools to facilitate the learning and communication process. Thus learners will be able to search, access and download information from a variety of sources in a variety of media formats.

The tools

The software tools available in the work - station will be a critical element of this interface (Figure 2).

Figure 2 : An educational multi - media networked interface



As well as tools for communication, management and storage of information, there will also be tools that assist in searching, accessing and compressing information, in analysing accessed data for relevance, in 'grouping' appropriate types of information, and tools for importing different types of media - based information, editing, and exporting them. These tools will be intuitively simple to use.

What will make or break such a system will be the creation of new organizational structures for educational institutions to provide the administrative and educational support for lifelong learners.

The educational institution

What will make or break such a system will be the creation of new organizational structures for educational institutions to provide the administrative and educational support for lifelong learners.

Roles for 'electronic' educational institutions

The critical roles of an 'electronic' educational institution built to meet the learning needs of the 21st century will be as follows :

- To provide information on education and training needs and opportunities;

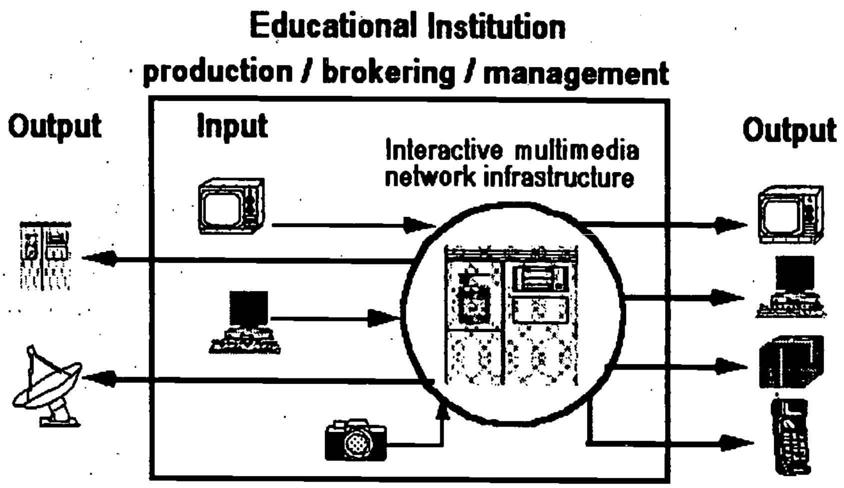
- To provide quality control;
- To provide accreditation, through independent assessment of learning;
- To develop coherent curricula, where appropriate;
- To broker and validate courses and materials from other education and training suppliers;
- To provide the service that will make the use of communications to import and export multi - media learning materials easy and user - friendly;
- To network learners and instructors;
- To create high quality educational multi-media materials in an easily accessible form; to conduct research into education and training needs;
- To apply new technologies, as they develop, to education and training, and to evaluate their use.

Many of the instructors or tutors that are used will not 'belong' or work for the educational institution; many will be independent contractors, or working full - time in a knowledge-based industry, or working for another educational institution. Nor will learners necessarily be 'registered' with that institution, in the sense of taking all or any courses. The institution is primarily a facilitator of learning. In the example of Sue and Wayne, all the educational institution may do is bill, and collect and deliver payment, regarding fees and royalties, to and from Sue and Wayne, the owners of the software, and possibly the telecoms companies (plus a service charge). In other cases, it may offer a full program to groups of students with its own instructors and multi - media materials, leading to its own credential. In others, it will be like a multi - media reference library, with learners just accessing the information they need. It may provide the technology infrastructure for a system of 'mid mode' institutions, that register their own students, but share the technical facilities of the electronic institution. It could be quite a commercial organization, collecting fees for many of its services, where this is appropriate.

The heart of this service is the internal multi - media network infrastructure, that allows the institution to access, create and deliver educational multi - media services in a variety of formats and a variety of modes.

The technical nature of this institution is reflected in Figure 3 :

Figure 3: Technical configuration for an electronic educational institusion

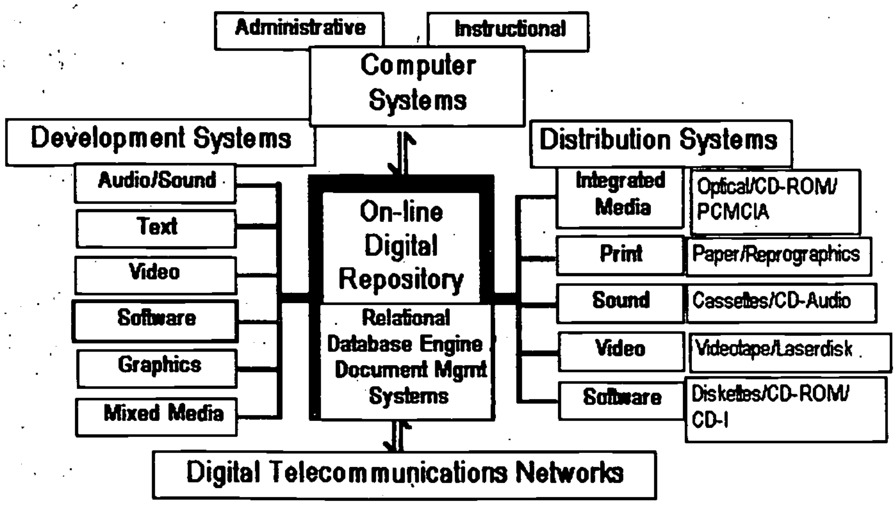


Over the next 10 years, there will be growing variation in the technology that potential learners can access. It will be increasingly important to delicer in whatever formats the learners need.

The internal multi-media network infrastructure

The heart of this service is the internal multi - media network infrastructure, that allows the institution to access, create and deliver educational multi - media services in a variety of formats and a variety of modes. The Open Learning Agency is developing an integrated information management approach that will include both administrative and instructional systems (Figure 4).

Figure 4 : A networked multi-media relational data - base



Basically, learning materials can be accessed, created and stored digitally in any format (video, audio, text, graphics, or any combination). Course designers can access this material electronically, re - edit and re-create learning materials, store and export this learning material in a variety of ways (print, CD - ROM, or down - loaded to local work - stations), depending on the learners' needs. Over the next 10 years, there will be growing variation in the technology that potential learners can access. It will be increasingly important to deliver in whatever formats the learners need.

The system will also allow for the tracking of materials and services, the on-line payment of fees and charges for services, and student or client record - keeping (including grades and credentials), as well as providing management information on finances and learner activities. This infrastructure is connected through the information highway to multi - media servers or switches (Figure 4).

Even for full - time students, it will be difficult to categorize them as either 'campus - based' or 'distance education' students within a few years.

Implications for learning

While schools, colleges and universities will still have reason to provide campus - based learning to groups of learners over set terms or semesters, for social and for some instructional reasons, a great deal of learning will take place outside of this context. Full - time students will in any case soon be a minority in Canadian universities and colleges (63% of all college enrolments in Bristish Columbia were part - time in 1992/93 - B.C. Ministry of Skills, Labour and Training, 1993). Even for full - time students, it will be difficult to categorize them as either 'campus - based' or 'distance education' students within a few years. They will be accessing information and communicating with their instructors, other students, and other subject experts outside their own institution, through multi-media telecommunications, from home and the work - place. Furthermore, multi-media telecommunications will allow them to do this whenever they want, in small chunks as well as in whole courses or programs of study, thus making learning more flexible and accessible, to all ages of learners, and not just young people in the formal system. Learners will also have a much wider choice of sources of learning, being able to access expertise and courses from anywhere in the world.

As important as the context of learning will be the approaches to learning and instruction. Multi-media telecommunications will allow learners and subject experts to engage in dialogue, questioning, and exploration of a wide range of alternative approaches, as well as the sharing and joint working of multi-media telecommunications can also encourage collaborative approaches to learning. Learning will often occur without the direct intervention of a 'formal' instructor, through the use of peers and people working in a job but who have expertise. Most important of all, as they learn through multi - media telecommunications, people will use the same tools and develop the same skills that will be an essential part of their work and leisure activities.

'Stand - alone' multi - media applications will still have an important role to play, especially where learners need to work through carefully a disciplined set of principles and ideas, or need a great deal of practice and experiment to fully understand a subject of study. Their use will increase if learners are given the opportunity to re - work and re-create their own multi - media applications, as projects or for the purposes of assessment. However, stand - alone applications will be a specialized and relatively limited use of nulti-media within a much richer learning environment, that will include two - way communication and the transporting of multi-media materials between learners, and between the learner and a mentor. (More details of the different curricula approaches made possible through multi - media telecommunications are given in Bates, 1993).

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those countries that harness the power of multi - media communications for education and training purposes will be the economic powerhouses of the 21 st century.

Conclusion

This vision for a system is nor a utopia, not even many years away. The wide band highways are at this moment being constructed, and should be in place within 10 years. Multi-media switches, using ATM technology, are now being built. Interfaces to the information highway, and software tools to facilitate multi-media learning, are being designed. The software for handling multi - media communications is being developed by companies such as Oracle.

However, the most difficult part of the system to put in place will be an appropriate educational infrastructure to support the kind of learning needed in the 21st century. The provision of appropriate education and training services to run on the information highway is critical; there is no automatic guarantee that people will use the information highway to an extent that justifies the cost of investment, if services are not provided that meet people's needs. Unfortunately, existing educational institutions were created to meet the needs of a society that are fast disappearing. We need new educational organizations that can exploit the information highway to meet the needs of the 21st century. Economic development will depend as much on the success of creating and supporting such organizations, as on establishing the technological infrastructure. It is critical to get this right because those countries that harness the power of multi - media communications for education and training purposes will be the economic powerhouses of the 21st century.

Acknowledgement

This is based on a presentation made to the World Conference on Educational Multimedia in Vancouver, 1994, and published in the conference proceedings (Ottman and Tomek, 1994). I am grateful to the Association for the Advancement of Computing in Education for permission to reproduce a large part of that paper.

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PRODUCTION OF INTERACTIVE MULTIMEDIA PACKAGES

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Abstract

The development of multimedia technology for microcomputers has opened a new era of applying information technology to education and training fields. Teaching and learning methods have been renovated by interactive multimedia products. This paper deals with production steps of interactive multimedia courseware, of which the most important are contents and editing. Some experiences will be also discussed.

Pedagogical Revolution

From the ending years of the 20th century, we realise that in the information age, a great mass of new knowledge and techniques have to be mastered for their application and adaptation. Consequently a lot of persons have to be trained, retrained and supplemented with new knowledge regularly, if not throughout their working life. Traditional class contact training has become unsuitable vis-à-vis such growth in quality and quantity. Technology-based training appears to be the solution. The development of microcomputers has resulted in new media such as CD-ROM, CD-I, hypermedia, multimedia, computer-based training (CBT) packages, electronic performance support system, Intranet and Internet access facilities...They in turn have modified learning habits, and thus teaching methods. As a matter of fact, with great volume of information on CD-ROM, high level of self-controllability in CBT programs, a learner can choose various learning alternatives, a far cry to the method in which students just listen to the teacher and the latter just delivers a lecture. The teacher nowadays has to think of what students will do to learn, not of what he or she will deliver. Now people talk about interactive multimedia courseware.

From my own understanding and experience I would like to describe in greater detail the way how to develop an interactive multimedia courseware.

Developing an Interactive Multimedia Product

1. Definition

I will try to make clear the concept of interactive multimedia. A more precise definition includes three components:

- *Computer Base* – It is a program runs on a general or specialised computer.
- *Interactivity* – It means a computer will perform nothing until a user sets it in motion.

- *Existence of Graphics and Sound* – Graphics can be images; still or moving pictures; sound can be music, voice and/or special effects.

Since the Compact Disk technology develops, there are many interactive multimedia products, which are roughly classified into ten categories, products given in brackets are typical.

- Reference (Encarta by Microsoft)
- Games (Seventh Guest by Virgin-Tribolyte, Đố vui* (Entertaining Riddles))
- Entertaining Education (Just Grandma and Me by Mercer Mayer, Đảo Phù Thủy* (Sorcerer's Island))
- Entertaining Information (From Alice to Ocean by Odds, Đồng quê Nam bộ qua những bức tranh* (South Vietnamese Countryside through Pictures))
- Education (Virtual Body by IVE, Tìm hiểu về cơ thể con người* (Understanding Human Body))
- Simulation (Fax Simulator*)
- Self-Improvement (Góc sáng tạo* (Creativity Corner))
- Dictionary (MTD by Lạc Việt)
- Demo Samplers

*N.B. The items marked with an asterisk * are produced by Scitec Co.*

2. Technical Issues

Once the product theme and users have been determined, the approach to the product has to be decided before realisation: the product will look like a book, a feature-length film, a picture album, or combinations of them. The approach chosen will affect the cost of production and distribution.

The following table lists the technical factors and some comments which have to be taken into consideration before planning an interactive multimedia product.

Factor	Alternatives	Conditions to consider
Background O/S	DOS, Windows, Macintosh, Multi-Platformed	
Computer	Software, Reading Drive	
Language	Mono-, multi-lingual	Affecting design and storage
Video	Qtime, AVI, MPEG	Compression techniques
Sound	MIDI, WAV	Depending on sound natureand standardisation requirement

Developing Tools	Authoring System: Macro Director, Apple's Hyper Card, Asymmetric's Tool Book, AimTech's Icon Author, Macro-Media's Authorware...), High Level Programming Languages (Visual Basic, Delphi, C, C^{++}...)	Giving rise to different developing cost and time, run speed

3. Human Resource Factors

Development of an interactive multimedia product requires many specialists of different disciplines. They all must be able to work as a well co-ordinated team.

Producer

The person responsible for the whole project from the conceptualisation stage to marketing. A competent producer understands, and better still, has had some practical experience in different production jobs; and now concentrates on business management.

Project Manager

The person in charge of assignment and co-ordination of the rest of the team during production. He or she must has some background in art, music, film, computer programming or engineering, but the most important the project manager must have working experience in different product forms, and command the respect of the team. In our company the manager has been trained in project management so that he knows how to initiate and monitor a project, working procedure, reporting.

Content Specialist

This position can be held by a writer, a teacher or by a team of specialists.

Art Director

It is the person who sets art criteria for the product. He or she can also directly directs the project's artists. The director must have an in-depth understanding of computer interface design and interactivity modes.

Artists

They are persons who can draw, design 2D or 3D graphics, image processing...In most products for children, there are animated cartoons, thus artists to draw them will be included in the team. In games and educational entertainment where graphics are extensively used, the specialization of artists works the same way as in a cartoon film production, but they are trained further with skills required for a specific form of realisation.

Information Designer

The person responsible for layout of the content and the way to realise it. He or she must have a firm understanding of communication, pedagogical method and all the details of the content. The editor can also be the author of the content.

Programmers

Their tools are computer softwares for developing the product. They usually work under a programming head unless this job is undertaken by the very project manager. Since they will have to edit various components of the program latter, a multimedia programmer has to know to manipulate software tools for treatment of sound, image, video...

Camera Operators

If a project requires new film clips, they will produce them. If the clips are used for CD-ROM production, camera operators will have to use special effects for costume color, acting motion, setting layout, lighting...The film clips produced will then be amenable to the suitable form by persons familiar with computer tools.

Sound Engineer

The person in charge of all aspects, including technical and creative, of sound. He or she also cooperates with other sound specialists for sound special effects, actors and actresses for voice recording, and collates in the final product.

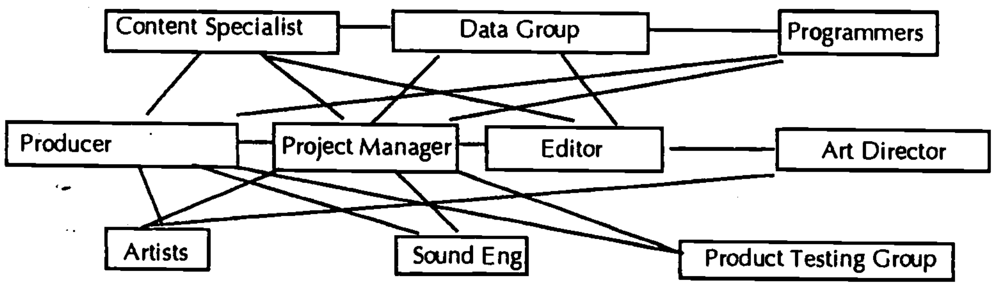
Data Processors

They are responsible for entering text, pictures, sound. Sometimes they have to gather from other sources.

Product Testers

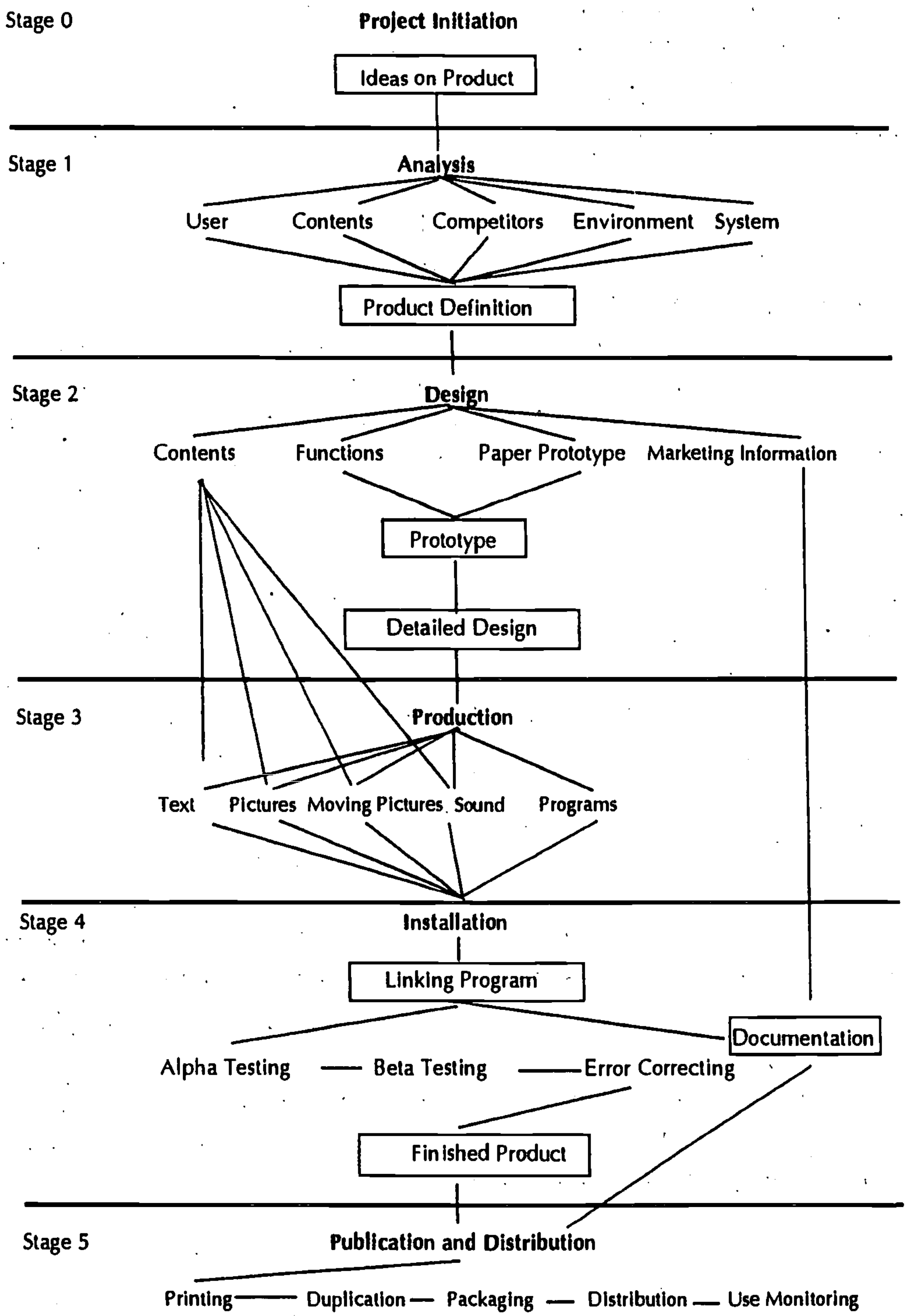
They test the product to make sure that it has been produced according to specifications and standards. In a big production firm, they have to check the whole product. They set up testing standards and plans before actual testing.

The relationship between the team members are described in the following diagram.



4. Development Procedure

The development of interactive multimedia products like traditional software packages involves five major stages: analysis, design, production, implementation and distribution. Each stage requires tens of different operations. The procedure is summarised in the following diagram.



In order to ensure the initial definition and the final realisation of the product respond well to the needs, bring about benefits and suit exploitation conditions of users, the project team must have measures to approach customers and gather their opinions as soon as possible. It is particularly important for interactive multimedia coursewares.

Evaluation of Pedagogical Contents of Interactive Multimedia Coursewares

As mentioned earlier, while designing an interactive multimedia courseware, the teacher has to think of what a trainee will do to learn but not of what is taught. This is really not customary at all.

The need analysis stage has to be carried out seriously on what learners know and wish to know.

In the alpha testing stage, information on the product collected from learners will assist the production groups to see the effectiveness of their effort. Information collection methods commonly used include objective multiple choice test, test of knowledge before and after using the courseware, interview, observation of learners using the program...The producers can also use a program to record branching paths navigated by learners. This method is particularly useful for courseware in hypermedia, also for understanding the general level of learners and generating a resource for writing instructions for other learners.

Some Experiences

Since the establishment of our multimedia department involving in training and production, we have marketed 18 products covering many areas as mentioned above. For many reasons, we have not carried out extensive evaluation of learning effectiveness of our products. However we still can draw the following lessons.

1. On production team, we still lack creative writers, competent editors. Technical aspects alone do not bring about success to a product.

2. On realisation techniques, we should concentrate much more on the need analysis, existing skills and prospective learners' habits, so that we can produce more acceptable products. It is imperative to check the compatibility of the product against different hardware configurations available on the market, and exploitation environments.

3. On users, Vietnamese customers are very demanding on Vietnamese products. To them the products have to be cheap, of high quality, rich in content, lively characterisation. Some schools utilise our products in practical lessons but with new tools – this wrong approach needs to be rectified by better cooperation between the producer and schools, making the learning process more effective.

DIGITAL SIGNAL PROCESSING APPLIED IN MULTIMEDIA

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1.The problem of Digital signal processing applied in Multimedia

An image is one of the strongest tools that help people with solving a lot of problems , for example , in digital telecommunication , broadcasting , medical imaging and especially Multimedia systems . People can learn a lot of interesting things with the help of images must be and as same as the described objects .So Digital image processing become an important problem in the field of science and engineering .

Multimedia is the star ring in the networking firmament. It allows audio and video to be digitised and transported electronically for display. Most multimedia projects use the MPEG standards and transmit the data over ATM connections.

Literally, multimedia is just two or more media. In practice, the two media are normally audio and video, that is sound plus moving pictures. For this reason, we will begin our study about DIGITAL SIGNAL PROCESSING with an introduction to multimedia.

Digital signal processing (DSP) is an area of science and engineering that has developed rapidly over the past 30 years. For many reasons, especially, the rapid developments in integrated circuit technology has spurred the development of powerful, smaller, faster, and cheaper digital computers and special purpose digital hardware, The advantages of DSP compared with analogue processing such as more reliable, more easily modify the signal functions to be performed by hardware through associated software, and so on, There has been an explosive growth in digital signal processing theory and applications over three decades. The DSP subject is based for some other processing areas, for example, image processing, speech processing, digital communication ... Since then, it has produced a number of powerful tools. Many of which of practical use in engineering to solve difficult problems normally requiring DSP, Two of these tools and technique will be reviewed in this paper. They are: Fast Fourier Transform, Filtering with FIR,IIR filter. These tools have been existence for more than thirty years and have found applications in engineering. In addition, this paper will demonstration some application of those by some included figured extracted from DSP1 program, which performed by students of Information Technology Faculty of HCM Technology University.

Dsp is processing with changing the signal characteristics or extracting some desired information from it, and the signal here has been discrete by sampling and quantification process in AD converter. The signal here can represented as a sequence

x[n,m...], and we only review about sequence has one depend variable, time. So, the sequence is x[n].

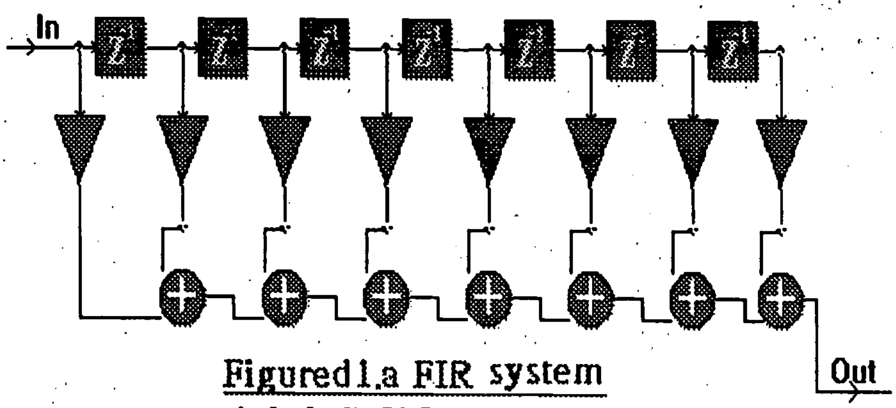
An DSP system can be a device or a algorithm with that operates on discrete -time signal, called *input* or *excitation.* According to some well defined rule, to produce an other discrete time signal call *output* or *response* of the system.

Some important characteristics of a DSP system were considered because of some mathematical techniques that we latterly develop for analysis and design an systems depend heavily on those, they are static or dynamic, Time invariant or time variant, Linear or non-linear, Causal or non-causal, stable or unstable. This paper turn on attention to analysis of the important class of linear, time invariant (**LTI**) system, Which response for any arbitrary input signals can be decomposed and represented as a weighted sum of unit sample sequences.

Suppose that input signal is x[n], and response of system for unit sequence is h[n], we have, response of system for x[n] is y[n] = x[n]*h[n]. where '*' operation is called *convolution sum* or *convolution.*

An DSP system can be analysis in time domain or in frequency domain, Those two topics will be treated later in section 2 and 3, And the important topics now we considered is design and implementation of these of system. In practice, system design and implementation are usually treated jointly rather than separately. Some of realisation of LTI system have been development are direct form ,cascade, parallel and lattice structures, Which have separate advantage, about quantification effect, computationally efficient, memoryless. Two classes of DSP system is considered are **Finite Impulse Response** (*FIR*), and **Infinite Impulse Response** (*IIR*) system, Which characterised by equation

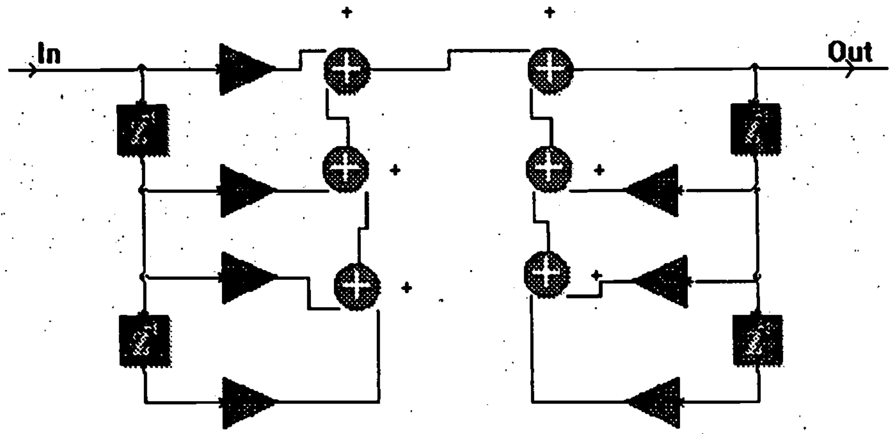
$$y(n) = \sum_{k=0}^{M-1} b_k x(n-k) \qquad (1.1)$$



Figured 1.a FIR system
(take by DSP1 Program, N=8)

and

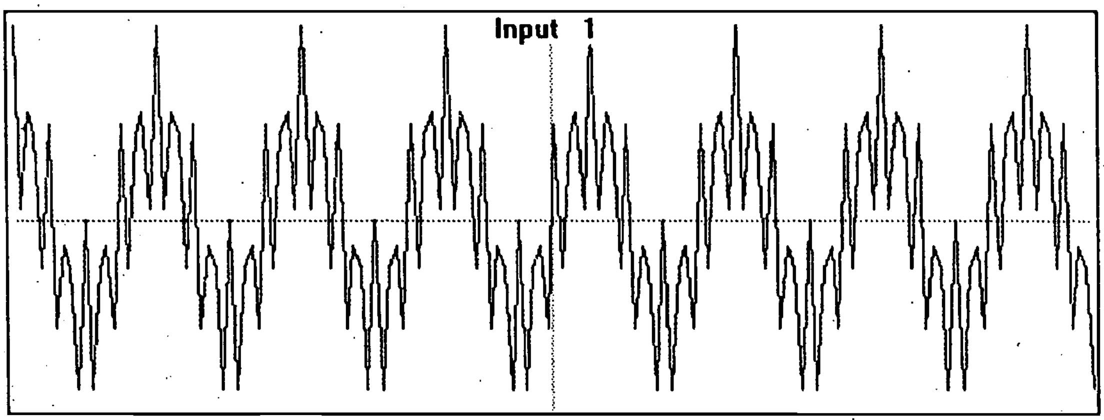
$$y(n) = -\sum_{k=1}^{N} a_k y(n-k) + \sum_{k=0}^{M} b_k x(n-k) \qquad \textbf{(1.2)}$$



Figured 1.b Strucure IIR

The sample was used to illustrate here is sum of number of sinusoid, which have same magnitude (*unity,* for simple) and different *normal frequency* f = F/F_s, where F_s is sampling frequency, and F is frequency of cosine. So, to avoid alias, $0<f<0.5$.

In figure 2, the wave - form of sum of two cosine have frequencies 0.05 and 0.4



Figured 2. Sample waveform
(frequency 0.05&0.4)

2. Time Domain Processing (Filtering routine)

Filtering is the most commonly useful signal processing technique. Filter are usually used to remove or attenuate an undesired portion of a signal's spectrum while enhancing the desired portions of the signal. Often the undesired portion of signal is random noise with different frequency content then the desired portion of the signal, Thus,

by design a filter to remove some of random noise, the signal to noise ratio can improved in some measurable way.

Filtering can be performed using analogue circuits with continuous time analogue signal or using digital circuit with discrete time digital input. Digital filtering can be perform in time domain or frequency domain, with general computers using previously stored digital samples or in real-time with dedicated hardware. In this section we consider the time domain methods of implement digital filters, In next section we will concern with frequency domain.

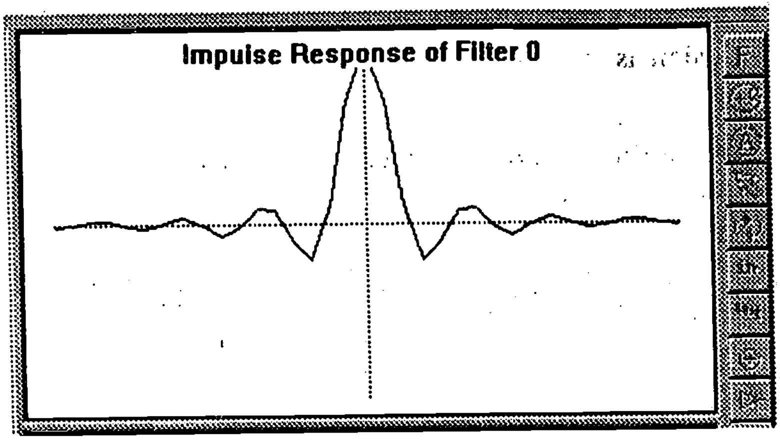
A typical filter structure contain N memory elements used to store the input samples and N memory element used to store output samples. As a new sample come in, the content of each of the input memory elements are copied to the memory elements to the right. As each output sample is formed by accumulating the products of the coefficients and the stored values, the output memory elements are copied to the left. The series of memory elements forms a *digital delay line* , The delayed values used to form the filter output are called *taps*. In the figured 1a, the FIR filter is illustrated and in the IIR figured is in figured 1b.

The FIR filter have several properties that make them useful for wide range of applications. A perfect linear phase response can easily be constructed with an FIR filter allowing the signal to be passed without phase distortion, FIR filters are inherently stable so stability concerns do not arise in the design or implementation phase of development. Even through FIR typical require a large number of multiplies and adds per input samples, they can implemented using fast convolution with FFT algorithm(see section 3). Many techniques have been developed for design and implementation FIR filter.

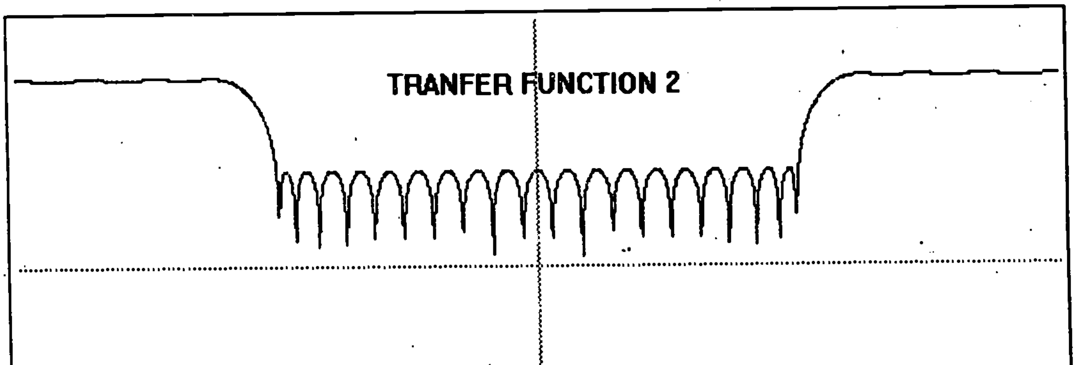
Windowing is perhaps the simplest and oldest FIR design one. But the window design method has no independent control over the passband and stopband ripple . Also the filter with unconventional responses such as multiple passband filters can not be design.

The other method is optimal FIR filter design with equiripple error with different weights in the passbands and stopbands. This class of FIR filters is widely used primarily because of the well-known Remez exchange algorithm developed for FIR filters by McClellan and Parks.

The Impulse response of 35 point FIR lowpass filter design using McClellan-Park program is illustrated in figured 4 and figured 5.



Figured 4. Impulnse Response of lowpass filter

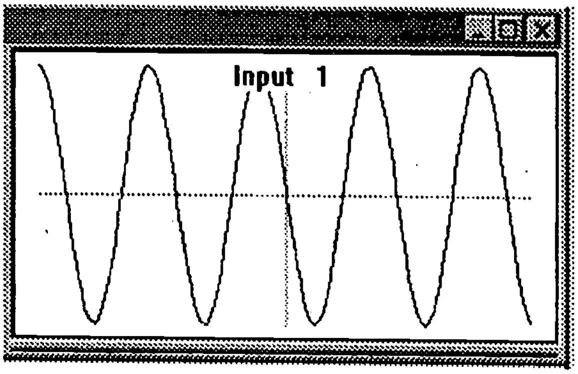


Figured 5. Transfer function of Lowpass filter in figured 4. (taken 1024 points)

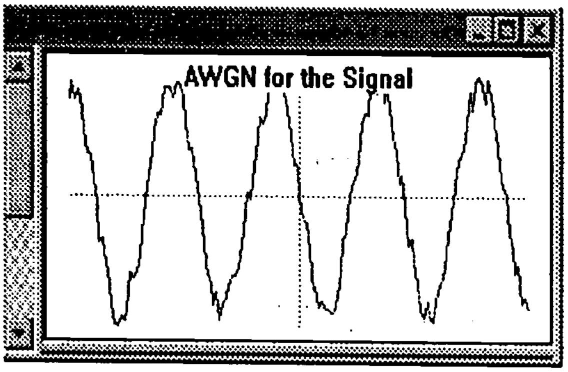
Infinite Impulse Response IIR filters are commonly realised recursively by feeding back the weighted sum of past output values and adding this to a weighted sum of the previous and current input values. The advantage of IIR compared to FIR filters is that a given order IIR can made much more frequency selective than the same order FIR filters, in other words, IIR filters are computationally efficient. The disadvantage of the recursive realisation is that IIR filters are much more difficult to design and implement, stability, round-off noise, and sometimes phase non-linear must be considered carefully in all but more trivial IIR filter design. We now review a structure where parallel or cascade some second order section. To design IIR filter, we can use many ways, but by far the most common IIR design method is bilinear transform. This method relies on the existence of a known s-domain transfer function (or Laplace transform) of the filter to be designed, the s-domain filter coefficients are transformed into equivalent z-domain coefficients for use in an IIR digital filter. This might seem like a problem, since s-domain transfer function are just hard as to determine as z-domain transfer functions, fortunately, Laplace transform in s-domain transfer function were developed many years ago for designing analogue filters as well as for modelling mechanical and even biological systems. Thus,

many tables of s-domain filter coefficients are available for almost any type of filter function. So the IIR design is performing the bilinear transform from set of s-domain coefficients to z-domain.

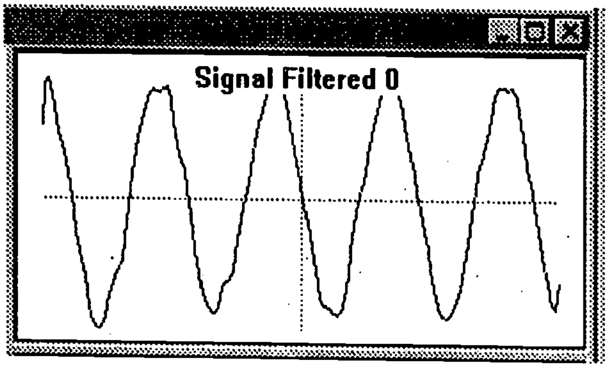
Some Application of filter can be introduced here is filtering a band, filtering noise, and interpolation and decimation.



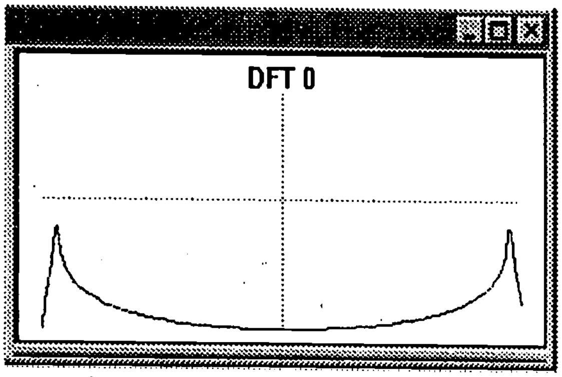
Figured 11a. Original signal to noise (frequency = 0.03,Length = 150)



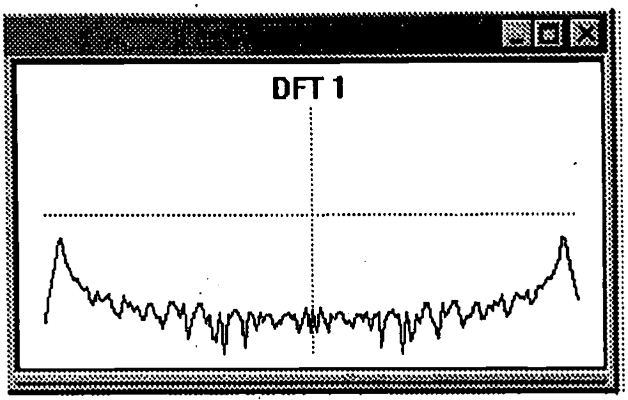
Figured 11. Noise add to signal (150 poitns, factor = 0.3 where maximun of signal is unity)



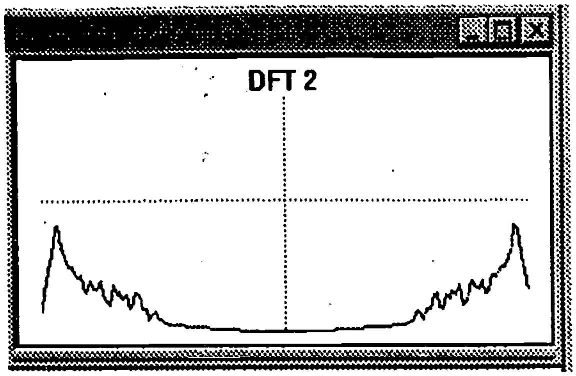
Figured 11c. After Lowpass filtering



Figured 11d. Spectrum of original signal in figured 11a.



Figured 11e. Spectrum of noisy signal in figured 11.b



Figured 11f. Spectrum of signal after lowpass filtering shown in figured 11c

3. Frequency Domain Processing (Discrete Fourier transform & Fast Fourier Transform)

Spectrum analysis is the process of determining the correct frequency domain representation of a sequence. From spectrum analysis information about the underlying frequency content of a sampled waveform such as bandwidth and central frequency is derived. There are many methods to determine frequency content and the choice of method depends on the characteristics of the signal to be analysed. Some of the characteristics important to determining the spectrum analysis method are :

(1) signal to noise ration of the signal;

(2) statistical character of the noise (Gaussian or the other);

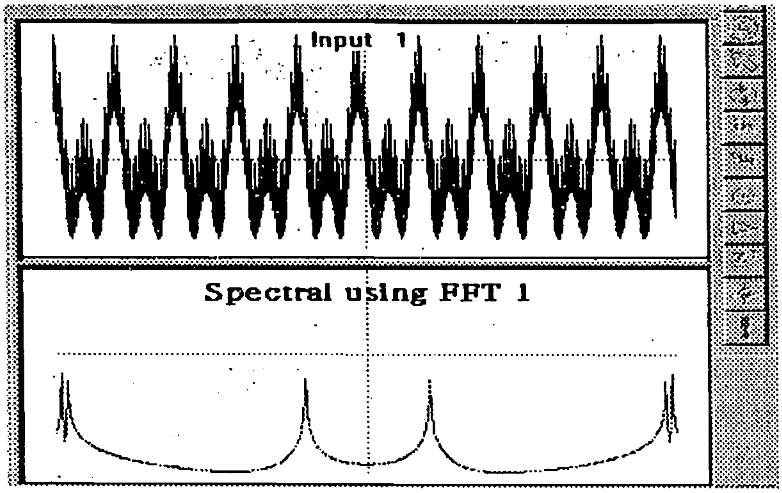
(3) spectral character of the noise (white, colour);

(4) length of sequence compared to rate of sampling

(5) any corruption of the signal due to interference.

There are two broad classes of spectrum analysis techniques : those which are based on Fourier transform and those which are not, We now turn our attention to the first, and the techniques begin with the discrete Fourier transform and its inverse(DFT&IDFT). The reason Fourier transform techniques are so popular and practical is the existence of the fast calculation algorithm, the FFT, which uses the symmetry and periodicity property of DFTs , the development of these computationally efficient algorithms is adopt a divide and conquer approach, this approach is based on the decomposition of an N points DFT into successively smaller DFTs , We now review split N points DFT into 2 N/2 points DFTs , with N is power of 2, and say FFT radix-2 algorithm, there two ways to compute FFTs radix 2 is decimation in frequency(DIF) and in time(DIT) .

The figured 11 is illustrated for FFT and DFT. With the signal sequence input is sum of three sinusoid have 0.01,0.02,0.4.



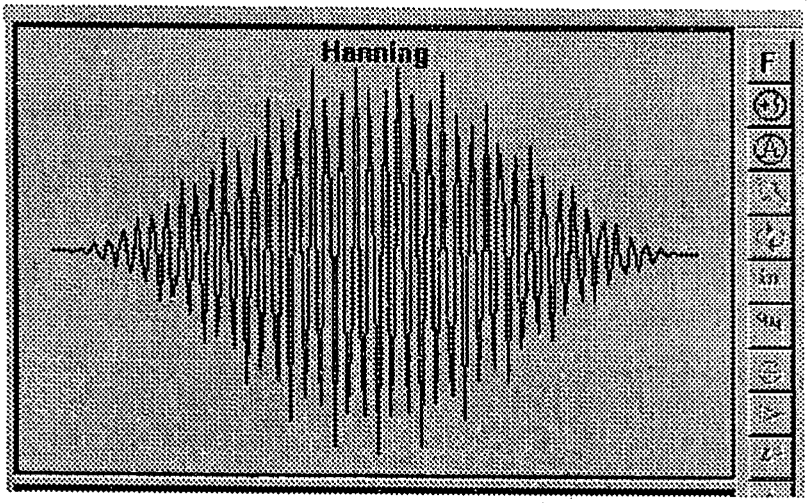
Figured 1. Spectral of signal withs 3 terms (0.01,0.02,0.4)

When we uses FFT or DFT the problem arise is the sideslopes of a spectral output. To reduction that phenomenon, we uses ***window*** , they accomplish this by forcing beginning and end of any sequence to approach each other in value, and for satisfy any sequence this values near to zero, To make up for this reduction in power , windowing process give extra weight to the values near middle of the sequence.

For example the Hanning window is :

$$h[n] = 0.54 - 0.46*\cos(2\pi n/(N-1))$$

The window is illustrated here in figured 8b.



Figured 8b. Hanning Window

The FFT is an extremely useful tool for spectral analysis, the applications of its can be recalled are fast convolution, power spectrum estimation and interpolation/decimation. Once important application of FFTs are often used is *fast convolution* . Most often a relatively short sequence say 20 to 200 points in length (for

example, FIR filter) must be convoluted with a number of longer input signal sequences, the input sequence length might be 1000 samples or greater and may be changing with time as, for instance, new data samples are taken. We can straightly implement of time domain convolution equation, but using the convolution theorem , we can have an alternative method

$$x(n) < \frac{FFT}{IFFT} > X[k]$$

$$h(n) < \frac{FFT}{IFFT} > H[k]$$

$$y(n) < \frac{FFT}{IFFT} > Y[k]$$

so, if

$$y[n]= x[n]*h[n]$$

then $$Y[k]= X[k]H[k]$$

(1) we first create array H(k) from impulse response h[n] using FFTs,

(2) then create array X(k) from the sequence x[n] using FFTs.

(3) Multiply H by X point by point thereby obtaining Y(k)

(4) Apply the inverse FFT to Y(k) in order to create y[n].

The speed of FFT make convolution using FFTs a practical technique, In fact many application fast convolution using the FFT can be significantly faster than normal time domain convolution.

The second important application of FFT is *Power spectral estimation* , signal found in most practical DSP systems do not have constant power spectrum. The spectrum of Radar signals, communication signals and voice wave forms change continually with time . This mean that an FFT run on a single set of samples is of very limited use. More often a series of spectral are required at time intervals determined by the type of signal and the information to extracted.

Power spectral estimation using FFTs provides these power spectrum snapshot (called *periodograms*). The average of a series of periodograms of the signal is used as a estimate of the spectrum of signal at a particular time. One common application areas for power spectral estimation is speech recognition. The power spectral of voice signal give essential clues to sound which was being made by the speaker. Almost all the information in voice signals is contained in frequencies below 3500 Hz, A common voice sampling frequency which gives some margin above the Nyquyst rate is 8000Hz. The spectrum of a typical voice signal change every 10 msec or 80 samples at 8000Hz, As a result popular FFT sizes for speech research are 128 points.

The third application is interpolation using FFTs, in section 2 , we was discussed about interpolation in time domain using FIR filters, The interpolation now can be perform in frequency domain using FFTs techniques. The results is the same of that of precise, but speeds are more increase.

4.Conclusion

This paper is only cover some essential parts of DSP, the theory and application in DSP are still left so much, the Objective of this paper is to present an introduction of the basic analysis tools and techniques for DSP. Although the DSP of analog signals has some drawbacks, for example, conversion of an analogue signals into digital form, accomplished by samplings the signal and quantizing the samples, results in a distortion that prevents us from reconstructing the original analog signal from quantized samples, or the finite precision effects that must be considered in DSP, But with all advantage of digital signal processing over analogue signal processing, the DSP is the basic subject of almost of the present processing.

Generally , Digital signal processing is a very important task . The final purpose is to satisfy request of human being . These requests designer to manage to build models of Digital signal processing practically and perfectly .

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[2] Akaike,H,-"Power Estimation through auto regression Model Fitting" 1969

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SESSION 3

Thursday, 15 January 1998

Session 3: Educational software

Chair:
Prof. Tran Van Hao, University of Education, HCMC,Vietnam

3-1.Courseware Engineering
Nguyen Thanh Son,Ngo Ngoc Bao Tran, Quan Thanh Tho,Nguyen Hong Lam, University of Technology, HCMC-Vietnam

3-2. Machine Discovery theorems in Geometry: A helpful tool in teaching Geometry
Hoang Kiem, Vu Thien Can, University of Natural Sciences, HCMC,Vietnam

3-3. Model of Problems in analytic geometry and automatically solving
Do Van Nhon, University of Natural Sciences, HCMC,Vietnam

3-4.Heuristic Based Scheduling in High School
Nguyen Duc Thang, College of General Studies, HCMC,Vietnam

3-5.Model of Knowledge of analytic geometry
Do Van Nhon, University of Natural Sciences, HCMC,Vietnam

COURSEWARE ENGINEERING

Nguyen Thanh Son, Nguyen Ngoc Bao Tran
Quan Thanh Tho, Nguyen Hoang Lam
University of Technology, HCMC, Vietnam

Abstract

This report contains a method of engineering courseware. The method emphasizes on finding out the main ideas of the subject. From these ideas, the objectives and requirements are constructed. After that, the demonstration are performed on discrete mathematics and electronic experimentals of high school degree.

Contents

The courseware is an environment to help the studying. The environment assists to develop the structure of the lectures and to set up a control system. This system manages the activities of the learner. It also gives the feedbacks and evaluations on the activities of the user. The education and training are two main domains of the courseware.

First of all, the courseware satisfies the needs of education of everyone. In the situation of lacking teacher, courseware are considered as a teacher. Secondly, it assists teacher and learner. Thirdly, it standardizes the content and form of the lectures. Next, the courseware helps the learner to study all the life. At last, it contributes on the education emotionous and intellectual.

The courseware includes:

- Tutorial - Drill and practice
- Simulation - Game.

From the survey on discrete mathematics, the courseware should have the properties: generalization, specialization, computability, symbolization ...

Conclusion

The development of the courseware will support the standardization of the lecture and it will equalize the education degree between areas. Many programmers will get a lots of works from the development. Besides, the information technology will be progressed naturally. The responsibility of the young people in society will be increased. When developing, the priority of the specific and local problems will be higher than others. In the future, a data bank of courseware should be setup rapidly.

MACHINE DISCOVERY THEOREMS IN GEOMETRY: A Helpful Tool In Teaching Geometry

Hoang Kiem , Vu Thien Can
University of Natural Sciences, HCMC, Vietnam

Abstract

In teaching mathematics, especially geometry, the teacher's task for making students know how to find a problem is much more difficult than to solve a problem. The schools are teaching a set program of mathematics, rather how to do mathematics. Very few writers indeed have taken an interest in more active, as opposed to the usual passive, methods of teaching, to the phenomenon of discovery, to include reasoning , to the way the thought process works. There is a need to study the technical and cognitive aspects of the teaching process and to make a full evaluation of there.

Our aim is to help the teachers, as well as the students, to find the geometrical problems easily via experiments.

This paper describes a system for discovering and proving theorems in the domain of plane geometry. Our system generates geometrical figures by itself and acquires expressions describing relations among line segments and angles in the figures. Such expressions can be extracted from the numerical data obtained in the computer experiments. For proving theorems, we use the Wu's algorithm.

1.Discovering geometry theorems

1.1 We use the following two heuristics to discover geometry theorems

(H_1) drawing figures by adding lines.

(H_2) focusing on the expressions about lines segments and angles which are newly generated by the last additional line.

The former enables the system to draw various figures automatically and to acquire data by observing the figures. The latter avoids the combinatorial explosion without using knowledge for search.

1.2 Algorithm

The followings are the main steps of the algorithm.

- Drawing figures

In order to draw various figures for the acquisition of data, lines are added one by one on a given base figure. In this paper, a circle is chosen as the base figure since many interesting

figures can be drawn from a circle. To guide line drawing, focus points are introduced as the center of a circle, a point on the circumference, contact points, and intersection points. Lines are drawn on the following way according to the focus points:

From a focus point outside the circle

- Draw a tangential line to the circle
- Draw a line which passes through the center of the circle
- Draw an arbitrary line which has common points with the circle

From a focus point on the circle circumference

- Draw a tangential line which touches the circle at the focus point
- Draw a line which passes through the center of the circle
- Draw an arbitrary line to a point on the circumference

From a focus point outside the circle

- Draw a line which passes through the center of the circle
- Draw an arbitrary line which has common points with the circle

One can also draw a line parallel (or perpendicular) to a line joining two points in the figure and passing a point in the figure.

Figure 1 shows a part of drawn figures in the above way.

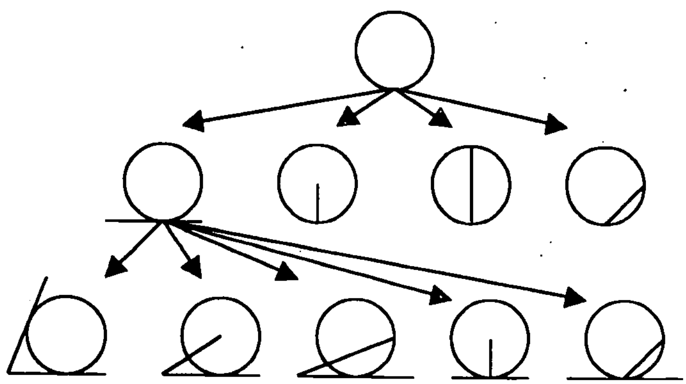


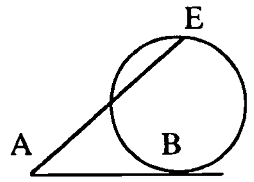
Figure 1

Acquisition of theoretical candidates

By observing the figure drawn in the above procedure, numerical data are acquired such as the length of line segments and the measure of angles. The length of line segments, and the sum and the product of the length of two arbitrary line segments are

listed from the data. An expression, which we call a theoretic candidate, is acquired from two approximately equal numerical values in the list. From the data of angles also, theoretic candidates are acquired in the same manner.

Figure 2 shows a theoretic candidate : $AB^2 = AD.AE$



AB = 11.0	AB*AB = 121.0
BC = 7.5	AB*BC = 82.5
AC = 18.5	AB*AD = 91.3
AD = 8.3	.....
DE = 6.2	AD*AE = 120.4
AE = 24.5	....

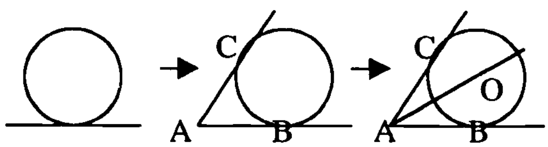
Figure 2

Selection of useful theoretic candidates

Many theoretic candidates are acquired from a figure. As additional lines are drawn on a figure, the number of line segments and angles increases, and the combination of line segments and angles increases accordingly. As a result, numerous theorematic candidates can be acquired from a complicated figure composed of many lines. To obtain only useful theorems from many acquired theorematic candidates, it is important to select useful theorematic candidates.

Let us focus on the relations of line segments and angles which are newly generated by drawing an additional line on a figure. Since theorematic candidates about the newly generated line segments and angles cannot be acquired from the figure before drawing additional line, such candidates can be considered useful.

Figure 3 shows the selection of useful theorematic candidate



AB = AC $\angle OAB = \angle OAC$

Figure 3

Verification of theorematic candidates

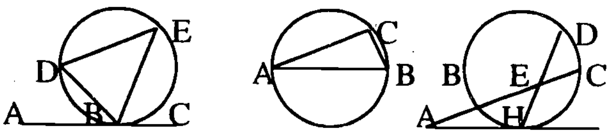
The theorematic candidates which hold only for the original figure, the figure from which they are acquired, are not true theorems. To remove such candidates, every candidate from the original figure should be tested whether the candidates holds for other

figures which topologically resemble the original figure. Such figure are re-drawn by adding lines in the same order as the original figure. This is because the figures are used for making other experiments which resemble the one using the original figure. Since an additional line is drawn at random in length and in direction, re-drawn figures are, in general, partly different from the original figure. As a result of the above experiments, a theorematic candidate which holds for all the figures is regarded as a useful theorem of great generality.

1.3 Conclusion

We have proved that, using the above algorithm, the hypotheses and conclusions of the theorematic candidates acquired can be expressed by polynomial equations which coefficients are in a field E containing the field Q of all rational numbers as a subfield.

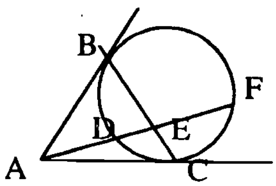
Using the above algorithm, we also rediscover many well-known theorems (Figure 4), as well as many theorems which are not found in a conventional book of geometry (Figure 5).



$\angle DEB = \angle DBA$ $\angle ACB = 90^0$ $AB.AC = AH^2$

$\angle EDB = \angle EBC$ $BE.BC = DE.EH$

Figure 5



$$AE.AF = AC^2 + AD.EF$$
$$AD.AF = AE^2 + CE.CB$$
$$AD.AF = AE^2 + DE.EF$$
$$EF.AF = AD.DE + DF^2$$
$$AE.EF = DE.AF + CE.EB$$
$$AD.EF = AE.DE + CE.EB$$
$$AD.EF = DE.AF$$

Figure 6

2.Proving Geometry Theorems

2.1 An overview of Wu's algorithm

Wu's method was introduced as a mechanical method for proving those statements in elementary geometries for which, in their algebraic forms, the hypotheses and the conclusion can be expressed by *polynomial equations.*

For a geometry statement (S), after adopting an appropriate coordinate coordinate system, the hypotheses can be expressed as a set of polynomial equations:

$h_1(u_1, ..., u_d, x_1, ..., x_t) = 0$

$h_2(u_1, ..., u_d, x_1, ..., x_t = 0$

....

$h_n(u_1, ..., u_d, x_1, ..., x_t) = 0$

and the conclusion is also a polynomial equation $g = g(u_1, ..., u_d, x_1, ..., x_t) = 0$; where $h_1, ..., h_n$ and g are polynomials in $Q[u_1, ..., u_d, x_1, .., x_t]$. Here $u_1, ..., u_d$ are parameters and $x_1, ..., x_t$ are dependent variables.

The assignment of parameters and variables is based on the following heuristics rules:

(1) Non-zero coordinates of an arbitrarily chosen point are parameters.

(2) If a point is constructed from one geometric condition, then one of its two coordinates is a parameter and the other is a variable.

(3) The two coordinates of a point constructed from two geometric conditions are variables.

It should be emphasized that these rules are based on the heuristic rule in algebra: one equation determines one unknown. It is the responsibility of the user to justify whether a point can be arbitrarily chosen or two conditions can really construct a point based on the geometric meaning of a given problem.

2.2 Some definitions and results

Pseudo Division

Let A be a computable commutative ring (e.g., $Q[y_1, ..., y_m]$). Let $f = a_n v^n + ... + a_0$ and $h = b_k v^k + ... + b_0$ be two polynomials in A[v], where v is a new indeterminate. Suppose k, the leading degree of h in v, is greater than 0. Then the pseudo division proceeds as follows:

First let $r = f$. Then repeat the following process until $m = deg(r,v) < k$: $r = b_k r - c_m v^{m-k} h$, where c_m is the leading coefficient of r. It is easy to see that m strictly decreases after each iteration. Thus the process terminates. At the end, we have the *pseudo remainder prem*(f,h,v) = r = r_0 and the following formula:

$$b_k^s f = qh + r_0 \text{, where } s \le n - k + 1 \text{ and } deg(v_0, r) < deg(v, h).$$

Proposition: (The remainder formula)

Let $f_1, ..., f_r$ and R_0 be the same as above. There are some non-negative integers $s_1, ..., s_r$ and polynomials $Q_1, ..., Q_r$ such that:

(1) $I_1^{s1}.I_2^{s2} \ldots I_r^{sr}.g = Q_1.f_1 + Q_2.f_2 + \ldots + Q_r.f_r + R_0$ where the I_i are the leading coefficients of the f_i .

(2) $\deg(R_0, x_i) < \deg(f_i, x_i)$, for $i = 1,2,\ldots,n$.

A Triangulation Procedure: Ritt's Principle

<u>Theorem</u>: (Ritt's principle)

Let $S = \{h_1, \ldots, h_n\}$ be a finite nonempty polynomial set in $A = K[y_1, \ldots, y_m]$ and I be the ideal $(h_1, \ldots, h_n)$ of A.

There is an algorithm to obtain an ascending chain C such that either

- C consists of a polynomial in $K \cap I$ or
- $C = f_1, \ldots, f_r$ with $\text{class}(f_1) > 0$ and such that $f_i \in I$ and $\text{prem}(h_j, f_1, \ldots, f_r) = 0$ for all $i = 1, \ldots, r$ and $j = 1, \ldots, n$.

Ascending chain C is called *an extended characteristic set* of S.

Ritt's Decomposition Algorithm

<u>Definition</u>: A subset V of E^m is called an *algebraic set* if V is the set of common zeros of all elements of a nonempty polynomial set S, i.e.

$$V = \{(a_1, \ldots, a_m) \in E^m \mid f(a_1, \ldots, a_m) = 0 \text{ for all } f \in S\}$$

We often denote V by V(S).

<u>Theorem</u>: (Ritt's decomposition algorithm)

For any finite nonempty polynomial set S of A, there is an algorithm to decide whether Ideal(S) = (1) or (in the opposite case) to decompose

$$V(S) = V(P_1) \cup V(P_2) \cup \ldots V(P_s)$$

where P_i are prime ideals given by their irreducible characteristics sets.

Notion: Let E be any extension of the based field K. When we mention the algebraic set V(S), we mean the algebraic set V(S) in E^m.

The Algebraic formulation of Geometry Statements

<u>Definition</u>:

Let a geometry statement (S), in its algebraic form, be given by $u_1, \ldots, u_d, x_1, \ldots, x_r, h_1, \ldots, h_n$ and g, where u_i, x_i, h_i and g are the same as before. (S) is called generally true (or generally valid) if g vanishes on all non degenerate components $V(P_i^*)$ of $V = V(h_1, \ldots, h_n)$. "(S) is not generally true" is the negation of "(S) is generally true". If g vanishes on none of the nondegenerate components $V(P_i^*)$, the (S) is called generally false.

2.3 The Wu's method consists of the following steps

Step 1: Conversion of a geometry statement into the corresponding polynomial equations.

Step 2: Triangulation of the hypothesis polynomials using pseudo division.

Step 3: Successive pseudo division to compute the final remainder R_0. If $R_0 = 0$, then by the remainder formula we can infer the conclusion by adding the subsidiary or

nondegenerate conditions available after triangulation. If R_0 is not zero, then the decomposition or check of irreducibility is needed to make further conclusions.

Step 4: Analysis of nondegenerate conditions $I_1 \neq 0, ..., I_r \neq 0$.

2.4 Some important results:

Theorem: Let (S), $h_1, ..., h_n$, g and $f_1, ..., f_r$ be the same as above. Suppose $f_1, ..., f_r$ is irreducible. If prem(g, $f_1, ..., f_r$) = 0 then:

(i) (S) is generally true, and

(ii) For all fields, ($h_1 = 0, ..., h_n = 0, I_1 \neq 0, ..., I_r \neq 0$) $\Rightarrow$ g = 0, where the I_k are the leading coefficients of the f_k.

Theorem: Let (S), $h_1, ..., h_n$, g and $f_1, ..., f_r$ be the same as above. Suppose ascending chain $f_1, ..., f_r$ is irreducible. Let P be the prime ideal wih the characteristic set $f_1, ..., f_r$. Let E be the field associated with the geometry G. prem(g, $f_1, ..., f_r$) = 0 is the necessary condition for (S) to be generally true if one of the following conditions is satisfied:

(i) For E, V(P) is of degree d

(ii) E is algebraically closed field

(iii) $f_1, ..., f_r$ has a generic point in E.

Let C_i be the characteristic set of P_i as above.

Theorem: If prem(g,C_i) = 0 , i = 1,2,.., c then (S) is generally true.

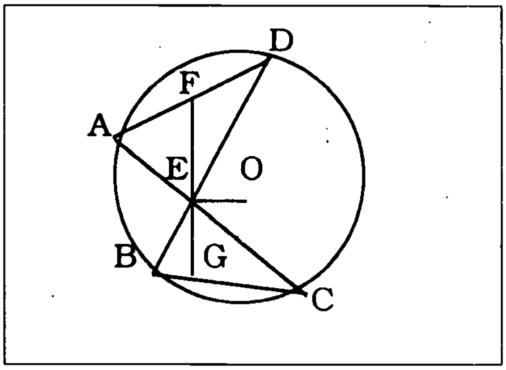
2.5 Conclusion

Using the above theorems, we can prove automatically whether or not a theorem is true.

3.An example

Generate figure

Figure 1 shows one figure generated by our system:



Acquisition of theorematic candidates

The observed numerical data:

OE = 7.5 EA = 8.5 ;EB = 6.2 ;EC = 8.4 ;ED = 11.02 ; EF = 7.8 ;EG = 7.7 ;

FA = 6.8 ;FD = 9.4 ;GB = 4.2 ;GC = 6.1 ;

We have: EF and EG are approximately equal.

Verification of theorematic candidates

The FIGURE 1 is re-drawn by adding lines in the same order as the original figure and we have the same result.

<u>*Theorem:*</u> (The Butterfly theorem)

A, B, C and D are four points on circle (O). E is the intersection of AC and BD. Through E draw a line perpendicular to OE, meeting AD at F and BC at G. We have EF = EG.

<u>*Proof*</u>:

Let E (0,0), O(u_1, 0), A(u_2, u_3), B(x_1, u_4), C(x_3, x_2), D(x_5 x_4), F(0, x_6), G(0, x_7). Then the hypotheses equations are:

$h_1 = x_1^2 - 2u_1x_1 + u_4^2 - u_3^2 - u_2^2 + 2u_1u_2 = 0$ OA = OB

$h_2 = x_3^2 - 2u_1x_3 + x_2^2 - u_3^2 - u_2^2 + 2u_1u_2 = 0$ OA = OC

$h_3 = u_3x_3 - u_2x_2 = 0$ Points C, A, E are collinear

$h_4 = x_5^2 - 2u_1x_5 + x_4^2 - u_3^2 - u_2^2 + 2u_1u_2 = 0$ OA = OD

$h_5 = u_4x_5 - x_1x_4 = 0$ Points D, B, E are collinear

$h_6 = (-x_5 + u_2)x_6 + u_3x_5 - u_2x_4 = 0$ Points F, A, D are collinear

$h_7 = (-x_3 + x_1)x_7 + u_4x_3 - x_1x_2 = 0$ Points G, B, C are collinear

The conclusion is $g = x_7 + x_6 = 0$.

We can let: $f_1 = h_1$, $f_2 = \text{prem}(h_2, h_3, x_3)$, $f_3 = h_3$, $f_4 = \text{prem}(h_4, h_5, x_6)$, $f_5 = h_5$, $f_6 = h_6$, $f_7 = h_7$ to obtain a triangular form:

$f_1 = -x_1^2 + 2u_1x_2 - u_4^2 + u_3^2 + u_2^2 - 2u_1u_2 = 0$

$f_2 = (-u_3^2 - u_2^2)\, x_2^2 + 2u_1u_2u_3x_2 + u_3^4 + (u_2^2 - 2u_1u_2)\, u_3^2 = 0$

$f_3 = -u_3x_3 + u_2x_2 = 0$

$f_4 = (-x_1^2 - u_4^2)\, x_4^2 + 2u_1u_4x_1x_4 + (u_3^2 + u_2^2 - 2u_1u_2)u_4^2 = 0$

$f_5 = -u_4x_5 + x_1x_4 = 0$

$f_6 = (-x_5 + u_2)x_6 + u_3x_5 - u_2x_4 = 0$

$f_7 = (-x_3 + x_1)x_7 + u_4x_3 - x_1x_2 = 0$

If we do successive pseudo divisions of g with respect to the above triangular form, then the final remainder R_0 is not zero. The reason is that the above triangular form is *reducible*. This reducibility comes from a special kind of degeneracy when using algebraic equations to encode certain geometric conditions. Equations h_2=0 and h_3=0 specify point

C: C is on circle (O) and on line AE. However, there are two points satisfying these equations: one is C, which we really want; the other point is A. Because A has been constructed before C, reducibility arises. We might use the Wu' method to deal with such reducibility. However, for such special reducibility, we can use elementary method, which is more satisfactory in geometry.

Because $f_2 = 0$ and $f_3 = 0$ have two solutions (one is for $A(u_2, u_3)$ and the other is for $C(x_3, x_2)$), $x_2 - x_3$ is a factor of f_2 under the previous geometric conditions: $f_2 = (x_2 - u_3)((-u_3^2 - u_2^2)x_2 - u_3^3 + (-u_2^2 + 2u_1u_2)u_3)$. Thus we can use the division to obtain $f_2^1 = (-u_3^2 - u_2^2)\, x_2 - u_3^3 + (-u_2^2 + 2u_1u_2)u_3$ and replace f_2 by f_2^1. In the same way, we have: $f_4 = (x_4 - u_4)f_4^1 + r$ where $f_4^1 = (-x_1^2 - u_4^2)x_4 - u_4x_1^2 + 2u_1u_4x_1 - u_4^3$, and $r = -u_4^2x_1^2 + 2u_1u_4^2x_1 - u_4^4 + (u_3^2 + u_2^2 - 2u_1u_2)u_4^2$.

We have $\mathrm{prem}(r,f_1,x_1) = 0$. Hence, under the previous conditions $f_i = 0$ and $I_i \neq 0$ ($i=1,2,3$): $f_4 = (x_4 - u_4)f_4^1$. We can replace f_4 by f_4^1 to obtain the nondegenerate triangular form f_1, f_2^1, f_3, f_4^1, f_5, f_6, f_7. Now we can do the successive divisions of g with respect o the new triangular form:

$R_6 = \mathrm{prem}(R_7,f_7,x_7) = (-x_3 + x_1)x_6 - u_4x_3 + x_1x_2$

$R_5 = \mathrm{prem}(R_6,f_6,x_6) = ((u_4 + u_3)x_3 - x_1x_2 - u_3x_1)x_5 + (-u_2x_3 + u_2x_1)x_4 - u_2u_4x_3 + u_2x_1x_2\,)$

$R_4 = \mathrm{prem}(R_5,f_5,x_5) = (((-u_4 - u_3)x_1 + u_2u_4)x_3 + x_1^2x_2 + u_3x_1^2 - u_2u_4x_3)x_4 + u_2u_4^2x_3 - u_2u_4x_1x_2)$

$R_3 = \mathrm{prem}(R_4,f_4^1,x_4) = ((-u_4^2 - u_3u_4)x_1^3 + (2u_1u_4^2 + 2u_1u_3u_4)x_1^2 + (-u_4^4 - u_3u_4^3 - 2u_1u_2u_4^2)x_1)x_3 + (u_4x_1^4 + ((u_2 - 2u_1)u_4)x_1^3 + u_4^3x_1^2 + u_2u_4^3x_1)x_2 + u_3u_4x_1^4 + (-u_2u_4^2 - 2u_1u_3u_4)x_1^3 + (u_3u_4^3 + 2u_1u_2u_4^2)x_1^2 - u_2u_4^4x_1)$

$R_2 = \mathrm{prem}(R_3,f_3,x_3) = (-u_3u_4x_1^4 + (u_2u_4^2 + 2u_1u_3u_4)x_1^3 + (-u_3u_4^3 - 2u_1u_2u_4^2 - 2u_1u_2u_3u_4)x_1^2 + (u_2u_4^4 + 2u_1u_2^2u_4^2)x_1)x_2 - u_3^2u_4x_1^4 + (u_2u_3u_4^2 + 2u_1u_3^2u_4)x_1^3 + (-u_3^2u_4^3 - 2u_1u_2u_3u_4^2)x_1^2 + u_2u_3u_4^4x_1$

$R_1 = \mathrm{prem}(R_2,f_2^1,x_2) = 2u_1u_2u_3^2u_4x_1^4 - (2u_1u_2^2u_3u_4^2 + 4u_1^2u_2u_3^2u_4)x_1^3 + (2u_1u_2u_3^2u_4^3 + 4u_1^2u_2^2u_3u_4^2 + (-2u_1u_2u_3^4 + (-2u_1u_2^3 + 4u_1^2u_2^2)u_3^2)u_4)x_1^2 + (-2u_1u_2^2u_3u_4^4 + (2u_1u_2^2u_3^3 + (2u_1u_2^4 - 4u_1^2u_2^3)u_3)u_4^2)x_1$

$R_0 = \mathrm{prem}(R_1,f_1,x_1) = 0$

Since the final remainder R_0 is 0, the theorem follows from the following subsidiary conditions:

$I_2 = u_3^2 + u_2^2 \neq 0; I_3 = u_3 \neq 0; I_4 = x_1^2 + u_4^2 \neq 0; I_5 = u_4 \neq 0; I_6 = x_5 - u_2 \neq 0; I_7 = x_3 - x_1 \neq 0;$

4.Conclusion

We have described an approach for discovering useful theorems in the domain of plane geometry by employing experimentation. Our system discovers theorems by using nothing but the heuristics of drawing figures and the heuristics on focusing on newly generated line segments and angles. We have rediscovered theorems in conventional documents of plane geometry. We have also discovered a number of of usefule theorems.

Logically, we have used Wu's algorithm for demonstrating the preciseness of these theorems. Additionally, we have determined that the above theorems can be proved by Wu's algorithm. For illustration: The Butterfly Theorem.

The topic we mentioned in the paper can be leaded in two ways:

(1) With the above discovery, whether any proofs are needed ?

(2) If needed, whether any manipulations more simple than Wu's algorithm to prove the preciseness of the theorems we have found ?

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MODEL OF PROBLEMS IN ANALYTIC GEOMETRY AND AUTOMATICALLY SOLVING

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Abstract

Our aim is to analyze and design a system for solving problems in 3-dimensional analytic geometry. We would like to produce a useful program for students in learning mathematics. We researched some problems to construct the components in the structure of the system.

In this paper we propose a general model that can be used for representing problems of 3-dimensional analytic geometry according to the model AG. By this modeling we have some algorithms to solve automatically problems in 3-dimensional analytic geometry on computer. So we can construct an inference engine of the program that solve problems in analytic geometry.

1. The model of problems in analytic geometry.

1.1 General form of problems

Consider problems in 3-dimensional analytic geometry we can see that each of them has the hypothesis part and the conclusion part (or the question part, goal). The hypothesis and the conclusion have the following forms.

1.1.1. Hypothesis

According to AG model the hypothesis of problems may consists of some or all of the cases below:

- Given objects in which there are some objects that is determined and another objects are not determined. For example, the point A(1,2,3) and the plane (P) which has the equation 2x+3y-z=0 are determined objects, the line (d) which has the unique fact that passes the point A is not determined.

- Some attributes of the objects may be given by parameters.

- We may also have some geometry relations between objects in the hypothesis. For example, the line (d) / / the plane (P).

- Some computing relations may be given in the hypothesis. For example, u + v = w.

1.1.2. Question or goal of problems

In analytic geometry problems questions or goal has the general form which consists of some of the following cases:

- Determine an object or an attribute (or some attributes) of an object.
- Compute the value of parameters.
- Prove a relation between objects.
- Find some relations between objects.

1.2. Model of a problem

From the general form of problems in the above subsection we see that a problem can be represented by the sets below:

$$O = \{O_1, O_2, \ldots, O_n\},$$
$$R = \{r_1, r_2, \ldots, r_m\},$$
$$F = \{f_1, f_2, \ldots, f_p\}.$$

In the model the set O consists of n objects, R is the set of facts that give geometry relations between objects, and F consists of computing expressions on the objects or their attributes. In the set F there are also equalities that give us the values of some attributes of objects.

The goal of problem may be one of the followings:

- Determine an object.
- Determine an attribute (or some attributes) of an object.
- Consider a relation between objects.
- Find a relation between objects.
- Find an expression relative to some objects.
- Compute a parameter (or some parameters).
- Compute a value relative to objects such as the distance between a point and a line.

Example: Given the points E and F, and the line (d). Suppose E, F, and (d) are determined. (P) is the plane satisfying the relations: $E \in (P)$, $F \in (P)$, and $(d) // (P)$. Find the general equation of (P).

In this exercise the objects and the facts are listed in the tables below:

Kind of object	Name of object	determination
point	E	yes
point	F	yes
line	D	yes
plane	P	no

The geometry relations between objects:

Kind of relation	Name of object	Name of object
∈	E	P
∈	F	P
//	D	P

Expressions: don't have.

The goal of the problem:

Goal	Object	Name of object	attribute
Attribute	plane	P	*equation*

2. Solving problems

2.1. Forward Chaining Algorithm

From the idea of the forward chaining algorithm we can find out a solution of the problem by the following algorithm:

<u>Algorithm 1</u>:

step 1. Record the objects in the problem and the goal of the problem.

step 2. Initialize the solution be empty.

step 3. Record the facts given (hypothesis):

- Determination of objects.
- Relations between objects.
- Expressions relative to objects.
- Attributes which are determined of objects.

step 4. Test the goal. **If** the goal obtained **then goto** the reducing step (step 9).

step 5. Search for the rule that can be applied to produce new facts or new objects.

step 6. if the search in step 5 fail **then**

conclusion: Solution not found, and **stop**.

step 7. if the search in step 5 success **then**

record the information about the rule found into the solution,

and the new facts or new objects produced by applying the rule.

step 8. goto step 4.

step 9. Reducing the solution found.

2.2. Forward Chaining Algorithm with heuristics

To find out a solution more quickly we will use heuristic rules in the above algorithm. Consider the way people solve the problems we use heuristic rules in our algorithm. The followings are some of the rules we use.

Rule 1. priority to use the rules for determining objects, features of objects. For examples:

- A point which has coordinates known is determined.
- A point and a perpendicular vector of a plane will determine the plane.
- A plane which has the equation known is determined.
- A line which has two points determined is determined.

Rule 2. priority to use the rules for producing new relations relative to the goal.

Rule 3. priority to use the rules for producing new objects relative to the goal. For examples:

- A plane has two points determined $\Rightarrow$ produce a direction vector of the plane.
- A line (d) determined and (d) // a plane (P) $\Rightarrow$ produce a direction vector of the plane (P).
- A line (d) determined and (d) $\perp$ a plane (P) $\Rightarrow$ produce a perpendicular vector of the plane (P).
- A line (d) determined and (d) $\subseteq$ a plane (P) $\Rightarrow$ produce a direction vector of the plane and a point in the plane (P).

Rule 4. priority to use backward chaining step in the case it has one branch.

Rule 5. priority to determine the object has relations to the goal.

Rule 6. if a parameter need to be determined then we should use computing rules and operations.

Rule 7. If we could not produce new facts or objects then use parameters and equations.

By using heuristic rules we have the folowing algorithm:

<u>Algorithm 2</u>:

step 1-4. The same as the algorithm1.

Step 5. Use heuristic rules to select a good direction for producing new facts or objects and obtain a new situation.

step 6. if selecting in step 5 success **then**

record a stage in the solution, and **goto** step 4.

step 7. Search for the rule that can be applied to produce new facts or new objects.

step 8. if the search in step 7 fail **then**

conclusion: Solution not found, and **stop.**

step 9. if the search in step 7 success **then**

record the information about the rule found into the solution,

and the new facts or new objects produced by applying the rule.

step 10. goto step 4.

step 11. Reducing the solution found.

2.3. Using patterns

Solving many problems we can see that there are patterns of problems usually met. Recording those patterns and their solutions will help us improve the solving of problems. From the algorithm 2 we can write down the algorithm 3 in which there is the step for considering the ability to use patterns. However, the algorithm 3 is not written here. Belows are some patterns of problems:

- Pattern 1: Find the plane passes the intersection of two planes and passes a point.
- Pattern 2: Find the plane passes two lines.
- Pattern 3: Find the plane perpendicular to two planes and passes a point.

2.4. Testing algorithms

In the above algorithm we need some algorithm for testing the determination of objects. The following is the algorithm for testing the determination of a plane.

Algorithm for testing the determination of a plane (P)

1. Compute number of points determined in (P): d.
2. Compute number of vectors determined perpendicular to (P): n.
3. **if** $(d \geq 1)$ **and** $(n \geq 1)$ **then** P is determined

   else continue step 4.
4. **if** $(d \geq 3)$ **and** (there are 3 points of (P) that are not alignment) **then**

   P is determined

   else continue step 5.
5. Compute number of vectors determined parallel to (P): u.
6. **if** $(d \geq 1)$ **and** $(u \geq 2)$ **and**

   (there are 2 vectors v1, v2 not parallel each other and they parallel to P) **then**

   P is determined.

3. Examples

Example 1:

Given the points E and F, and the line (d). Suppose E, F, and (d) are determined. (P) is the plane satisfying the relations: E ∈ (P), F ∈ (P), and (d) // (P). Find the general equation of (P).

Solution:

By the algorithm 2 we have a solution consists of the following steps:

1. E ∈ (P), F ∈ (P) produce a vector u // (P). (rule 2 &3)
2. (d) // (P) produce a vector v // (P). (rule 3)
3. (P) is determined. (rule 1)
4. we have the equation of (P) from the object (P). (rule 1)

Example 2

Given the planes (Q1) and (Q2), and the line (d). Suppose (Q1), (Q2), and (d) are determined. (P) is the plane satisfying the relations: (d) // (P), and (P) passes the intersection of (Q1) and (Q2),. Find the general equation of (P).

Solution:

By the algorithm 2 we have a solution consists of the following steps:

1. (d) // (P) produce a vector v // (P). (rule 3)
2. Produce a line (d') such that: (d') ⊆ (P), (d') ⊆ (Q1), (d') ⊆ (Q2).
3. (d') is determined.
4. produce a point M determined in (P) and a vector v // (P).
5. (P) is determined. (rule 1)
6. we have the equation of (P) from the object (P). (rule 1)

4. Conclusions

The method of modeling problems in the above sections and algorithms for solving problems represent a natural way to solve the problems of people. It help us to design and implemented programs that can automatically solve exercises in 3-dimensional analytic geometry. We hope that our results may be developed and applied in the design and implement program that can automatically solve different problems

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HEURISTIC BASED SCHEDULING IN HIGH SCHOOL

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1. Scheduling problem and Min-Conflicts Heuristic

1.1. Scheduling problem

- Scheduling is the process of selecting among alternative plans and assigning resources and times to the set of activities in the plans. The assignments must obey a set of rules or constraints that reflect the temporal relationships between activities and the capacity limitations of a set of shared resources.
- Scheduling have been shown to be an NP-hard problem (Garey & Johnson, 1979; Graves, 1981; French, 1982).

1.2. The Min-Conflicts Heuristic

A constraint-satisfaction problem (CSP) consists of a set variables and a set of constraints. A solution is an assignment specifying a value for each variable, such that all the constraints are satisfied.

The min-conflicts heuristic includes two phases :

Preprocessing phase: generating an initial assignment for all variables. Two variables conflict if their values violate a constraint.

Repairing phase: repeating to repair constraint violations until a consistent assignment is achieved. This phase can be characterized by following procedure : *Select a variable that is in conflict and assign it a value that minimizes the number of conflicts.*

This procedure results in a hill-climbing search.

2. Scheduling in High School

2.1. School scheduling problem

Given : Let L= {Lessons(Teacher, Subject, Class)} be a set of lessons and D a set of time-slots in a week.

Require : Assign a value $Di \in D$ for each lesson $Li \in L$ so that all the constraints are satisfied. Essential constraints include :

-No class and no teacher can have more than one lesson at a time,

-a teacher has unavailable time-slots,

-the lessons of a class in a day must be continuous ,

-a teacher has a limit on the number of all lessons in a day and a limit on the number of lessons of a class in a day,

-a set of lessons must be taken simultaneously,

2.2. The criteria to evaluate quality of school time-table

2.2.1.Defining the priority point for teacher

-Teachers are principal factor to realizing STB (*school time-table*). A teacher has a private situation determining his/her priority if there is any difficulty in scheduling.

-Priority point of the teachers PP(t) is defined as follow :

PP(t) = Priority Point(teacher) = 1 for every teacher. In addition, PP(t) will be added :
+ 1, if the teacher is female,

+ 1, if the teacher is female and has baby,

+ 1, if the teacher is old.

PP(t) = 5 in special case.

2.2.2. The conception of an "un -arrangable lesson"

A time slot Di ∈ D is "assignable" for a lesson Lj ∈ L if it can be assigned to Lj so that all constraints are satisfied. If an "assignable" Di for lesson Lj is not existing then Lj will be called "un-arrangable" into STB .

2.2.3.The penalty point of school time-table

When there is an "un-arrangable" lesson of a teacher with priority point PP(t) = K , the STB will incur penalty point = K. The penalty point of the STB is :

$P = \sum_t N_t * PP(t)$; N_t: number of "un-arrangable" lessons of teacher t.

2.2.4. The fragment of school time-table

When a teacher's arranged lessons in a day are not continuous, they are called fragment. Most teachers don't want their lessons to be fragment.

time-slot	Mon	Tue	Wed	Thu	Fri	Sat
1						class 9A2
2		class 8A2			class 8A3	class 8A1
3						
4						
5					class 9A1	

Figure 1 : The time-table of a teacher with fragment point = 5

-The fragment point of a teacher in a day is defined as follows :

FP(t, d) = 0, if the teacher t hasn't any lesson in the day d

= 3, if the teacher t has only one lesson in the day d

= number of the teacher's empty time-slots of his/her lessons in the day d.

-The fragment point of STB is : $F = \sum_t \sum_d FP(t,d)$

2.2.5. The quality of STB

The quality based on 3 criteria:

1. With the same a set of data, less "un-arrangable" lessons, the better STB is. The main goal of scheduling is minimizing a number of "un-arrangable" lessons into STB.

2. If two STBs have an equal number of "un-arrangable" lessons, less fragment point, the better STB is.

3. If two STBs have an equal number of "un-arrangable" lessons, less penalty point, the better STB is.

3. Implement the scheduling

The scheduling system includes two phases : *initial assignment* and *repairing school time-table.*

3.1. The initial assignment

Purpose: Creating initial STB with most lessons assigned assignable values.

Method : Using principle of order, the more lessons, the more priority is.

In following schema, LC is a set of the "un-arrangable" lessons .

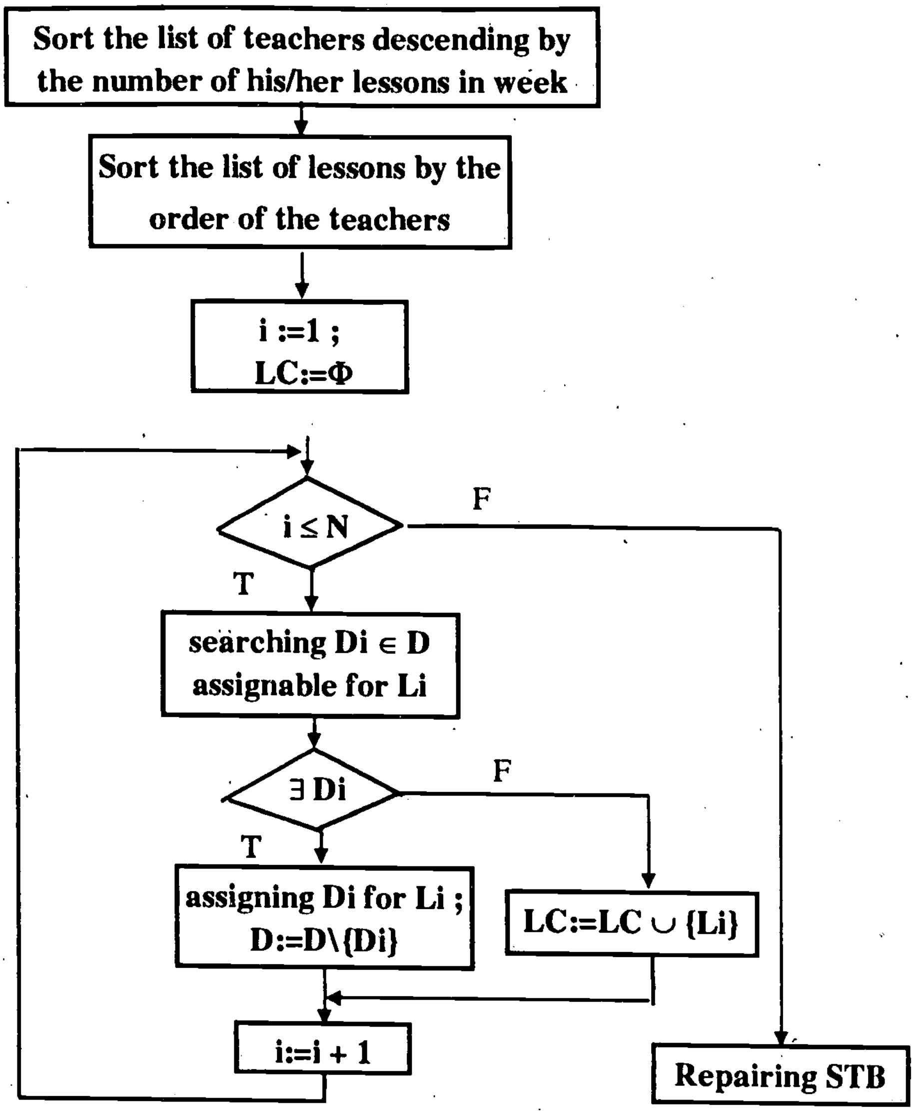


Figure 2: Schema of the initial assignment
(*N : number of lessons*)

3.2. The repairing STB

3.2.1 General schema of the repairing STB

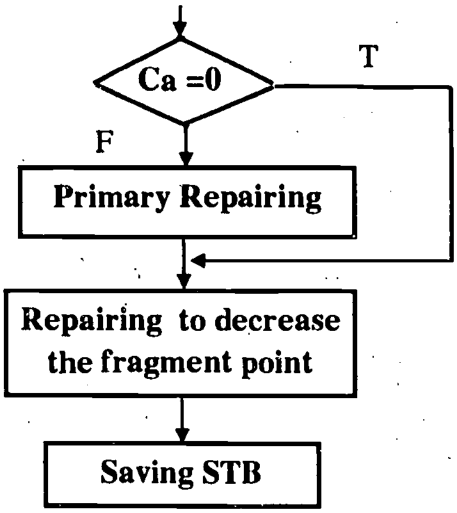


Figure 3: General schema of the repairing STB
(*Ca : Cardinality(LC)*)

3.2.2. The primary repairing STB

Purpose :Minimizing the Cardinality(LC) while reducing the fragment point and penalty point of STB.

Step 1 : Sort the list of teachers descending by the priority point of the teachers.

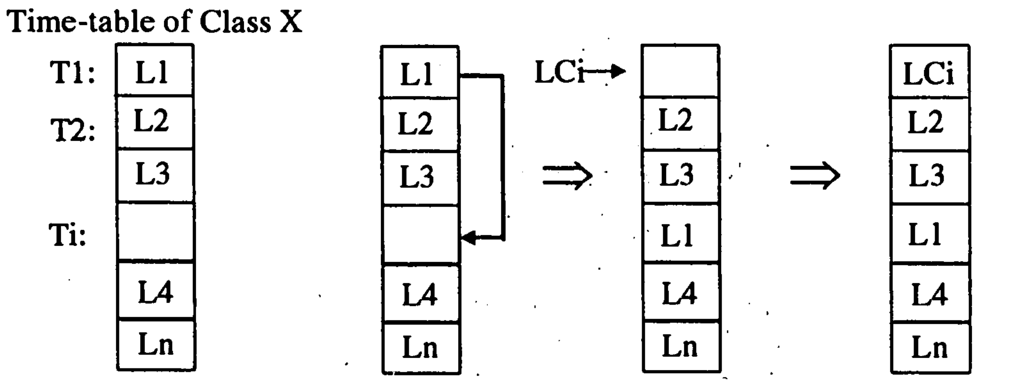
Step 2 : Sort the list of lessons $\in$ LC by the order of the teachers.

Step 3 : For each lesson LCi $\in$ LC , swap the values assigned for the lessons $\in$ L \ LC to search a value Di "assignable" for LCi, and then assign Di for LCi.

Step 4 : Repeat step 2 and step 3 until LC = Φ.

In the step 3, there are some special procedures. Below just is the illustration of the procedure named Vertical Repairing.

Let LCi $\in$ LC be an " un-arrangable" lesson of the class X and L1, L2,..., Ln be lessons arranged into time-table of the class X .



Moving L1 to empty Ti & assigning T1 for LCi creates the less fragment than moving L2 to Ti & assigning T2 for LCi

Moving L1 to the empty time-slot Ti

Assigning T1 for LCi

LCi is arranged into time-table of the class X with the lest fragment.

Figure 4: A effective case of vertical repairing

3.2.3. Repairing to decrease the fragment

Purpose: Minimizing the fragment point of STB.

Step 1: Un-assigning values Di assigned for Li that creates high fragment point, and add Li into LC,

Step 2 : Call the procedure primary repairing,

Step 3 : Repeat step 1 and step 2 until fragment point of STB < a constant ε.

4. The applications and the pending questions

The system is applied to the scheduling problems for three schools in Ho Chi Minh city: Tran Van On secondary school, ThanhDa high school and GoVap evening continuation high school. The qualities of the time-tables are rather good.

However, fragment points of the some teachers were still high.

References

[1] Masazumi Yoshikawa, Kazuya Kaneko, Toru Yamanouchi, and Masanobu Watanabe C &C Research Laboratories, NEC Corporation," A constraint-based high school scheduling system " - AI in Japan, February, 1996.

[2] Monte Zweben, Mark S. Fox - " Intelligent Scheduling " - Morgan Kaufmann Publishers Inc., San Francisco, California, 1994.

The appendix

1. The database

Scheduling problem at Tran Van On secondary school includes 14 classes (class 7A1,.., class 7A14), 28 teachers, 30 weekly time-slots, and 350 lessons. A teacher, which is the head of a class, has more one lesson CỜ and one lesson SHCN. The lessons CCỜ of all classes are simultaneous, the lessons SHCN are similar.

The unavailable days for the lessons of the subjects :

1. Monday :	SỬ , ĐỊA	4. Thursday:	GDCD
2. Tuesday :	TOÁN, LÝ	5. Friday:	SINH, ANH
3. Wednesday:	HÓA ,VĂN	6. Saturday :	KỸ.T

Below is the database of the problem.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
No	Name	code	Subj	head of	class 7A1	class 7A2	class 7A3	class 7A4	class 7A5	class 7A6	class 7A7	class 7A8	class 7A9	class 7A10	class 7A11	class 7A12	class 7A13	class 7A14	Σ less	PP(t)
1	Thuận	VA2	VĂN	7A4	5			5								5			17	2
2	Yến	VA4	VĂN	7A11			5							5	5				17	2
3	Trang	TO1	TOÁN	7A1	5	5								5					17	2
4	Hường	TO3	TOÁN	7A6			5		5	5									17	2
5	Hội	TO6	TOÁN	7A8								5	5				5		17	2
6	Thể	SI1	SINH		2		2	2	2	2	2				2	2			16	6
7	Lộc	LY2	LÝ		2		2	2	2	2	2						2	2	16	6
8	Mai	VA3	VĂN									5	5				5		15	2
9	Thảo	VA5	VĂN						5	5	5								15	1
10	Vân	AV4	ANH	7A5					4			4		4					14	2
11	Nga	AV2	ANH	7A9	4								4					4	14	2
12	Nghĩa	SI2	SINH	7A14		2						2	2	2			2	2	14	2
13	Trân	DI1	ĐỊA		2		2	2	2	2	2				2				14	2
14	Hiền	LY1	LÝ	7A10		2						2	2	2	2	2			14	2
15	Thanh	AV3	ANH	7A3		4	4										4		14	2
16	Hùng	DI2	ĐỊA			2						2	2	2		2	2	2	14	1
17	Lan	TO2	TOÁN	7A7				5			5								12	2
18	Lợi	VA1	VĂN	7A2		5												5	12	2
19	Nhi	AV5	ANH					4		4	4								12	2
20	Danh	TO4	TOÁN												5	5			10	6
21	Hương	SU2	SỬ	7A13		1						1	1	1	1	1	1	1	10	2
22	Hằng	AV1	ANH	7A12											4	4			10	2
23	Chính	GD1	GDCD			1	1	1	1	1		1	1	1	1	1			10	1
24	Thu	KY2	KỸ.T			1						1	1	1	1	1	1	1	8	2
25	Nhung	SU1	SỬ		2		1	1	1	1	2								8	2
26	Thủy	KY1	KỸ.T		1		1	1	1	1	1								6	2
27	Diệp	TO5	TOÁN															5	5	2
28	Chi	GD2	GDCD														1	1	2	2

Database of scheduling problem at Tran Van On school

2. The Initial School time table :

Number of un-arrangable lessons : 21 Arrangable ratio : 94%

Penalty point : 68 Fragment Point : 77

Class	7A1	7A2	7A3	7A4	7A5	7A6	7A7	7A8	7A9	7A10	7A11	7A12	7A13	7A14
2.1	ANH (Nga)	TOÁN (Trang)	GDCD (Chính)	TOÁN (Lan)	TOÁN (Hường)	ANH (Nhi)	VĂN (Thảo)	ANH (Vân)	VĂN (Mai)	VĂN (Yến)	SINH (Thể)	VĂN (Thuận)	TOÁN (Hội)	LÝ (Lộc)
2.2		TOÁN (Trang)	KỸ.T (Thủy)	TOÁN (Lan)	TOÁN (Hường)	LÝ (Lộc)	SINH (Thể)	ANH (Vân)	VĂN (Mai)	VĂN (Yến)	LÝ (Hiền)	VĂN (Thuận)	TOÁN (Hội)	ANH (Nga)
2.3	KỸ.T (Thủy)	SINH (Nghĩa)	ANH (Thanh)	VĂN (Thuận)	VĂN (Thảo)	TOÁN (Hường)	TOÁN (Lan)	VĂN (Mai)	TOÁN (Hội)	TOÁN (Trang)	VĂN (Yến)	SINH (Thể)	LÝ (Lộc)	ANH (Nga)
2.4	TOÁN (Trang)	VĂN (Lợi)	ANH Thanh)	VĂN (Thuận)	ANH (Vân)	TOÁN (Hường)	TOÁN (Lan)	TOÁN (Hội)	ANH (Nga)	LÝ (Hiền)	VĂN (Yến)	ANH (Hằng)	VĂN (Mai)	SINH (Nghĩa)
2.5	CCỜ (Trang)	CCỜ (Lợi)	CCỜ (Thanh)	CCỜ (Thuận)	CCỜ (Vân)	CCỜ (Hường)	CCỜ (Lan)	CCỜ (Hội)	CCỜ (Nga)	CCỜ (Hiền)	CCỜ (Yến)	CCỜ (Hằng)	CCỜ (Hương)	CCỜ (Nghĩa)
3.1		ANH (Thanh)		ĐỊA (Trân)	ANH (Vân)	SINH (Thể)	VĂN (Thảo)	SINH (Nghĩa)	ANH (Nga)	VĂN (Yến)	ANH (Hằng)	VĂN (Thuận)	VĂN (Mai)	VĂN (Lợi)
3.2	VĂN (Thuận)	ANH (Thanh)	VĂN (Yến)	ANH (Nhi)	SINH (Thể)	ĐỊA (Trân)	VĂN (Thảo)	GDCD (Chính)	SINH (Nghĩa)	ANH (Vân)	ANH (Hằng)	ĐỊA (Hùng)	VĂN (Mai)	VĂN (Lợi)
3.3	VĂN (Thuận)	VĂN (Lợi)	VĂN (Yến)	SINH (Thể)	SỬ (Nhung)	VĂN (Thảo)	ANH (Nhi)	ĐỊA (Hùng)	VĂN (Mai)	ANH (Vân)		SỬ (Hương)	SINH (Nghĩa)	KỸ.T (Thu)
3.4	ANH (Nga)	ĐỊA (Hùng)	SINH (Thể)	GDCD (Chính)	KỸ.T (Thủy)	VĂN (Thảo)	ANH (Nhi)		VĂN (Mai)	SINH (Nghĩa)	KỸ.T (Thu)	ANH (Hằng)	ANH (Thanh)	GDCD (Chi)
3.5	#	#	#	#	#	#	#	#	#	#	#	#	#	#
4.1	SỬ (Nhung)	SINH (Nghĩa)	ANH (Thanh)	ANH (Nhi)	GDCD (Chính)	TOÁN (Hường)	TOÁN (Lan)	ANH (Vân)	ANH (Nga)	TOÁN (Trang)	ĐỊA (Trân)	SINH (Thể)	TOÁN (Hội)	LÝ (Lộc)
4.2		ANH (Thanh)	SỬ (Nhung)	TOÁN (Lan)	ĐỊA (Trân)	TOÁN (Hường)	LÝ (Lộc)	ANH (Vân)	SINH (Nghĩa)	TOÁN (Trang)	SINH (Thể)	LÝ (Hiền)	TOÁN (Hội)	ANH (Nga)
4.3		TOÁN (Trang)		TOÁN (Lan)	TOÁN (Hường)	ĐỊA (Trân)	SINH (Thể)	SINH (Nghĩa)	TOÁN (Hội)	ANH (Vân)	LÝ (Hiền)	ĐỊA (Hùng)	LÝ (Lộc)	ANH (Nga)

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Lớp	7A1	7A2	7A3	7A4	7A5	7A6	7A7	7A8	7A9	7A10	7A11	7A12	7A13	7A14
4.4	ANH (Nga)	TOÁN (Trang)	LÝ (Lộc)	TOÁN (Lan)	TOÁN (Hường)	SINH (Thể)	GDCD (Nhung)	LÝ (Hiền)	TOÁN (Hội)	ANH (Vân)	SỬ (Hương)	TOÁN (Danh)	SINH (Nghĩa)	ĐỊA (Hùng)
4.5	#	#	#	#	#	#	#	#	#	#	#	#	#	#
5.1	VĂN (Thuận)	ĐỊA (Hùng)	VĂN (Yến)	LÝ (Lộc)	SINH (Thể)	VĂN (Thảo)	ANH (Nhi)	TOÁN (Hội)	LÝ (Hiền)	KỸ.T (Thu)	ANH (Hằng)	TOÁN (Danh)	ANH (Thanh)	VĂN (Lợi)
5.2	VĂN (Thuận)	LÝ (Hiền)	VĂN (Yến)	SINH (Thể)	LÝ (Lộc)	VĂN (Thảo)	ANH (Nhi)	TOÁN (Hội)	SỬ (Hương)	ĐỊA (Hùng)	ANH (Hằng)	TOÁN (Danh)	ANH (Thanh)	TOÁN (Diệp)
5.3	TOÁN (Trang)	ANH (Thanh)	TOÁN (Hường)	ĐỊA (Trân)	VĂN (Thảo)	LÝ (Lộc)	SINH (Thể)	VĂN (Mai)	KỸ.T (Thu)	SỬ (Hương)	TOÁN (Danh)	ANH (Hằng)	ĐỊA (Hùng)	TOÁN (Diệp)
5.4	TOÁN (Trang)	ANH (Thanh)	TOÁN (Hường)	VĂN (Thuận)	VĂN (Thảo)	ANH (Nhi)	ĐỊA (Trân)	VĂN (Mai)	ĐỊA (Hùng)	VĂN (Yến)	TOÁN (Danh)	LÝ (Hiền)	KỸ.T (Thu)	LÝ (Lộc)
5.5	#	#	#	#	#	#	#	#	#	#	#	#	#	#
6.1	SỬ (Nhung)	VĂN (Lợi)	ĐỊA (Trân)	TOÁN (Lan)	KỸ.T (Thủy)	VĂN (Thảo)	LÝ (Lộc)	KỸ.T (Thu)	VĂN (Mai)	TOÁN (Trang)	VĂN (Yến)	VĂN (Thuận)	TOÁN (Hội)	ĐỊA (Hùng)
6.2	LÝ (Lộc)	LÝ (Hiền)	TOÁN (Hường)	GDCD (Chính)	ĐỊA (Trân)	SỬ (Nhung)	VĂN (Thảo)	ĐỊA (Hùng)	TOÁN (Hội)	TOÁN (Trang)	VĂN (Yến)	VĂN (Thuận)	VĂN (Mai)	VĂN (Lợi)
6.3	ĐỊA (Trân)	TOÁN (Trang)	TOÁN (Hường)	KỸ.T (Thủy)	LÝ (Lộc)	GDCD (Chính)	VĂN (Thảo)	SỬ (Hương)	TOÁN (Hội)	VĂN (Yến)	TOÁN (Danh)	KỸ.T (Thu)	VĂN (Mai)	VĂN (Lợi)
6.4	TOÁN (Trang)	KỸ.T (Thu)	LÝ (Lộc)	VĂN (Thuận)	VĂN (Thảo)	KỸ.T (Thủy)	TOÁN (Lan)	TOÁN (Hội)	LÝ (Hiền)	VĂN (Yến)	GDCD (Chính)	TOÁN (Danh)	ĐỊA (Hùng)	SỬ (Hương)
6.5	#	#	#	#	#	#	#	#	#	#	#	#	#	#
7.1	VĂN (Thuận)	SỬ (Hương)	VĂN (Yến)	TOÁN (Lan)	TOÁN (Hường)	ANH (Nhi)	ĐỊA (Trân)	VĂN (Mai)	GDCD (Chính)	ĐỊA (Hùng)	SINH (Thể)	TOÁN (Danh)	LÝ (Lộc)	TOÁN (Diệp)
7.2	ANH (Nga)	VĂN (Lợi)	TOÁN (Hường)	TOÁN (Lan)	ANH (Vân)	ANH (Nhi)	SINH (Thể)	VĂN (Mai)	ĐỊA (Hùng)	SINH (Nghĩa)	TOÁN (Danh)	GDCD (Chính)	TOÁN (Hội)	TOÁN (Diệp)
7.3	TOÁN (Trang)	VĂN (Lợi)	ĐỊA (Trân)	VĂN (Thuận)	ANH (Vân)	TOÁN (Hường)	TOÁN (Lan)	TOÁN (Hội)	ANH (Nga)	LÝ (Hiền)	VĂN (Yến)	SỬ (Hương)	ANH (Thanh)	SINH (Nghĩa)
7.4	SHCN (Trang)	SHCN (Lợi)	SHCN (Thanh)	SHCN (Thuận)	SHCN (Vân)	SHCN (Hường)	SHCN (Lan)	SHCN (Hội)	SHCN (Nga)	SHCN (Hiền)	SHCN (Yến)	SHCN (Hằng)	SHCN (Hương)	SHCN (Nghĩa)
7.5	#	#	#	#	#	#	#	#	#	#	#	#	#	#

3. The School time table repaired:

Number of un-arrangable lessons : 0   Arrangable ratio : 100%

Penalty point : 0   Fragment Point : 79

Lớp	7A1	7A2	7A3	7A4	7A5	7A6	7A7	7A8	7A9	7A10	7A11	7A12	7A13	7A14
2.1	ANH (Nga)	TOÁN (Trang)	GDCD (Chính)	LÝ (Lộc)	TOÁN (Hường)	VĂN (Thảo)	KỸ.T (Thủy)	LÝ (Hiền)	VĂN (Mai)	VĂN (Yến)	SINH (Thể)	VĂN (Thuận)	SINH (Nghĩa)	TOÁN (Diệp)
2.2	SINH (Thể)	TOÁN (Trang)	KỸ.T (Thủy)	ANH (Nhi)	TOÁN (Hường)	LÝ (Lộc)	VĂN (Thảo)	ANH (Vân)	VĂN (Mai)	GDCD (Chính)	LÝ (Hiền)	VĂN (Thuận)	TOÁN (Hội)	ANH (Nga)
2.3	KỸ.T (Thủy)	SINH (Nghĩa)	ANH (Thanh)	VĂN (Thuận)	VĂN (Thảo)	TOÁN (Hường)	TOÁN (Lan)	VĂN (Mai)	TOÁN (Hội)	TOÁN (Trang)	VĂN (Yến)	SINH (Thể)	LÝ (Lộc)	ANH (Nga)
2.4	TOÁN (Trang)	VĂN (Lợi)	ANH (Thanh)	VĂN (Thuận)	ANH (Vân)	TOÁN (Hường)	TOÁN (Lan)	TOÁN (Hội)	ANH (Nga)	LÝ (Hiền)	VĂN (Yến)	ANH (Hằng)	VĂN (Mai)	SINH (Nghĩa)
2.5	CCỜ (Trang)	CCỜ (Lợi)	CCỜ (Thanh)	CCỜ (Thuận)	CCỜ (Vân)	CCỜ (Hường)	CCỜ (Lan)	CCỜ (Hội)	CCỜ (Nga)	CCỜ (Hiền)	CCỜ (Yến)	CCỜ (Hằng)	CCỜ (Hương)	CCỜ (Nghĩa)
3.1	ĐỊA (Trân)	GDCD (Chính)	ANH (Thanh)	SỬ (Nhung)	ANH (Vân)	SINH (Thể)	VĂN (Thảo)	SINH (Nghĩa)	ANH (Nga)	VĂN (Yến)	ANH (Hằng)	VĂN (Thuận)	VĂN (Mai)	VĂN (Lợi)
3.2	ANH (Nga)	ANH (Thanh)	VĂN (Yến)	ANH (Nhi)	SINH (Thể)	ĐỊA (Trân)	VĂN (Thảo)	GDCD (Chính)	SINH (Nghĩa)	ANH (Vân)	ANH (Hằng)	ĐỊA (Hùng)	VĂN (Mai)	VĂN (Lợi)
3.3	VĂN (Thuận)	VĂN (Lợi)	VĂN (Yến)	SINH (Thể)	SỬ (Nhung)	VĂN (Thảo)	ANH (Nhi)	ĐỊA (Hùng)	VĂN (Mai)	ANH (Vân)	ĐỊA (Trân)	ANH (Hằng)	GDCD (Chi)	KỸ.T (Thu)
3.4	VĂN (Thuận)	ĐỊA (Hùng)	SINH (Thể)	ĐỊA (Trân)	VĂN (Thảo)	ANH (Nhi)	SỬ (Nhung)	ANH (Vân)	VĂN (Mai)	SINH (Nghĩa)	KỸ.T (Thu)	ANH (Hằng)	ANH (Thanh)	GDCD (Chi)
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4.1	GDCD (Nhung)	SINH (Nghĩa)	ANH (Thanh)	ANH (Nhi)	GDCD (Chính)	TOÁN (Hường)	TOÁN (Lan)	ANH (Vân)	ANH (Nga)	TOÁN (Trang)	ĐỊA (Trân)	SINH (Thể)	TOÁN (Hội)	LÝ (Lộc)
4.2	SINH (Thể)	ANH (Thanh)	SỬ (Nhung)	ANH (Nhi)	ĐỊA (Trân)	TOÁN (Hường)	LÝ (Lộc)	ANH (Vân)	SINH (Nghĩa)	TOÁN (Trang)	TOÁN (Danh)	LÝ (Hiền)	TOÁN (Hội)	ANH (Nga)
4.3	LÝ (Lộc)	TOÁN (Trang)	SINH (Thể)	TOÁN (Lan)	TOÁN (Hường)	ĐỊA (Trân)	ANH (Nhi)	SINH (Nghĩa)	TOÁN (Hội)	ANH (Vân)	LÝ (Hiền)	ĐỊA (Hùng)	SỬ (Hương)	ANH (Nga)

3.4.11

Lớp	7A1	7A2	7A3	7A4	7A5	7A6	7A7	7A8	7A9	7A10	7A11	7A12	7A13	7A14
4.4	ANH (Nga)	TOÁN (Trang)		LÝ (Lộc)	TOÁN (Hường)	SINH (Thể)	ĐỊA (Trân)	LÝ (Hiền)	TOÁN (Hội)	ANH (Vân)	SỬ (Hương)	TOÁN (Danh)	SINH (Nghĩa)	ĐỊA (Hùng)
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5.2	VĂN (Thuận)	LÝ (Hiền)	VĂN (Yến)	SINH (Thể)	LÝ (Lộc)	VĂN (Thảo)	ANH (Nhi)	TOÁN (Hội)	SỬ (Hương)	ĐỊA (Hùng)	ANH (Hằng)	TOÁN (Danh)	ANH (Thanh)	TOÁN (Diệp)
5.3	TOÁN (Trang)	ANH (Thanh)	TOÁN (Hường)	SỬ (Nhung)	VĂN (Thảo)	KỸ.T (Thủy)	ANH (Nhi)	VĂN (Mai)	KỸ.T (Thu)	SỬ (Hương)	TOÁN (Danh)	ANH (Hằng)	ĐỊA (Hùng)	TOÁN (Diệp)
5.4	TOÁN (Trang)	VĂN (Lợi)	TOÁN (Hường)	KỸ.T (Thủy)	VĂN (Thảo)	ANH (Nhi)	SỬ (Nhung)	VĂN (Mai)	ĐỊA (Hùng)		TOÁN (Danh)		KỸ.T (Thu)	
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6.1	GDCD (Nhung)	VĂN (Lợi)		ĐỊA (Trân)	TOÁN (Hường)	VĂN (Thảo)	LÝ (Lộc)	LÝ (Hiền)	VĂN (Mai)	TOÁN (Trang)	VĂN (Yến)	VĂN (Thuận)	TOÁN (Hội)	ĐỊA (Hùng)
6.2		LÝ (Hiền)	TOÁN (Hường)	TOÁN (Lan)	ĐỊA (Trân)	LÝ (Lộc)	VĂN (Thảo)	ĐỊA (Hùng)	TOÁN (Hội)	TOÁN (Trang)	VĂN (Yến)	VĂN (Thuận)	VĂN (Mai)	VĂN (Lợi)
6.3		TOÁN (Trang)	TOÁN (Hường)	VĂN (Thuận)	LÝ (Lộc)	GDCD (Chính)	VĂN (Thảo)	SỬ (Hương)	TOÁN (Hội)	VĂN (Yến)	ĐỊA (Trân)	LÝ (Hiền)	VĂN (Mai)	VĂN (Lợi)
6.4	TOÁN (Trang)	KỸ.T (Thu)	LÝ (Lộc)	VĂN (Thuận)	VĂN (Thảo)	SỬ (Nhung)	ĐỊA (Trân)	TOÁN (Hội)	LÝ (Hiền)	VĂN (Yến)	GDCD (Chính)	TOÁN (Danh)	ĐỊA (Hùng)	SỬ (Hương)
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7.1	VĂN (Thuận)	SỬ (Hương)	VĂN (Yến)		VĂN (Thảo)	ANH (Nhi)	GDCD (Nhung)	VĂN (Mai)	GDCD (Chính)	ĐỊA (Hùng)		TOÁN (Danh)	ANH (Thanh)	TOÁN (Diệp)
7.2	SINH (Thể)		TOÁN (Hường)		ANH (Vân)	ANH (Nhi)		VĂN (Mai)	ĐỊA (Hùng)		TOÁN (Danh)	GDCD (Chính)	GDCD (Chi)	TOÁN (Diệp)
7.3	TOÁN (Trang)	VĂN (Lợi)	ANH (Thanh)	VĂN (Thuận)	ANH (Vân)	TOÁN (Hường)	TOÁN (Lan)	TOÁN (Hội)	ANH (Nga)	LÝ (Hiền)	VĂN (Yến)	ANH (Hằng)	SỬ (Hương)	SINH (Nghĩa)
7.4	SHCN (Trang)	SHCN (Lợi)	SHCN (Thanh)	SHCN (Thuận)	SHCN (Vân)	SHCN (Hường)	SHCN (Lan)	SHCN (Hội)	SHCN (Nga)	SHCN (Hiền)	SHCN (Yến)	SHCN (Hằng)	SHCN (Hương)	SHCN (Nghĩa)
7.5	#	#	#	#	#	#	#	#	#	#	#	#	#	#

A MODEL OF KNOWLEDGE OF ANALYTIC GEOMETRY

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Abstract

Our aim is to analyze and design a system for solving problems in 3-dimensional analytic geometry. We would like to produce a useful program learning mathematics. We researched some problems to construct the components in the structure of the system.

In this paper we propose a model that can be used for representing knowledge of 3-dimensional analytic geometry called AG model. We also discuss some problems to construct knowledge base of 3-dimensional analytic geometry.

1. The AG-model for representing knowledge

One of the applications of Information Technology in education is to produce programs for supporting learning and teaching. Our subject is to analyze and design a system that can solve exercises in 3-dimensional analytic geometry. First of all, we need a model for representing knowledge of analytic geometry. The model will be a tool which help us to organize and implement the knowledge base of the system. In the following we propose the AG model for representing knowledge.

Our **AG model** consists of five sets Co, Ca, O, R, and L. We denote the model by

(Co, Ca, O, R, L).

Each set in the model is described as follows:

Co is the set of concepts. Each concept is concerned with a kind of objects. An object has attributes and between them there are internal relations which are manifested in the following features of the object:

- Given a subset A of attributes of the object. The object can show us the attributes that can be determined from A.
- The object will give us the value of an attribute if we request it.
- One object can also show us the internal process of determining the attributes.
- The object can give us the answer about the determination of object.

For example, the concepts "point", "vector".

Ca is the set of concepts relative to objects. These concepts may be concerned with attributes of objects. The concepts in Ca may also be concerned with values or objects can

be produced from another objects by certain rules. For example: coordinates of a point, equation of a line.

O is the set of operations such as dot product (or scalar product) of two vectors, and cross product of two vectors.

R is the set of kinds of relations between objects such as parallelism between two vectors, perpendicular between two vectors.

L is the set of rules. Each rule gives us a way for computing and/or deducing something relative to concepts, operations and relations.

In many subjects knowledge may be represented as AG model. In the next sections we will represent knowledge of 3-dimensional analytic geometry by the AG model.

2. Knowledge of 3-dimensional analytic geometry & AG model.

2.1. Knowledge of 3-dimensional analytic geometry

A part of knowledge of 3-dimensional analytic geometry is listed as follows:

2.1.1 The Cartesian coordinate system.

2.1.2 The concept "point" and some relatives:

- Coordinates of a point.
- Projection of a point on a line or on a plane.
- Distance or length between two points.
- Alignment of three points or more.

2.1.3 The concept "vector" and some relatives:

- Coordinates of a vector.
- Projection of a vector on a vector, on a line or on a plane.
- The vector between two points.
- The angle of two vectors.
- Operations on vectors: addition, subtraction, etc ...
- Relations between vectors: parallelism, perpendicular, etc ...
- Theorems and formulas.

2.1.4 The concept "plane" in space and relatives:

- Direction vectors of a plane.
- Perpendicular vector of a plane.
- A point belonging to a plane.
- Equation of a plane.

- Angle between two planes
- Relations between planes, etc .

2.1.5 The concept "line" and some relatives:

- Direction vector of a line.
- A point is belongs to a line.
- Equation of a line.
- Angle between two lines.
- Relations between lines, etc ...

2.1.6 Some rules:

- $u \perp v, u // w \Rightarrow v \perp w$
- $u // v, u \perp w \Rightarrow v \perp w$
- $u \perp v \Leftrightarrow u.v = 0$

2. 2. Dimensional analytic geometry Knowledge based on AG model.

From the list of knowledge in the above we can represent the of 3-dimensional analytic geometry knowledge based on AG model as follows:

2.2.1 The set Co consisting of the concepts: point, vector, plane, line, etc ...

2.2.2 The set Ca consisting of the following concepts:

- Coordinates (of a point, of a vector).
- Magnitude or length (of a vector).
- Direction vectors (of a plane).
- Perpendicular vector (of a plane).
- Equation (of a plane, of a line).
- Relative position (of two planes, of two lines, etc.).
- Intersection, etc.

2.2.3 The set O consisting of the following operations:

- Operations on vectors: addition, subtraction, scalar product, cross product, etc ..
- Distance computing.
- Intersection computing.
- Compute the angle (between two vectors, between two planes).
- Projection Computing, etc....

2.2.4 The set R consisting of the relations such as parallelism, perpendicular, alignment.

2.2.5 The set L consists of rules. They can be classified into following classes:

- Geometric relations.
- Properties of operations.
- Rules relative to computing expressions.

2.2.6 The set of objects and facts relative to the Cartesian coordinate system. It consists of the point O, the axes Ox, Oy, Oz, etc ....

3. Organization of Knowledge base

3.1. Components of knowledge base

Concerning the above representation of the knowledge, we can be organized the knowledge into the following components.

3.1.1 The dictionary of concepts about kinds of objects, attributes, operations, relations, computing values or objects, etc ....

3.1.2 Table for descriptions of structure and features of objects. For example, when a plane is determined we can ask it to compute and give us its attributes such as the equation of the plane, a perpendicular vector of the plane.

3.1.3 Rules for determining objects.

3.1.4 Rules for computing values or objects.

3.1.5 Rules or properties of the operations.

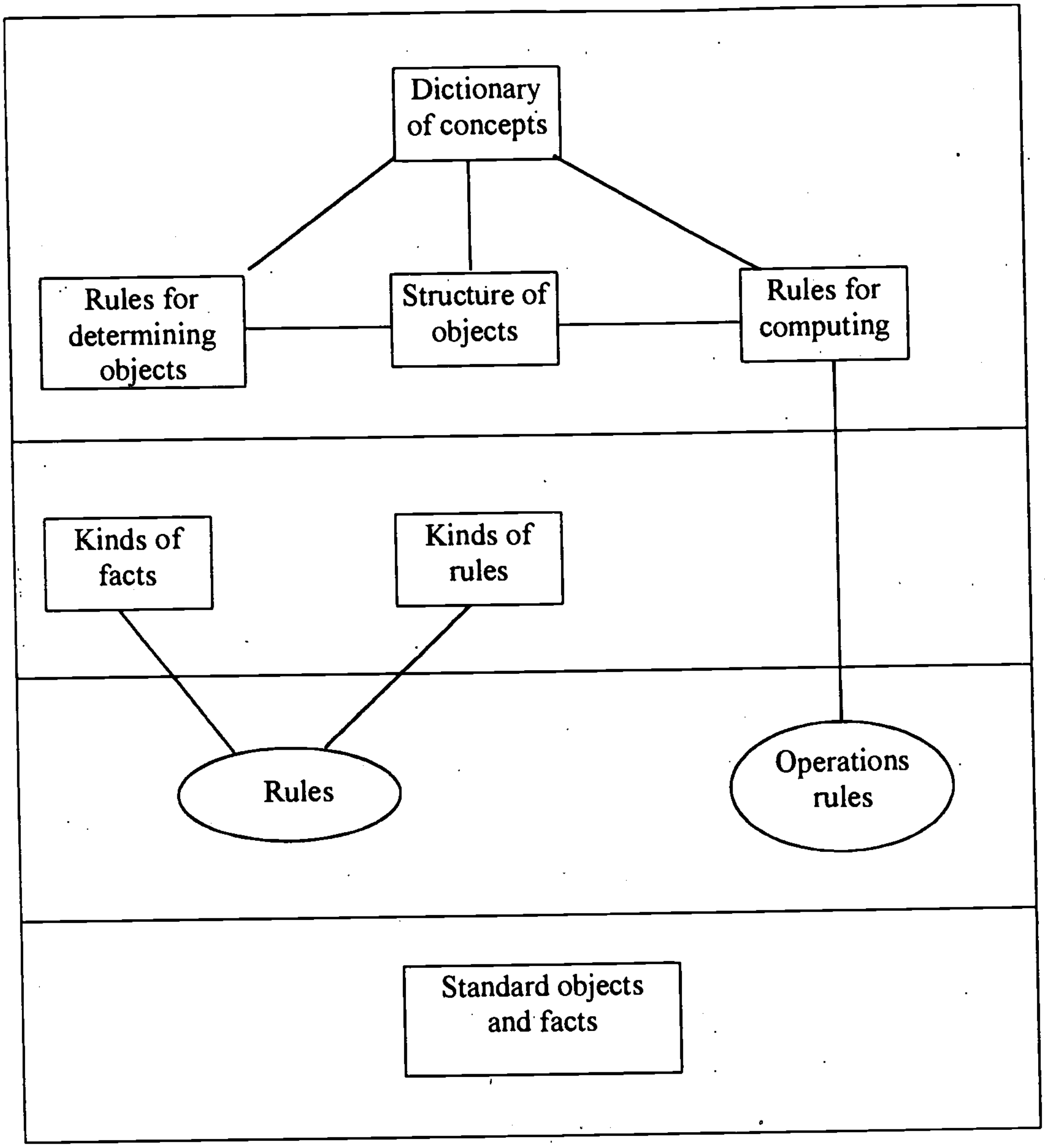
3.1.6 Table for descriptions of kinds of facts. For example, a relational fact consists of kind of the relation and the list of objects in the relation.

3.1.7 Table for descriptions of rules. For example, a deducible rule consists of hypothesis part and conclusion part. Both of them are the lists of facts.

3.1.8 The list of rules.

3.1.9 The list of standard objects and facts.

3.2. Diagram for classifying and the relation of the components.



4. Knowledge Base Access

By the organization of the knowledge base of 3-dimensional analytic geometry we can easily access the knowledge base of the system. Concepts, operations, facts and rules can be added or deleted.

For adding a new kind of objects we have to give the name, the attributes, the internal relations and features of objects. Besides, we may give some relations relative to another kind of objects and some rules.

In the case of adding a new operation, it has to be determined by the computing rules given and there may be another relative rules.

If we want to delete a concept, relations which have relationship with that concept must be deleted. Relative facts, operations and rules must also be deleted.

For the above comments about knowledge base we can draw a process of access the knowledge base.

5. Conclusion

Knowledge representation model proposed in this paper give us a natural way for representing knowledge. This is the base for constructing the knowledge base of the system that can solve exercises in the field of analytic geometry. We hope that our AG model will be researched and developed to become a useful tool for designing the knowledge part in knowledge systems.

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SESSION 4

Friday, 16 January 1998

Session 4: Keynote address

Chair:
Dr. Dao Huu Chi ,Van Lang University, HCMC, Vietnam

4-1.**Impacts of Information Technology in education and training**
Prof. Vuong Thanh Son, UBC, Canada

4-2.**Management changes in the information age**
Dr. Pattrick Tantribeau, FutureCom Intl Holdings Ltd, Canada

4-3.**Restructuring the University for technology change**
Prof. Tony Bates, UBC, Canada

4-4.**Interactive Multimedia Technology contributing in solving the problem of national education**
Dr. Tran Ha Nam, SCITEC, Vietnam

4-5.**Information Technology will transform the university**
Dr. Wm. A. Wulf, University of Virginia, USA

IMPACTS OF INFORMATION TECHNOLOGY IN EDUCATION AND TRAINING

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Abstract

In the past, educators asked themselves if they needed to change. Today, the question is not IF but HOW education will reengineer itself. In this talk we will examine a range of issues related to reengineering education infrastructure in the information society, including elements of effective computer science, how to partner with industry, the need for making educational structure more flexible, new possibilities in distance education and some Web-based education experiences.

Introduction

Information technology (IT) revolution at the turn of the century has shaped our society in many important ways, especially in the domain of education and training. Even the strongest proponents of traditional teaching methods now find themselves using email to supplement office hours. Desktop computers are showing up in faculty office and become indispensable to both teachers and students, class sessions are held in computer labs, software packages and simulators accompany textbooks, and homework often consists of Web searches.

However, simply being caught up in technology and merely using advanced techniques and tools for education and training would not be adequate to meet the demands of an information society. We must do much more. We must aggressively go after the skills and methods needed to produce designers of the complex information systems our society requires. A range of important issues must be examined in a proactive approach to reengineering our education infrastructure in the information society: "Are we ready to scale up information technology?", "Can our current infrastructure support the demands of the information society?", "To what degree must we reengineer it?", "What stays, what goes?", "How much should industry be involved in our reengineering process?". If we do not address these issues properly, we jeopardize not only the future of our graduates, but also our ability to produce systems with increasing complexity, and thus our intellectual wellness and our ability to cope with the information society.

1. How Will the Program Change?

1.1. Elements of Effective Computer Science

In 1995, Peter Freeman suggested the concept of effective computer science (CS) consisting of a strong core computer science coupled with emphasis (application) areas that focus on interactions with other disciplines. The "emphasis areas" element require that we seek ways to work on problems and provide educational experiences in which computer science is an effective element of some larger, often real-world, context. If we compromise the core of computing science, we risk losing long-term, foundational skills. If we fail to take into account the concerns of the computing professional, we risk becoming obsolete. The key is to achieve the right balance - but there are more than one way to get there. This is actually an individual decision; at least for the foreseeable future, each faculty must decide for itself what aspects of CS are fundamental in the context of their particular educational programs and chosen emphasis, or application, areas.

What we can and should work out is some way to characterize the applications we choose so that we can measure how effectively they are contributing to the evolution of the computer science program. To fulfill this goal, future educational program should provide the following three components:

- Broader understanding of information technology (IT). How is IT used in other disciplines and activities? We professors must be familiar with some of the most ubiquitous computer applications (e.g. email, WWW). Otherwise, how can we expect our students to be well prepared to go out into the world and help create new generation of applications and the scientific basis on which they are built?
- Ability to understand an application's essence. As computer science increasingly interacts with other disciplines in a variety of ways, it is important to have coherent means of characterizing these applications so as to enhance our understanding of computer science and application relationship. Students should be led to a more generalized ability to understand an application's key aspects.
- Ability to interact effectively with others. The CS students' communication skills are increasingly required in at least two ways. First, students must be able to communicate with a much broader range of people and in different ways; effective communication skill has become critical to their career's success. Second, students must be able to communicate deeply with experts in other fields to achieve effectively the computer science vision outlined earlier.

An important and exciting challenge is how to educate those who will create future generations of technology-intensive applications and their underlying technologies.

1.2. A New Educational Focus: Information Systems Engineering

The development and maturity of the three disciplines, computer engineering, computer science and information systems with their increasing interrelations have led to

an additional educational focus, so-called *information systems engineering* [Stokes97]. This new focus is necessary if we are to create the large, complex, integrated information systems we will need in the next few decades.

Information systems engineering does not radically change existing disciplines. It simply adds a role to the development and implementation of an information system. The computer engineer provides the hardware innovations. The computer scientist adds the cooperating software elements and creates a viable user environment. The information system engineer collects the enterprise's information needs and designs and develops and enterprise information system that comprises hardware, software, and an enterprise-operating environment. The information system specialist assists in the development, then manages and operates the information system to carry out the design intent and meet the user need. But this new focus poses several problems for educators because it requires a systems approach performed in a team environment and it is characterized by complex problem environments with uncertain routes toward the goal – several people can contribute to the success of the problem solution without a clear assignment of domains to individuals. Four fundamental changes in our educational approach are deemed essential:

- *Adopt a student-centered approach.* As the available computing power and our ability to use technical tools increase, we instructors can move from being the "sage on the stage," dispensing information, to the "guide by the side," managing the learning experience.
- *Add a system view of problem solving.* The student must understand the need to integrate components into a comprehensive whole. Software must be developed that let students participate in complete systems, not just selected components of a project.
- *Emphasize skills in cooperative problem solving.* We need to promote teamwork through systems-oriented problem-solving environments, e.g. using proven components or code from others' information systems or class libraries.
- *Organize joint projects.* We must provide the opportunity for students and enterprise professionals to work together to solve real information systems problems. Distance learning and related technology would be an effective mechanism for this kind of cooperation.

A conscious effort to change our educational approaches and incorporate systems and teaming into our educational processes is essential in letting us move forward and provide people who can design and implement complex information systems of the future.

2. How Will Curricula and Methods Change?

2.2. Whom Are We Teaching?

Adult education is evolving rapidly. As organizations continue to want updated skills and technical expertise, the typical university student is less likely to be 20 years old, living and working on campus, but a mature worker who may live anywhere in the world, pursuing a course of study through tele-technology. All this presents opportunities and

challenges for our universities, particularly in computing and information technology where principle and practice change more rapidly than in other disciplines. How do we teach these mature worker-students?

What are the requirements of these new students? For one, they tend to approach their studies as consumers and will demand value and relevance of the study material and teaching methods delivered to them. They will also expect a "professional" relationship with the university. This has several implications for the institutions. It may involve setting standards for the presentation of the course material; it may mean ensuring that student feedback is properly evaluated and incorporated into course development.

The implications for the academic staff are considerable: Not only they must know how to use new technologies (multimedia, Web, email) as part of their teaching armory, but they must also understand the (actual or potential) working environments of their students to provide relevance.

We need to find new ways to assess students' performance, define work-based projects and evolve course validation criteria. There must be a balance between technology and principles so that the students can relate their academic study to the needs of their work environment. This, in turn, means making the education process an integration of academic methods, technical skills, and context setting. Change is thus inevitable. Those who continue to prove theorems on a chalky board are likely to find themselves among the extinct academic species!

Blend of Old and New

A truly effective solution to rapid advances in IT and changes in education methods should carefully consider the potential value of old methods as well as embracing the obvious benefits of the new ones.

As we consider the implications of new technologies for education and for careers our students will pursue, it would be easy to forget the most basic characteristic of an educated person: the ability to communicate well. The new technologies, which are affording us the opportunity to change education, make communications skill even more critical. That's one part of the old system we should keep.

What we should throw away is the current grading system. Both independence and collaboration figure in the essential characteristics of modern workers. As professionals, out students will have to make judgement calls, independently gather information and analyze it, and exercise an enormous amount of creativity. Rarely does one person oversee an entire project. Instead, each individual is accountable and responsible for part of a project that must be combined with other parts to make the whole thing work. How can we possibly evaluate this kind of collaborative responsibility and creativity with an A, a 92 percent or a point on the bell curve? Why not make the "grades" comprise a list of the course's learning objectives and the level of learning each student has achieved for each objective? Forget about one grade per a course.

If we are to effectively educate the new generation of students, we must carefully think through our options. The methods we use should comprise both old and new methods so as to accurately reflect stated needs.

3. Ethical Behavior in the Curriculum.

As the computing sciences move rapidly toward "professionalization," we must begin to incorporate new topics into the curriculum. One of these is ethics or professional ethical behavior. For example, professionals are responsible for designing and developing products, which avoid failures that might lead to losses, cause physical harm, or compromise national or company security. With so much information flowing across the Internet and the Web and because of the rising popularity of Java applets and similar modular applications, it is vital to teach our students their responsibility in maintaining high standards for the products they will develop as professionals.

Some institutions require undergraduates to participate in a non-credit seminar, which typically covers topics like current computing applications, resume writing, and opportunities in the field. It may be straightforward to include ethics here. Regardless whether ethics is taught as a separate course or lumped with other topics in a course or seminar, we should emphasize ethics by the way we teach it. In an operating system course, we can point out ethical issues dealing with hacking into systems and systems security. In database courses, data security and privacy are natural topics. We can set ethical examples by making it clear that we obey the IEEE Computer Society's and ACM's codes of ethics, e.g. when we copy class materials, we abide the copyright rules and when use software, we do so ethically.

4. What Can We Expect From Technology?

4.1. Are We Ready to Scale up Information Technology

Large-scale use of information technology in education has been talked about with great excitement. Advanced telematics services, like the Internet and the Web, can provide innovative teaching tools such as rapid and pervasive access to multimedia and mechanism for collaborative learning. However, are we prepared for the change? Can our current infrastructure adequately meet the challenges?

First, how exactly do we make computing and information technologies accessible to everyone when even in modern countries, computer use in elementary and high schools is far from common practice? Our goal should be to provide everyone with basic concepts and skills on the use of information technology and to keep pace with the rapid developments in this field. We should begin to deal with these issues in elementary schools, laying the foundation for more complex topics in much the same way as in other curricula.

Second, how do we teach responsibility when we pay little attention to computing ethics and related issues in our current curricula? Computers and information systems have already become crucial in commerce, business, science and entertainment.

Technology is neither good nor bad until it is applied. Then a range of psychological and ethical implications arises. The Web is a perfect example. There is also the danger of substituting virtual contact for human interaction, through excessive surfing on the Web, for example, or to mistake the distorted use of technology portrayed in movies and televisions as acceptable.

Third, how exactly do we scale the use of information technology to systematic use at any educational level and in every field when we cannot successfully integrate it into a computing science curriculum on a small scale? For example, to locate relevant resources in the maze of information on the Web may be difficult or impossible. Even if we did not have technological limitations, we must still face methodological problems.

We are not clear on how to adapt teaching and learning activities to computer-based technologies. Most people still teach, learn and interact in the same traditional way. We must clearly refine infrastructures and create tools to make the information available for the real benefit of teachers and learners, and we must develop new approaches to education that take these tools into account. The Renaissance project in Europe is experimenting with the integration of technologies for user and network services in higher level of education (colleges, universities and vocational institution), specifically, learning support environments, multimedia courseware authoring, and networking infrastructure. These technologies have great potential for local and distance vocational training.

We must be careful to lay the foundation for a wide-scale use of information technology. We still have a long way to shift from a stage where mainly universities pioneers and lead the introduction of new tools and techniques to the stage where they are made available to any kind of education and related institutions, e.g. libraries.

4.2. New Possibilities for Distance Learning

It is interesting to note that the concepts behind buzzwords such as network learning environments, teletraining, and virtual university are identical to those we had for distance learning nearly 20 years ago. The traditional distance education model however is not without shortcomings. Personal communication via phone, fax, and email are no substitute for eye-to-eye discourse. But with the Web, affordable multimedia equipment, and an increase in networked personal computers, we now have the possibilities to overcome these limitations, as demonstrated in a number of ambitious research projects,e.g. the University of British Columbia's WebCT, the University of Simon Fraser's VirtualU and Fern University's Virtual University System.

The first is electronic materials catalogs. These catalogs contain fragment of education materials that are both reusable and platform independent. We can seamlessly integrate different forms of asynchronous and synchronous communication with the development, delivery, collaborative revision, and storage of course and working materials. Teaching units, for example, can now be downloaded or remotely accessed interactively. Teachers can also correct and enhance these units continuously.

Another improvement area is learner-controlled interactivity. Researchers are discovering how to tailor navigation to the student's pace and knowledge and to persistently record the structure of individual learning processes.

The third improvement area is increasing integration with physical systems, e.g. linking educational material to real-world components (like a robot cart) to understand and explore real-world phenomena (e.g. tract control) from a distance.

We are gradually replacing much paper-based study material with multimedia courses, using hyperlinked interactive animation, simulation package, video and software for experimentation.

Finally, research is finding ways to increase connectivity with the information Web, including digital library projects and video teleconferencing systems.

Despite progresses in the above areas, two problems remain: mainly because the interoperability of tools, operating systems, and vendor platforms is poorly developed and Internet solutions, like HTML and Java, are constantly changing: (i) scaling up (to support a large number of students) and (ii) evaluation mechanisms (for acceptance and measurable learning effectiveness); technical and didactic standards and guidelines related to teaching over the Internet need to be developed, tested and disseminated.

5. How Do We Partner With Industry to Achieve Change?

5.1. More Relevant Computing Skills

There is a considerable shortage of computing personnel with adequate skills in systematic thinking, problem solving, communicating (both written and oral), teaming with the project stakeholders, and assessing schedule, cost, risk and potential impediments. Industries must work closely with academic institutions to address these skill deficiencies through a new curriculum focus. Such a curriculum is long overdue, in part because collaborative relationships between industry and academic institutions have been lacking. This prevents computing graduates from smoothly transitioning to the industrial work force.

5.2. Making the Structure More Flexible

Computing education faces pressures to adapt not only to the rapid changes in information technology, but also to changes in the way businesses operate. But keeping educational programs current in both technology and business practices is no easy task. Traditional educational structure does not support rapid changes. So, how do we design programs that can keep pace with rapidly changing needs? To evolve a framework to replace the traditional education structure, we need the several things: stronger ties with industries, shorter time to adapt to changes, new reward structure for educational improvement, greater focus on continuing education, and more attention to pedagogy.

6. Conclusions

As educators, we are in exiting times. The need for complex information systems to support all aspects of business, industry, and government has exploded during the last decade. What we do now has the potential to enrich or impede the growth of the information society. As in any reengineering effort, we need to thoroughly understand our goals and requirements. We can begin by being proactive with industry in a partnership that cooperates not only in student training, but also in curriculum reform and resource sharing. Together, we can prepare those who will endure the next technology explosion.

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MANAGEMENT CHANGES IN THE INFORMATION AGE

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Abstract

Our existing concept of management is going out of date. Information is the new resource to be considered in most of our businesses. All companies are information related companies, and all managers also become information managers. Information is now the energy of enterprise, generating new products and services and enabling new ways of managing. A technology strategy, application plan and policies must ensure that information is not used up wastefully. In the next decade, the business strategy and the information strategy will be interrelated. The managers will have to become skilled at managing information as at managing conventional resources. As a need in the future new economy, academic curriculum should include training of information technology management in most programs.

Introduction

Up to date, our models of management was designed from and for the industrial era. From now on, in the post-industrial era, we are clearly on our way toward the *Information Era*. We are already moving more into the transition from the old to the new economy.

The fundamental difference is how we manage business resources. In the industrial era, business resources are based upon 4-Ms – Men, Machine, Material, and Money. From now on, we must add a 5th resource, that is Information.

In the next century, the business manager must understand information as a resource. He has to be able to manage information as an asset, both for business development and for managing the entire organization. In brief, every business becomes an information related business, and every manager also becomes an information manager.

The Information Resource

The main resource of the post-industrial era is information, which also is the energy of the entire organization, generating new products and services and creating new ways of managing. But what is information? To define the real meaning of information for every individual to understand is not easy. It kept many universities around the world occupied

for years, and their conclusions are often conditioned by their base disciplines. Engineers, Political Scientists, Sociologists and Economists see information in different ways.

Engineers and Technologists often see information as signals. They handle information as a matter of code, transmission and reception. Sociologists and Psychologists frequent see information as a way of communication. They are concerned with cognition, interpretation and meaning. Political scientists tend to connect information with power. They are concerned with its distribution and manipulation. Economists seem to have trouble dealing with the information. As a commodity, information is different from other resources. Information exchange does not necessary the same as value exchange in the conventional models.

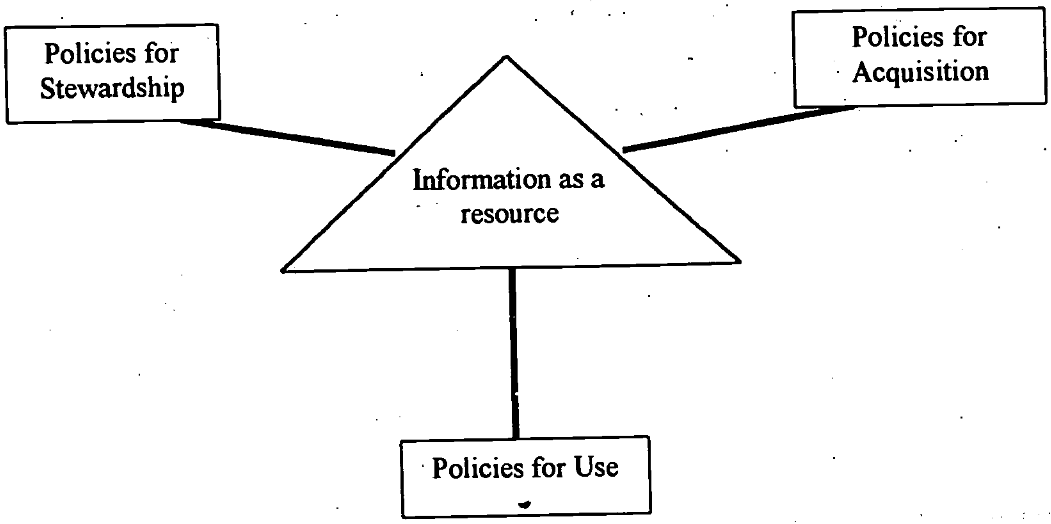
We, in the Information management, try to make a distinction between data, information and knowledge, often linking information value to decision-making. If we pass on an information to someone else, the receiver may gain value but we do not automatically lose value. Information can be communicated at minimal cost. In addition, the potential uses and the value added of information are unlimited.

These characteristics tend to destroy the traditional theories of the Economics of Trade and Organization. They pose threats and opportunities for business. The creative use of information can widely destroy the rules of competition and marketplace.

If you want to grow a business in the future, you have to see information as a resource and understand it as best you can. Implicitly, you will need policies for acquisition, stewardship and use of information. In any case, since the information is intangible, it is not easy to do. For instance:

1. Since we can never know the full scope of available information, and since one person sees information in a data or message that another does not, how can we know what information to collect? And how to collect? It is not just stored on paper or electronically; it is stored in actual form in our individual minds. Then what does stewardship of information mean?

2. Since the use of information is unpredictable and it can be good or bad depending upon the circumstances. What is the balance between information freedom and information control? These may depend upon a business context. However, when you realize that every business is an information business, and every manager an information manager, they becomes ever more important issue for management in the future. We will need policies as described in Figure 1.



Every Business is an Information Related Business

During the past decade, we have made distinction between the information-intensive sectors and the traditional ones. Financial services, airlines and retailers are a few examples.

Financial service businesses are the centers of information transactions where new products and services are developed by the collected databases of customer events and financial flows. The business is traded through electronic markets. In airlines industry, it is substantially based upon the command of electronic distribution via reservation systems and upon the aggressive sales and marketing by analysis of customer databases. Many retailers investing in customer "V.I.P." cards not just to offer discounts due to frequent and volume purchasing, but to capture individual consumer behavior in order to customize offerings and develop newly targeted services. As the media and telecommunication converge, businesses are stepping toward an information-driven market place by creating home pages, virtual shopping centers and information services on the internet, by buying information content and so on.

Recently, we often see the media, entertainment and network companies work together to create the so-called *Infotainment* sector such as MS-NBC (Microsoft and NBC News Network in the USA.) New sectors are emerging and conventional sectors are being eroded. The new businesses of tomorrow are founded on information. All these businesses are information businesses – they see information as the main support of their business, and information communication as their distribution channel.

Many entrepreneurs and MBA graduates are building business plans for information-based businesses – multimedia form of retailing, database analysis, marketing ventures and electronic trading systems. Today's entrepreneurs of the industrial age are now being replaced by tomorrow's *infopreneurs* of information age.

Every Manager also is an Information Manager

Clearly, business executives need an information strategy that ensures an appropriate infrastructure to run business in the information age. They need so-called Application Plans that guide investment decisions on the information systems required to support the business.

As mentioned earlier, they also need the information policies to ensure that the main resource of tomorrow is not used wastefully by losing information, by disputing about who owns and has access to a particular information, by configuring technology that impede information exchange, by developing managers and employees who do not have information skills, or by not thinking about information acquisition, stewardship and use in all the strategies that companies take years to put together.

By the end of this century, the questions about information policies will have to be addressed in strategy making for marketing, manufacturing, human resources, and research & development.

In fact, there is a bigger strategic question. In the information age, you simply cannot build business strategy as a whole without first considering information as an asset. That is why we can see the current wave of mergers and acquisitions, among the big companies, around ownership of both information content and information distribution. We can also see why today's information-intensive businesses have to consider threats from the new comers from other sectors – Insurers particularly Life Insurers offering banking, retailers offering insurance, software companies offering money transmission, and so on. The intermediaries are wiping out by many direct selling electronic systems.

Not only the information-intensive sectors have a changing face. Conventional sectors that were not seen to be information-intensive are changing their strategies as well. Pharmaceuticals companies are predicted to buy health management and prescription-processing organizations for their information contents, or acquire informatics businesses in order to create a new technology-based health care services. Food companies acquire many smaller distributors in order to capture more direct information from the market place. Recently, Oil companies are also planning different strategies to improve a better profit and to capture a bigger market share. In short, every sector will be an information-intensive.

Up to date, we often see information technology strategies to support the business strategy. More recently, we have understood that information technology (IT) creates opportunities to do business differently. Thus, information strategy and business strategy are more interrelated.

In the future, we cannot divide the two. The future business strategy has to consider information strategy as a factor in order to be positioned for the information age. Thus, IT technology and business strategy become one. A business strategy cannot be completed if the information resource is omitted. Information and IT can create (or destroy) a business.

That is why the requirement of strategic management in the future is to create an information business strategy. This idea can be summarized as indicated in Figure 2.

The Past	IT supports Business Strategy	Business Strategy --> Information Strategy
Present	IT supports Business Strategy & Presents Opportunities	Business Strategy <---> Information Strategy
Future (information age)	IT & Business Strategy are ONE.	Information Business Strategy

Figure 2: IT and Business Strategy in the Information Age

In our pervasive IT environment, Managers have to think information in their strategy making, they have to analyze and manipulate information in their daily decision making as managing the information resource. However, many managerial works always have been seen to be concerned with information processing. And organization design has been seen as a matter of creating an effective information and communication flows. Usually, Information processing occupies a substantial proportion of management and organizational time. So, it is not surprising that a mix of data processing, executive information systems and groupware can enhance the productivity within a department.

Organizations can be centralized or decentralized by adopting more advanced forms of information management systems. With the progress of telecommunication industry, the communication from enterprise to home have made many virtual offices and organizations a possibility.

One result of all these trends, together with the business changes described above, is that every manager also becomes an information manager. Managers are not only skilled at using IT, but they should be able to analyze, explore, and play with information. They are expected to collect, to add value to and share information. They will have to become as skilled at managing information resources as at managing conventional resources. Today's managers are experiencing a shift where the challenging questions are such as "If my business is an information business, does it have a future and is it being mapped out?" or better "Since I am an information manager, do I have a future and am I re-educating myself in order to survive?" The organizational architecture of tomorrow is being created today (Figure 3.)

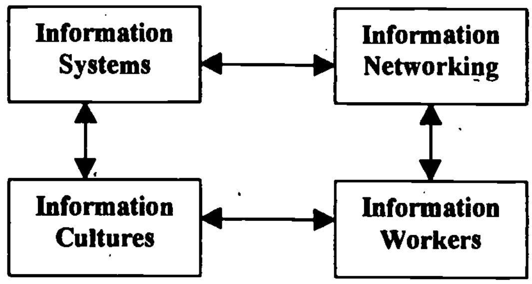


Figure 3 : Organizational Architecture of Tomorrow

Information systems are designed to support managers in creativity, decision making and control. Information network is configured to collect, and share information. Employees will be skilled at IT use and analysis. Organization will have to create culture where it is easy to share information, and where management processes are about adding value to information more than disputing "facts" and seeking data. Today, many manufacturing and service sector companies are working through these challenges already and are demonstrating a characteristic of the information age.

New Models for the Information Age

New manager and new business can be described by extrapolating today's trends. We, in the Technology & Business Consulting, are doing this and can help prepare managers for the next century. We have studied much management in our industrial age as being concerned with planning, organization and control. The scenarios of how these activities are practiced in the information age are definitely to be very different from the past. They include a shift from organizational hierarchies to multi-level networks, from physically bounded to virtual organizations, from decision-making by data analysis to decision-making by exploration and creativity, from work based on physical action to time spending on intellectual reflection, from programmed endeavor to business rapid change, from national and local context to global and cyberspace.

Our models of management are evolving but they need to have further research and development on the management in the information age. To master management in the next century, business schools or academic curriculum in most universities around the world need to study more closely with the enterprises to build better theories required for the information age - where it becomes more and more difficult to control information.

RESTRUCTING THE UNIVERSITY FOR TECHNOLOGICAL CHANGE

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Abstract

This paper forms the basis of a multimedia presentation (see http:// bates.cstudies. ubc.ca/). The paper argues that if the new information technologies are to play a central role in university teaching, each institution needs to develop a set of strategies for change which will amount to no less than restructuring the university.

Twelve strategies for change are outlined. While these and possibly other strategies are all essential, timing is critical. Such strategies require institutional leadership and a process that leads to widespread support for such strategies from a majority of staff within an organization through an inclusive process of involvement and participation in technology applications and policy making.

The paper concludes that the widespread introduction of technology - based teaching will require such fundamental changes to an institution that its use should not be embarked upon lightly, nor will it necessarily lead to any significant cost savings, but nevertheless such an investment will still be necessary if universities are to meet the needs of its students and society at large in the 21st century.

The challenge for universities

Many universities are making substantial investments in new technologies for teaching purposes. The increasing ease of use and improved presentational and interactive features of technologies such as the World Wide Web are leading many academics to use technology for teaching for the first time in a significant manner.

However, although there has been widespread adoption of new technologies for teaching in the last few years, they have yet to bring about major changes in the way teaching is organized and delivered. Without such changes, though, technology - based teaching will remain a marginalized activity, while at the same time leading to increased unit costs.

For technological change to be effective, it usually needs to be accompanied by major structural and organizational changes for its full potential to be realized. This paper attempts to indicate some of the strategies that universities may need to adopt in order to use technology effectively for teaching and learning.

Why use technology ?

Politicians, university presidents, keynote speakers at conferences from government and industry, and teachers themselves offer a number of different reasons to justify the use of technology for teaching and learning.

Here are four of the most frequent reasons given for using technology (there are probably many more) :

- to improve access to education and training
- to improve the quality of learning
- to reduce the costs of education
- to improve the cost-effectiveness of education.

Different people in different positions tend to place different emphasis on each of there rationales. For instance, what has really set fire to many university professors is the possibility of improving the quality of learning through the use of multimedia. The same professor though who is a startling innovator in the use of the technology for teaching can at the same time violently oppose any suggestion that more students might be served by the institution through using technology : more means worse - or at least more work for faculty.

Other professors are fired up by the idea that all the world can access their ideas, their research, their wisdom through the World Wide Web - a passion to widen access to their teaching. This is not always accompanied though by a similar passion to improve the quality of their teaching, as can be witnessed very easily by surfing their Wed pages.

Some politicians and business people see technology simply as a replacement for labor, and therefore anticipate that technology when applied properly will reduce the costs of education. Unfortunately, this is to misunderstand the nature of the educational process. While labor costs can be reduced by applying technology, unless done sensitively and carefully it can also lead to a large decline in the quality of learning, which in turn will eventually to a less skilled workforce.

Lastly others look to technology to improve the cost - effectiveness of education. This is not the same as reducing costs. The argument is that for the same dollar expenditure learning effectiveness can be increased, or more students can be taught to the same standard for the same level of investment.

While then technology is unlikely to reduce substantially the costs of education without a parallel loss in quality, the wise use of technology can simultaneously widen access, improve the quality of teaching, and improve the cost - effectiveness of education. That is not a bad goal to strive for.

This paper does not challenge the core functions of a university: teaching, research and public service. Nor does it assume that universities should convert to becoming

businesses, using technology to become financially independent of government. The paper assumes that public universities still have important social and public goals to serve.

However those core values need to be served in a rapidly changing world, not the least of which is the central role that technologies now play in everyone's life. Using technology for teaching can help universities serve the public more cost - effectively, and in particular can prepare students better for a technologically based society. There are also many things that are valuable in education, as in life, that technology cannot do, and we need to recognize that, but that is another topic. Given then that technology has an increasingly important role in teaching and learning, what do universities need to do to ensure that it is used to greatest effect

Selecting technologies

There is an increasing range of technologies from which to choose. Some of the criteria that have to be taken into consideration when choosing and using different technologies, and a strategy for decision - making, are discussed more fully elsewhere (Bates, 1995). In brief, these criteria are reflected in the **ACTIONSS** model:

A ccess

C osts

T eaching functions

I nteraction and user - friendliness

O rganizational issues

N ovelty

S peed of course development/adaptation

This paper is concerned primarily with the relationship between teaching, learning and organizational issues.

Technology and post-modernist organizations

Before putting forward 12 strategies for institutional change to exploit fully the potential of new technologies for teaching, it is important to understand the relationship between technology and the organizational structure of institutions using technology (for a full discussion of this issue, see Peters, 1973, Campion and Renner, 1992, Peters, 1994, Capion, 1995, Renner, 1995, Rumble, 1995).

Most manufacturing companies producing physical goods have until recently adopted a 'Fordist' organizational model. This is characterized by the production of uniform products ('you can have any colour you like, so long as it's black'), economies of scale (initial set - up costs are high, but large volume results in each extra unit having increasingly lower marginal costs), a division of labour (work is broken down into different elements conducted by different classes of worker), hierarchical management (decisions are made at the top, and passed down the line of command), and organization of people

and processes into discrete, large units which themselves are hierarchically managed (e.g. production, payroll, personnel, marketing, sales).

The best examples of this kind of manufacturing organization and structure in education are the large, national autonomous open universities in countries such as the United Kingdom, Netherlands, Thailand, Indonesia, India, etc., many of which have over 100,000 students (see Daniel, 199). The nearest examples in Canada are Athabasca University and Tele-Universite, although because of their provincial base they do not really reach the scale and hence 'purity' of the industrial model.

However, the rapid increase in the size and scale of 'conventional' universities in Canada, the USA, and many other industrialized countries since the 1960s has led to many elements of the industrial model being found in today's universities, such as division of labour and increasingly large classes. Nevertheless the core activity of teaching in conventional universities has been relatively untouched by the industrial process.

Information technology though has led to the growth of many knowledge based and service industries which have a very different structure from the industrial or 'Fordist' model. These newer forms of organization have been labeled as 'post-modern' or 'post - Fordist' in structure (see, for example, Farnes, 1993) and are characterized by the following :

- heavy dependence on information technologies (telecommunications, computers)
- customized products and services tailored and adapted to needs of individual clients.
- creators and developers of new knowledge/new ways of doing things, or transmitters and modifiers of existing information.
- directly networked to clients : rapid and immediate feedback used to modify products and services.
- rapid development and change : organizations are dynamic and move very fast.
- often small-scale and specialist; dependent on partnerships and alliances with other organizations with related but different competencies.
- decentralized, empowered, creative workers, often working in teams.
- strong leadership characterized by clear but broad vision and objectives, playing an integrating, co-ordinating and facilitating management role.
- global operations.
- post - modern industry sectors are often chaotic and characterized by new players, new amalgamations and unpredictable emergence of dominant technology - linked organizations.

Examples of post - modernist organizations are Apple Computers, started originally in a garage in California by two research graduates from Xerox Park, but now suffering

from the pains of growth and the failure to stay sufficiently dynamic and innovative; Microsoft Computers, which has the same revenues as Sony and Honda combined, but whose direct workforce is one hundred times smaller than each of those companies; and Netscape Communications Corporation, which did not exist five years ago, but now dominates the Internet market.

The post - modernist university?

Where does this leave the post-modern university ? The move in the 1960s to a mass higher education system has forced universities to adopt many features of an industrialized or Fordist organizational model :

- large class sizes for first and second year student (economies of scale),
- a differentiation between tenured (research) professors and graduate teaching assistants, and between academic (professors), management (deans and vice - presidents), and administrative staff (division of labour),
- large, hierarchical and distinctly separate core organizational structures (faculties).

Nevertheless, even modern universities still display many examples of pre-industrial or agrarian organizations, i.e. they are not post - Fordist but pre-Wattist. For instance the semester system with the long summer break reflects the origin of the land grant universities, where students had to return home for harvesting and to tend the crops. Teaching, at least in upper undergraduate and graduate levels, is craft-based with little or no division of labour, and is based on an apprenticeship model of handing down knowledge and teaching methods from one generation to the next.

In other words, university teaching is not professionalized, in the sense of being based on skills resulting from research into and analysis of the teaching process. For instance, most university teaching has not been influenced to any extent by recent research into the psychology of learning, organizational management research, communications theories or research into human-machine interaction, all of which have been critical for the development of post-modern knowledge-based organizations.

The new technologies will be exploited best by those that establish post-modernist forms of organization. We have not yet seen any advanced and sustainable form of such an organization in higher education, but elements are already visible in organizations such as the University of Phoenix's online programs, Nova South - Eastern University in Florida, the National Technological University, and the proposed Western Governors' Virtual University in the USA.

Nevertheless, there are certain features of a traditional university that lend themselves to the new post-Fordist environment. First of all, a university is an extremely decentralized organization. It has a large and highly creative 'core' of staff, faculty, who when they apply themselves are capable of creating new applications software, developing expert systems, and adapting or even inventing new forms of teaching and

learning. Furthermore they have one valuable commodity or quality that is lacking in many dedicated open universities : they have a research capability that enables them to generate new knowledge in a wide range of subject areas that can be assembled and marketed through the use of technology. Lastly, conventional universities have the advantage of what the marketing people call a strong brand image.

There are signs that some conventional universities, with good leadership and a shared vision, and sometimes goaded by strong external pressure from government, are re-generating and re-structuring themselves to meet the technological challenge. Whether they can do this fast and deep enough to need the growing competition from the private sector remains to be seen.

Universities in transition

The ease of use or 'transparency' of technologies such as the World Wide Wed and video-conferencing makes it much easier than in the past for faculty to develop technology - based learning materials and delivery.

The World Wide Web for instance allows a teacher easily to adapt materials created for lecture or classroom use and present them as attractive colour graphics and text. Once the materials are created as Web pages, it is a simple matter to make them available for off - campus as well as on - campus students. This means that innovation in teaching, which has traditionally been associated with more fringe areas of the university, such as the distance education units or specialist R & D educational technology units, is now coming from the 'core' : original and exciting technology - based materials initiated and developed by faculty themselves, through what I call the Lone Ranger and Tonto approach : the professor with their trusty computer - skilled graduate student, who does the HTML mark up and scanning.

There are however dangers in this approach. In an increasingly competitive environment, and where technology - based teaching is increasingly open to public inspection, the organizations that will survive, as with any of the other new knowledge-based industries, will be those that provide services that the public values, at a better price and quality than the competition.

However, on most Canadian university campuses, amateurism rules in the design and production of educational multimedia. A feature of many Lone Ranger projects is that technology applications end up as a costly supplement to conventional teaching, merely increasing the students' (and faculty) workload, and the institution's overall unit costs, because teaching with new technologies is rarely accompanied by the substitution of multimedia for face to face teaching. For the extra cost of using technology to be justified, it needs to be accompanied by the re-organization of the teaching process, moving away from fixed, scheduled group instruction to more flexible and individualized modes of learning.

Another common problem with the Lone Ranger approach is that often there is never a final product that can be used on a regular basis in a teaching context. This is because

the project drags on, being constantly up - graded or improved, or has to be re-designed as a result of inappropriate technology decisions in the early stages of development. Often the graphics and the interface are poor, compared with commercial games with which students are familiar, and the potential for high quality learner interaction with the multimedia materials is often missed. Products when finished have limited applicability because they are not of high enough standard in terms of graphics and interface, or sufficient in volume, to become a commercial product. In other words, Lone Ranger materials usually lack quality in the final product.

There are several components of quality in technology - based educational materials. The first is the quality of the content, which is where the brand image and the research capability becomes critical. Is this unique or valuable teaching material for which there is a need or demand ? this is not usually an issue in most research universities.

However, the second component of quality is the standard of media production. Are the graphics clear ? are the screens easy to read ? Is the sound and video easy to hear and see ? Are the unique features of each medium (video, audio, text, computing) fully exploited ? Is the material well assembled ? Is the screen designed in such a way that students intuitively understand the range of activities open to them and how to accomplish them (interface design) ?

The third component of quality is instructional design. Are the learning objectives clear ? Does the material result in the desired learning outcomes ? Does it have the appropriate mix of media to achieve the learning outcomes in the most efficient manner ? What is the quality of the interaction between student and learning materials ? What is the role of the tutor / instructor relative to the technology - based learning ? Is it well structured ? Can the students easily find all the material they need and move around the teaching materials easily ?

The fourth is the quality of delivery. Are the materials easily for the student to access ? Can learners ask questions or discuss materials with other students ? Who gives feedback ? What happens if they have technical problems ? At what times is help available ?

Fifth, there is the issue of project management (see Strategy 9, p.21). Timelines and budgets need to be established, teams created, meetings organized, materials produced, distributed and maintained, deadlines met. All these five factors contribute to quality in multimedia teaching and learning materials.

New technologies the are likely to remain marginal, despite high levels of capital investment, and will merely add costs to the system, if we do not at the same time deal with structural changes in our institutions, and in particular if we do not make fundamental changes to the ways we organize teaching.

Twelve organizational strategies for change

If we assume that the intelligent application of technology can improve learning, then what do we have to do to re-organize, re-structure or reengineer the university to

ensure that we achieve cost - effectiveness from the application of new technologies to teaching ?

From the basis of experience at UBC I am going to suggest 12 strategies for change. These are not my strategies; I am merely the chronicler. Some individual strategies have been developed deliberately and thoughtfully by the senior management at UBC, particularly the Committee of Deans, and the Media Resources Network and its successor, the Centre for Educational Technology. Others have been developed as a result of experience, or have emerged as issues to be addressed. While collectively they reflect an overall strategy for change, they have not been developed or promoted within UBC as a formal plan. Some have not been implemented at all, or where they have been implemented, not on any consistent basis. This list certainly does not represent the full range of possible strategies. Lastly, it is too soon to indicate whether these are in fact useful or validated strategies for change.

Nevertheless, they do constitute a useful range of options for consideration by management.

1. A vision for teaching and learning

I use vision in a specific sense : that of creating a concrete description of how teaching should take place in the future, given the current knowledge we have about the goals and purpose of the university, and the potential of new technologies for furthering those goals. Vision describes what we would really like to see or to happen.

It is difficult enough for an individual to identify and describe accurately a personal vision for the future; it is even more difficult to create one for an organization as complex and diverse as a large research university. However, the journey or the process is as important as the goal (Fritz, 1989, Senge, 1990). 'Visioning' is indeed a technique that allows those working in an organization to understand the full range of possibilities for teaching and learning that technology can facilitate, and the possible outcomes, acceptable or otherwise, that might result from its implementation (see Bates, 1995b). It helps people working in an organization to identify and share certain goals. Even more importantly, a shared vision is necessary as a benchmark against which to assess different strategies and actions regarding the development of technology - based teaching.

In particular, an institution needs to define what balance it wants between face - to - face and technology - based teaching. An institution could for very good reasons decide not to go down the technology - based teaching route and place special emphasis on face - to - face and personalized teaching. It is likely though to be a very elite and high cost institution. Alternatively, an institution might wish to vary within its structure the degree of dependency on technology-based teaching, giving more emphasis for instance to face - to - face teaching at the graduate level, and more to technology - based teaching at the undergraduate level. Lastly, other institutions may make a clear decision to emphasize technology - based learning throughout all its teaching.

Another issue that should be covered in a vision statement is the extent to which an organization sees itself operating on a local, regional, national, or international basis, and the implications of that for courses offered and student services. This is important because technology - based teaching does not respect political geographical boundaries. For instance, regional colleges may need to redefine their role if students are capable of accessing the college's standard courses from other, perhaps more prestigious institutions, anywhere in the world.

In 1996, the Centre for Educational Technology at UBC developed a vision for technology - based teaching (UBC, 1996 : http ://www.cet.ubc.ca/about/vision.html). The vision included several detailed scenarios of teaching and learning for different types of learners. There were several key features in the vision :

- a mix of teaching models, from programs delivered entirely in a face - to - face mode to courses available entirely at a distance; it was envisaged though that most students would take a mix of face-to-face and technology - based teaching over the life of a full degree program;
- an in crease in the provision of technology - based non - credit, certificate and diploma programs, aimed particularly at mature students;
- learning materials developed as discrete modules for multiple uses, i.e. the same CD-DOM might be used for on - campus and distance undergraduate students, as part of a certificate program, as continuing professional education for individuals, and as a stand - alone CD - DOM for employers / companies;
- more flexible admission and access, particularly for mature students, through the use of technology - based learning, allowing more students to be admitted to the university.

This vision statement has yet to go out to Faculties and departments for discussion and comment, partly because the CET Steering Committee felt that the statement may be too controversial or provocative, and that it might thus slow down the adoption of new technologies. It is clearly a judgement call whether to approach the introduction of technology - based teaching on a slow, incremental, ad hoc basis, or whether to have clear long - term objectives and goals driving the use of new technologies.

2. Funding re - allocation

The re-allocation of funds is another critical strategy. Too often technology implementation is driven by external grant funding or by 'special' funding arrangements, such as student technology fees. If the university sees the use of technology for teaching as critical for its development, then funds for implementing this must come from the base operating grant. Since most universities in Canada are receiving less rather than more government funding on an annual basis, this means re-allocating funds.

Figure 1 (below) is a theoretical or idealized strategy for funding re-allocations at a university - wide level. Between years two to five, despite cuts in overall levels of

funding, an increasing proportion of the general operating budget is allocated to the development of technology - based teaching. However, also in year five we see a small increase in funding due to a combination of increased enrolments and sales of learning materials as a result of earlier investments in technology - based teaching. This return on earlier investment continues and increases in years six and seven, until by year seven funds are almost back to year 1 levels, despite continues government funding cuts. Also in year six the university decides to stabilize the level of funding for face - to - face teaching, deciding that any further decrease would be out of balance with its overall teaching goals.

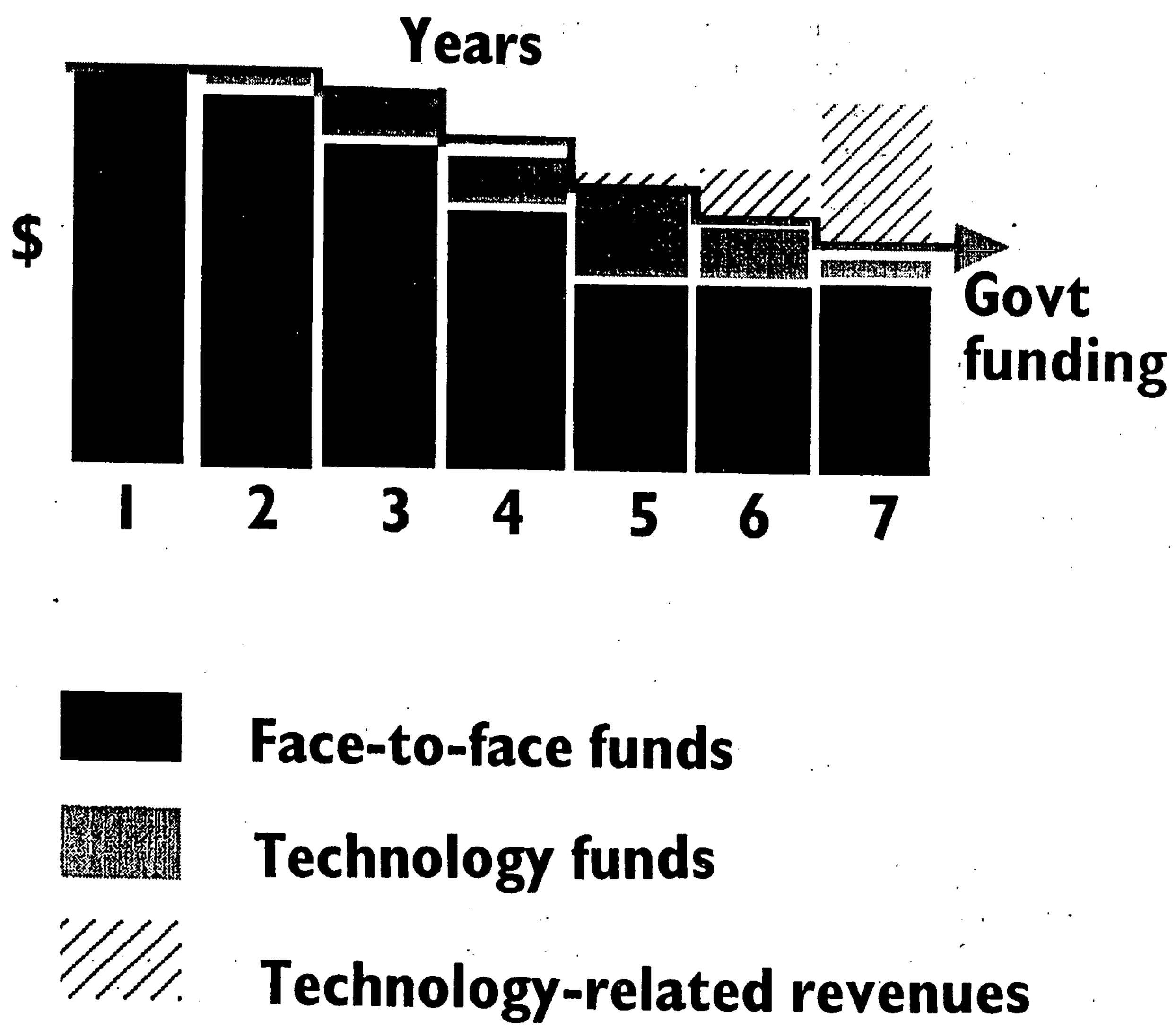

Figure 1: A model for re-allocating funds to support technology - based teaching.

The graph in Figure 1 does not indicate the organizational level at which these re-allocations are made. In 1994/95 the British Columbian government with - held 1% of all post - secondary institutions' operating budgets, and 0,5% in 1995/96, to be reclaimed by an institution if it came up with proposals for innovative teaching. In UBC's case this came to approximately $4 million over the two years. UBC decided to use half this fund for campus technology infrastructure improvements, and the other half for technology - based teaching applications, with a small amount held back for establishing a small Centre for Educational Technology.

For 1996/97, when the government discontinued its innovation fund strategy, the university itself increased the level of funding for its own Teaching and Learning Enhancement Fund to $2.2 million, to which individual faculty members could apply.

Eventually, funding re-allocation will need to be made at a Faculty or oven departmental level. Thus in 1997/98 the Faculty of Science has re-allocated $500,000 of its own budget to support technology - based teaching initiatives. The willingness to re-allocate funds is not only a necessary strategy if technology - based teaching is to become a core part of a university's operation, it is also a measure of the level of commitment to the concept by different organizational units.

3. Strategies for inclusion

One of the main challenges of making technology - based teaching a core function is to extend its implementation from a relatively small number of enthusiasts and early adopters to the main body of the teaching force. This means introducing a strategy for inclusion, to ensure that all faculty are encouraged and supported in their use of technology for teaching.

Either deliberately or accidentally this is exactly what UBC has done with the Innovation Fund and the Teaching and Learning Enhancement Fund. Because initially the funding for innovation was held back from general operating grant, the university applied the same principle as the government : faculties' operating budgets were reduced proportionally, then they were encouraged to put forward ideas as to how to spend 'their' proportion of the operating grant held back by the university for applications of technology. Thus instead of grants being awarded on a competitive bases across the university, each Dean made an assessment of the priority for funding for particular projects within his or her own faculty.

This had two consequences. Innovation grants had relatively weak criteria, in terms of conditions required; and secondly the money was spread right across the university roughly in proportion to the size of each faculty or department. This meant that between 1994 and the present, a relatively large number of academics in every faculty has had some hands - on experience of developing technology - based materials.

Another strategy that has increased participation in technology and its management was the creation of two sets of committees. The Advisory Committee on Information Technology was established, with the Vice-President, Student and Academic Services

(which includes the library and computer and telecommunications services) as chair, with a remit to advise on technology infrastructure and student and staff access issues.

The Media Resources Network (later Centre for Educational Technology), originally with the Associate Vice President, Computing and Communications, then later (as CET), with the Dean of Science as the Chair, was also established, with a remit to identify academic issues arising from the use of technology for teaching.

Both these committees set up a number of sub-committees, to cover such issues as campus connectivity, student access to computers, copyright, electronic library issues, distributed learning, faculty development, implications for research and evaluation. Between them, these committees involve well over 200 faculty in addressing issues arising from the use of technology.

4. Technology infrastructure

It is absolutely essential of course to have a strategy for developing the technology infrastructure of a university. Priorities must be set on both the level of investment and the areas of investment.

Large research universities such as UBC may need to spend up to $20 million to develop the necessary campus technology infrastructure : high speed networks that will link every building, and within every building, every classroom and office. Many universities have old buildings without adequate conduits for wiring, or asbestos fillings within walls that need to be removed before modern cabling can be installed. Many faculty and staff will not have a computer or know how to use one. Servers will need to be installed within each department, and networked to other servers on campus. Internet connections with the outside world will need to be established, and ports and other communications facilities installed to enable to enable students in residences or off - campus to access the main university campus, or satellite campuses and other institutions to be linked.

While such a technology infrastructure strategy is absolutely essential, unfortunately it is often the first - and sometimes the only - strategy adopted by universities : build it and they will come. However the technology infrastructure plan should be driven by, not lead, the university's overall vision and strategy for its teaching.

5. People infrastructure

Just as important as the physical infrastructure are the people required to make the physical infrastructure work.

There are in fact three levels of support required to fully exploit technology. The most obvious is the technical support, the people who make the networks operate and service the computers and telecommunications. At the second level are media production and services, those who produce educational products or supply educational technology services, such as interface designers, graphics designers, video - conferencing managers, or graduate students who do HTML mark - up. At the third level are those that provide

educational services, such as instructional design, faculty development, project management, and evaluation.

The major part of physical infrastructure, such as networks and major equipment purchases, is usually funded from capital budgets, and as such is less likely to compete for funds that impact directly on teaching, such as general operating budget. The cost of the human support though does compete directly with funds for teaching and research.

Furthermore the human cost of infrastructure support is recurrent, i.e. has to be found each year, whereas physical infrastructure is often seen as a once only investment, although rapid advances in technology and hence the need continually to replace or update networks and equipment make this a dangerous assumption.

As a consequence, the human support side is often under-funded. Probably the most consistent complaint across universities from those responsible for technology applications is the inadequacy of resources for technical support. Even so, the further down the chain, from technological support to educational support, the more difficult it becomes to secure adequate resources. If the network crashes, its impact is obvious; the value of an instructional designer is much harder to sell when funds are tight.

Nevertheless, from a teaching and learning perspective, it is critical that faculty receive the training and educational support needed, an issue discussed more fully in strategies 8 and 10.

6. Student computer access

Particularly for distance education students, but also for on - campus students, access to computer technology is a major issue. Approximately 40% of households in Canada have a computer, and about 10% have access to the Internet. Access amongst university students is higher. A recent IBM survey found 60% of USA university and college students had convenient computer access. At UBC, 70% of all undergraduates already have Internet accounts.

However, while access continues to grow, it is strongly related to income, gender and profession. Many of those that do have computers have machines that are not suitable for multimedia or Internet access. There is also a chicken and egg issue here. If students are not required to have a computer for their studies, they are less likely to purchase one. If students who are thinking of purchasing a computer are not given clear specifications as to what is needed, they are more likely to purchase a less powerful model.

Nevertheless, it would be a reasonable assumption to assume that within five years, at least in North America, most university students, both on and off campus, will have convenient access to a computer and Internet access. Universities though will need to put in place strategies to help students acquire the most appropriate kind of computer for their studies, and to help those students who do not have and cannot afford to purchase their own computer and network access.

There are several strategies that can be used to provide support for student access to computers (see Resmer, Mingle, and Oblinger (1995) for an excellent review). One is to provide computer labs on campus for students. Once again this is a useful start-up strategy, but in the long run it becomes unsustainable as the primary source of student support. There are several drawbacks to relying on computer labs for access. The first is that as the need to use computers for learning increases, either capital investment costs get out of control, or students' lining up for access reaches unacceptable levels. Secondly, given the rate of technological change, computers in labs quickly get out of date. More importantly, it requires students to access learning from a specific place, often at a specific time, if they have to book, thus removing one of the main advantages of using technology, its flexibility.

There will always be a need for specialist computer labs, for those subject areas requiring exceptionally high end or specialized machines and software. There will also always be a need for on - campus access through plug - in ports or drop in labs for casual use. However, in the long run the most flexible and most cost - effective approach is to encourage students to provide their own computers and Internet access.

Such a policy though cannot be implemented unless it is clear that students will need a computer, and that means ensuring that there are sufficient courses designed to exploit fully the instructional benefits of using a computer. Will access to a computer be compulsory for certain courses ? Will a whole program require computer access ? Which courses or programs should be the first to implement such a policy ? will there be common technical standards for computers for all the courses to these questions. This requires each department to develop a clear strategy for the use (or deliberate non - use) of computers, and this strategy needs to be clearly communicated to potential students. These departmental strategies need to be coordinated at a faculty and institutional level, so that students do not continually have to change machines, operating systems, Internet service providers, etc.

Sonoma State University, California, spent two and a half years preparing for the implementation of a policy requiring all freshmen students to have a computer. They made sure that there were sufficient courses developed in a way that exploited the use of a computer, and therefore made it essential and valuable to use one. This required a major investment in faculty development.

Sonoma State put in a place a whole range of strategies to help students who could not afford a computer : a work - on - campus scheme whereby students could get a computer then work to pay it off; relatively few students at Sonoma qualified for some form of supplementary State or federal grant that would enable them to purchase a computer, as those eligible for a grant were usually already 'mixed - out', i.e. were already receiving maximum allowable benefit, so for these students, there was a low - cost rental scheme and for some free loans of computers from a pool donated by IBM and Apple. There was an additional 'technology fee' imposed on all students. This was used to provide technical help support for students, improving the local area network, providing docking

ports for portables, and making available easy access to public computers in public places on campus. Students themselves play a large role in managing this fund and in approving the level the fee.

Sonoma State found that there was very high compliance for its policy of requiring all its freshman students to have a computer, it was well received by parents and by employers, who praised the university for making higher education more relevant, and also most students seemed to be pleased with the policy. The important point here is that it was a total strategy. Implementing only part of it - such as a technology fee when many students clearly don't need to use a computer for their studies - can lead to considerable student and faculty resistance.

Other strategies increase the accessibility of computers and networks for learners are the development of government - funded educational networks, through contract leasing or bulk buying of telecommunications services, teas breaks for students on computer purchase, and the development of local community learning centres equipped with advanced technologies.

Lastly, while technology may open up access to some and deny it to others, computer ownership is not the main obstacle to university access at the University of British Columbia. Many more potential students are decide access by restrictive grade point average entrance requirements, arbitrary prerequisites, residency or attendance requirements, and barriers to credit transfer from other institutions, If a primary purpose of introducing technology - based learning is to increase access, these admission policy issues need to be addressed as well.

7. New teaching models

In just the same way that the steam engine changed the forms of transportation, and the microchip, satellites and fibre optics are changing the forms of communication, so will technology change the forms of teaching and learning.

There is a synergistic relationship between different technologies and different approaches to teaching. This is a subject that deserves several books to itself (see for instance, Laurillard, 1993, Bates, 1995, Harasim 1995). However I want to make three general points that indicate the complexity of this issue.

First, the newer technologies are quite flexible in that they can be used in a variety of different ways for teaching. Secondly, humans vary enormously between their wish or requirement to follow tried and tested processes, and their ability to be imaginative and inventive. Thus technologies can be used to replicate traditional forms of teaching; at the same time, they can be used in quite new and different ways, depending on the imagination, skills and resources available to the teacher or learner. Thirdly, media such as video, audio, text and computing are all converging into single multimedia technologies such as the Wed or CD - ROM. This is making it increasingly difficult to identify educational applications with a particular technology.

Nevertheless, despite this variability, certain trends in the use of technology are evident. It appears that some technologies lend themselves more easily to certain approaches to teaching and learning, while other technologies lend themselves to others (see Bates, 1995, for a full discussion of this). So far there is no super technology that can meet to be mixed and matched to the educational purpose.

Thus we find that instructional television and video - conferencing (one - or tow - way television from one site to a class in another site) and certain applications of the World Wide Wed (for instance, where information is posted for students to read) tend to be used primarily for information transmission in a didactic style, very close to the classroom lecture model.

Other technologies, such as computer mediated communication using software such as Soft Arc's First Class, Simon Fraser University's Virtual-U, and Netscape's Hypernews, allow for more collaborative learning models. These technologies encourage or require a high level of discussion and participation by the learner, and very much resemble the seminar model of classroom teaching.

Although CD - ROM technology is often used merely to replicate a book (ie. a didactic style), but with better graphics, animation, audio and video, a number of applications that more fully exploit the technology are emerging. Thus CD-ROMs are increasingly being used to simulate human interaction (for language teaching), for representing expert systems, such as forestry management, and for problem - solving approaches based on scientific methodology, through for example the use of virtual laboratories. These approaches to learning enable students to apply their learning to para - realistic situations, to test their own ideas and use their own experience, and as a result to make and test decisions drawing on their previous learning, or even learning facts and principles during the process of decision - making.

The Web is a particularly interesting technology in the way that it is evolving. It has the ability to combine all these various approaches to learning. For instance, Web CT, designed at the University of British Columbia by Murray Golberg (see Goldberg, Salari, and Swoboda, 1996), is a Wed authoring system that combines deductive and collaborative learning tools, as well as a student learning management system, allowing subject experts without any specialist computer skills to construct their own courses. The limitation of the Web at the moment is bandwidth and the power of desk-top machines, which make it difficult or impossible to run the more powerful applications needed for expert systems, complex simulations and problem solving. However this will change quite rapidly.

It could be said with some justification that what I have described are not new ways of teaching, merely the application of well - tries teaching methods to delivery by technology. While that may be true, these technologies enable more powerful applications of such teaching methods in more flexible and accessible forms for students, with also the potential for economies of scale. Furthermore, what all these technologies have in common is that, when well designed, they enable learners, irrespective of the subject

matter, to develop skills of information navigation, acquisition, and analysis, application of knowledge to new situations, new knowledge creation, and decision - making, all skills essential for survival in an information society.

In terms of change strategies, these new approaches need to be tested and developed not just in a narrow setting of a particular class or course, but in a system of teaching as a whole, where appropriate replacing, not adding to, conventional teaching methods. Thus technology - based teaching needs to be built into the mainstream teaching, and not offered as peripheral or optional learning for students.

8. Faculty agreements and training

It should apparent by now that the use of technology needs to be accompanied by some major changes in the way faculty are trained and rewarded. Teaching with technology is not something that can easily be picked up along the way, as something to be done off the side of the desk while engaged in more important or time - consuming activities such as research.

The most common form of training given to faculty is to show them how to use the technology. This though is starting at the wrong place. Many faculty need to understand why it is important to use technology for teaching in the first place. It has to be related to the changing environment in which universities find themselves, and in particular to the changing needs of learners.

Secondly, some basic understanding of the teaching and learning process, and in particular the different kinds of teaching approaches, and the goals they are meant to achieve, need to be understood.

Thirdly, faculty need to understand the different roles that technology can play in teaching, and how this alters the way that teaching needs to be organized. Only then does it make much sense to train faculty in how to use a particular piece of technology.

While this sequence may be logical, it is unlikely to be the most effective way to help faculty develop skills in using technology; 'show and tell' and hands on experience are most likely to lead to this full range of understanding, Nevertheless all four aspects need to be deliberately targeted in faculty development (see Holt and Thompson, 1995, for a good discussion of this issue).

University teaching is probably the last craft - or guild - based profession. However, the changing nature and variety of learners, the growing complexity and volume of knowledge, and the impact of technology on teaching now really require that university teachers should have formal training and qualifications in instructional methods. This should eventually become a condition for tenure.

Even more fundamental than faculty training is the need to change the reward system for faculty. While many universities have statements that equate teaching with research for tenure and promotion, the reality in most research universities is quite different : the only criterion that really matters is research.

Thus there is no point in pouring millions of dollars into infrastructure and computers and multimedia unless the faculty reward system is changed. Teaching ability must become in practice at least equal to research for promotion and tenure. The good news though is that technology - based teaching is usually more public, more observable, and hence more easily evaluated than conventional classroom methods. Furthermore, multimedia technologies provide an excellent means to convert research knowledge directly into teaching and into promotional material for the research itself.

Another way to reward faculty is to ensure that revenues generated by the use of technology by a department flow back into that department, and do not get swallowed by the central bureaucracy. Innovative mechanisms need to be developed for faculty (and other creative staff) to share in rights and royalties from the development of generic educational software and learning materials.

Lastly the very sensitive issue of faculty agreements needs to be addressed. There are short - term advantages in leaving things loose, but technological innovation will become unsustainable as faculty become more experienced, suffer from increased work-loads, and find that they are still unrewarded.

9. Project management

It has already been argued that there is a great deal to be learned about how to exploit fully the new technologies for teaching and learning. At the same time there is growing evidence that there is a major difference between 'experimenting' (R&D) and delivering cost - effective technology - based teaching (operations). The challenge is to encourage faculty to be innovative while at the same time maintaining quality control and cost - effectiveness in the delivery of teaching.

However, while new technologies require new applications, a great deal is already known about the process of producing high quality, cost - effective multimedia learning materials. This knowledge has been developed both in the large autonomous distance teaching universities, and also in private sector multimedia companies in areas such as advertising and film and television making.

The answer is project management. This means establishing each course or teaching module as a project, with the following elements :

- a fully costed proposal, which identifies
  - the number and type of learners to be targeted (and in particular their likely access to technology),
  - clear definition of teaching objectives,
  - choice of technologies,
  - a carefully estimated budget allocation (including staff time, copyright clearance, use of 'fixed' media production resources, such as video - compression, as well as actual cash),

- a team approach, involving any combination of the following :
  - subject experts / faculty,
  - project manager, instructional designer,
  - graphics designer,
  - computer interface designer,
  - text editor,
  - Internet specialist,
  - media producer,
  - depending on the design of the project,
- an unambiguous definition of intellectual property rights and a clear agreement on revenue sharing,
- a plan for integration with or substitution for face - to - face teaching,
- a production schedule with clearly defined 'milestones' or deadlines, and a targeted start date,
- an agreed process for evaluation and course revision and maintenance,
- a defined length of project before redesign or withdrawal of the course.

A project is not defined in one step. In the Distance Education and Technology unit, we have a five - stage approach to project definition. Following an invitation to all faculties to bid for funds, a department or individual academic is invited to submit a short proposal (usually two to four pages) requesting funds or assistance. We provide a short questionnaire to help faculty at this stage.

One of our senior managers then works with the lead academic to develop a fully costed proposal. This is a critical stage of the process, where objectives are clarified, alternative modes of delivery are explored, and resources are identified.

The project proposal then goes in competition with all the others to a university - wide committee of academics for adjudication. A set of criteria for selection has been developed, including the number of students to be served, strategic positioning in terms of technology applications, innovativeness, potential for revenue generation, etc.

Following allocation of funds, a detailed letter of agreement is drawn up between the academic department and the Distance Education and Technology unit, which clearly sets out responsibilities on both sides, and ties down production schedules, intellectual property, sharing of revenues, etc.

Once the project is funded, DET managers track progress, schedules are rearranged to take account of changing circumstances, budgets are sometimes changed (but more likely re-arranged) as a result, all by mutual agreement.

Funds for distance education then are allocated differently from the Teaching and Learning Enhancement Fund. The differences are really a matter of timing and purpose. To encourage staff who are 'novices' in using technology, and to encourage research and development in the use of new technologies, a 'weak' criteria approach may be best for TLEF. Often faculty with little experience of using technology prefer the privacy and control of the Lone Ranger approach. However, as one moves to regular teaching with new technologies, as more experience is gained by faculty, and the more independent the targeted learners, the more important it becomes to move to a project management model.

Faculty experienced in using technology soon learn that there are things they do not need to do, and that while a good graduate student is invaluable, there are other skills needed too. In the Distance Education and Technology unit we have found that most faculty welcome a structured approach to the development of multimedia courses, provided it does not interfere with their creativity in teaching, which it should not do.

10. New organizational structures

The challenge with regard to organizational structures is to develop a system that encourages teaching units to be flexible, innovative and able to respond quickly to changes in subject matter, student needs and technology, while at the same time avoiding duplication, redundancy and conflicting standards and policies.

There has been a long history in universities of setting up large central technology units. In the 1960s and 70s many universities invested in expensive, centrally managed television studios. More recently universities have established large central computing organizations. Too often these central services have had little impact on the core teaching activities of an institution, partly because faculties have felt that they do not control them. Such units are often subjected to attempts by Deans to break them up and reallocate their funding back to the faculties.

Although often dependent on centrally provided networks, new technologies such as the Web are more decentralized. The power is often (or appears to be) on the desktop. This provides considerable empowerment for the individual faculty member. However we have seen that high quality educational multimedia requires a range of specialist skills that go beyond the capability of any single individual. Furthermore the appearance of decentralization in the new technologies is deceptive. They depend on agreed standards and networks for communication and inter-operation, and they depend on human and technical support infrastructures that require policy making across the university.

The initial strategy at UBC in responding to the challenge of the Innovation Fund was not to centralise all the new technology support services into an existing unit such as Computers and Communications or Media Services, nor to set up a large New Media Centre, as many other universities have done, but to establish a very small co-ordinating unit, originally called the Media Resources Network and later the Centre for Educational Technology. This had a project director, a multimedia graphics designer, an interface

designer, and later a part - time secretary. These provided services that could be called on by faculty to help them if they wished.

This now means that UBC has several small - sized organizational units with somewhat linked activities : Media Services, which provides printing, photography, audio and video production and videoconferencing facilities, the Centre for Educational Technology, the Distance Education and Technology unit, which has project managers, instructional designers and more recently an Internet specialist, the Centre for Faculty Development and Instructional Services, and Computer and Communications, which provides network services across campuses and a somewhat decentralized computing support service for faculties. Health Sciences has its own media services unit and educational support units. Each of the directors of these units have different reporting relationships. Lastly, as well as individual faculty members or departments hiring graduate assistants to provide educational technology support, at least one Faculty has now appointed its own Director of Information Technology and Instructional Support.

This sound like recipe for chaos, but it works surprisingly well. For large projects, teams can be called together from across the various groups. Thus a project to put the whole of an introductory microbiology program on to CD - DOM and the Web has funding from the Faculty of Science, the Teaching and Learning Enhancement Fund, and the Distance Education fund, faculty and a project manager from Science, an instructional developer from Health Sciences, graphics and interface design from CET, media production from Media Services, and an Internet specialist from Distance Education and Technology. Figure 2 below indicates the kind of arrangement just described.

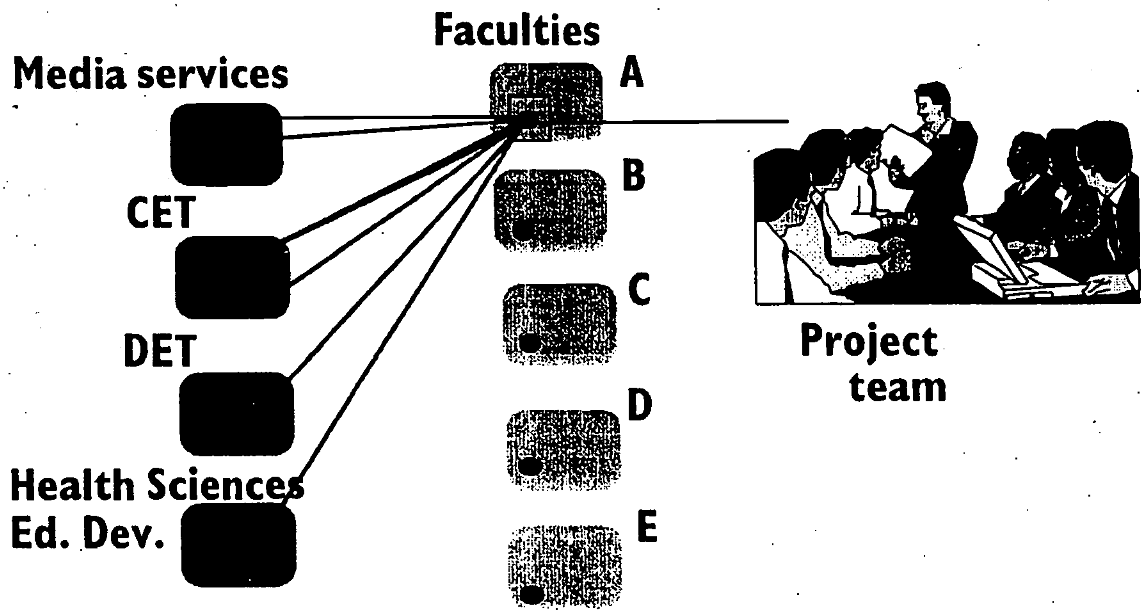

Figure 2: A decentralized model of multimedia course design and production.

At the other extreme, an individual faculty member can still work alone, or draw on any one the services, on a project - funded or fee for service basic.

Some institutions, especially in Australia (e.g. the University of Wollongong, and Griffith University), have integrated their professional development, distance education and media services units into a single multimedia department. The establishment of six co-operative multimedia centres in Australia, with university partners, suggests that multimedia production and services may even be shared between several neighbouring universities and private sector organizations.

However a major study of managing technology for teaching and administration in Australian higher universities (Australian Graduate School of Management, 1996) classified universities into three different groups : old, divisional and new. The study argued that while centralization of services is appropriate in a new institution with a major commitment to make IT a centre of its vision and strategy, this is less likely to be appropriate for large, well - established 'divisional' universities with a strong Faculty structure. It is certainly true that at UBC there has been concern not to weaken the control of Faculties over the teaching process, and to avoid setting up a large central unit that might develop its own autonomy.

With regard to the establishment of university - wide policies and strategies to support the use of educational technologies, we saw under strategy 3 that UBC has established two different reporting lines for policy initiatives, one through the Academic Vice - President and Provost, and the other through the Vice - President Student and Academic Services.

In the private sector a number of organizations have recognized the strategic importance of information technology by appointing a single Chief Information Officer at a Vice - President level, who has a full - time responsibility for information technology policy.

This person is not necessarily someone who has come from a career in computing or communications; in a university environment, it would be someone with a strong academic background, but who has a good understanding of the management and policy issues surrounding information technology, and commands respect and has at least equal status with the other Vice - Presidents and with Deans (see Bates and Mingle, 1997, for a more detailed discussion of this issue).

These are not the only structures for setting and co-ordinating information technology policy at a university level; a small committee consisting of the President, two Vice-Chancellors and two Deans could provide the same role.

While there are advantages and disadvantages of these various approaches, what is essential is that there is a mechanism in place by which university - wide policies and priorities for information technology can be set and implemented throughout the organization.

11. Collaboration and consortia

New technologies are resulting in global competition for universities. Already three Canadian universities (Queens, Western Ontaria, and Athabasca) are vigorously promoting and offering distance MBA's in British Columbia. In 1995 43% of all Masters in Education awarded to British Columbia teachers were from institutions in the USA. This competition is going to increase and will be impossible to regulate.

UBC's competitors are less likely to be our neighbours, such as Simon Fraser or the University of Victoria. There is a good deal of complementarity in programming within British Columbia; UBC offers courses not available from other BC universities, and vice - versa. For more than 10 years there has been collaboration and co-ordination in the offering of undergraduate distance education programs and a system of credit transfer between institutions, through the Open University Planning Council of British Columbia. Where such structures within a state or provincial jurisdiction do not exist, they will needed to prevent duplication and 'body snatching' (recruiting students from other institutions through distance education programs).

Our competition is more likely to come from universities such as the University of New South Wales, Strathclyde University, UK, and Penn State University. Even more of a threat is likely to come from multinational corporations in the areas of telecommunications, entertainment and information technology, such as Microsoft, IBM's Global Networks, and the Disney Corporation, who are all targeting education as a natural growth area for value added services and products.

As a consequence, we are beginning to see strategic alliances emerging between universities, and between universities and the private sector. UBC is developing a strategic partnership with the Monterrey Institute of Technology in Mexico, for staff and student interchange, and more significantly for the development of joint programs that can be delivered by technology throughout Latin America.

With the private sector, UBC and BCTel are entering into a partnership agreement that will provide improved connectivity on and off campus for the university, investment in program areas critical to the telecommunications industry, and the development of joint educational initiatives that provide benefits for both partners.

At a national level, a consortium of universities, colleges and private sector companies, called Oui. Can. Learn, is working towards establishing a national marketing strategy for Canadia distance education products and services. At a provincial level, UBC, Simon Fraser University, British Columbia Institute of Technology, the Open Learning Agency, BCTel, the IBM Pacific Development Centre, and Mobius are tentatively working towards the establishment of Distance Learning BC, to identify market needs for technology - based learning, as well as to market internationally.

These strategies enable universities to reduce risk, share the costs of new developments, and reach wider markets for their products and services.

12. Research and evaluation

The need for systematic research and evaluation into the use of new technologies should be obvious. However it is important that the right kind of research should be done. The wrong kind of research is to compare the learning effectiveness of technology - based teaching with the learning effectiveness of classroom based teaching, using the classroom based model as the baseline. Many hundreds of thousands of such comparative studies have been made in the past, and the usual result when the comparisons have been done using sound research methodology is that there is no significant difference (see, for instance, Clark, 1983).

As long ago as 1974, Wilbur Schramm pointed to the flaw in this kind of approach : technologies allow the achievement of new or different learning outcomes to those of the classroom lecture method, but if the classroom 'event' is the base, then the new learning outcomes that could be achieved are not usually measured. For instance, if a lecture is used primarily for transmitting information, but a CD - ROM is used for applying that knowledge to solving a problem, then the measure of success for the CD - ROM has to be different from the classroom lecture. The aim then should be to measure the success or otherwise of new technologies in extending the range of learning skills, as well as content acquisition.

Even more important than research into learning outcomes is research into learners' response to using technologies, and in particular what learners and teachers believe may be lost or gained in using such approaches to learning. These results are likely to vary considerably from individual to individual, so benefit more than others from technology - based teaching. This kind of research should also help identify the critical aspects of face - to - face teaching, which are likely to be as much social as instructional.

Another area of research that has so far been neglected is around the organization of technology - based teaching : which organizational arrangements seem to work best for different kinds of university ?

Yet another area where research and development is needed is into new interfaces and applications software that facilitate different kinds of skills, or the development of technology - based teaching. These are generic tools that could be used for the development of a wide range of courses.

Lastly and perhaps most important of all, there is a need for studies into the cost - benefits of technology - based teaching. As well as looking at the costs and benefits of a particular technology, it is also important to look at the social and economic impacts of moving to technology - based teaching (see Cukier, 1997).

Fortunately, at this point in time it is not too difficult to find external funds for this kind of research. For instance we have a grant through the Canadian government's National Centres of Excellence in Tele-learning program to conduct a cost - benefit analysis of on - line teaching and learning. We also have another grant from Human Resources Development Canada's Office of Learning Technologies to study the impact of

technology - based learning on different kinds of adult learners, in conjunction with Simon Fraser University, the University of Victoria, the Open Learning Agency, and community skills centres in British Columbia.

Conclusions

By this time you may well have asked the question : is it work it ? I must confess that I get tired merely thinking about what needs to be done. The implementation of these strategies will present a major challenge to any university administration. Are they all necessary ? If technology is to used to improve significantly the quality of learning in a cost-effective manner, I believe they are. Indeed there are probably many other strategies that are also necessary to facilitate the achievement of such a goal.

Furthermore, timing is critical. There is a stage for instance where an institution needs to move from a 'weak' criteria approach to a 'strong' criteria approach to funding. Organizational changes may have to take place later than funding re-allocations. Nevertheless these strategies are all inter-related. There is no point in making major technological investments without a parallel development of a vision of how the institution wishes to teach over the next 10 years. 'Build it and they will come' without the other strategies is a very high risk.

Then there is the cost of change. It takes time to design effective learning materials, to put technology systems in place, while at the same time the flow of conventional students and the necessity to conduct research does not stop.

Nevertheless Rome wan't built in a day. It took more than 100 years from the invention of the steam engine to Henry Ford's first production line. Such revolutionary changes have to progress at a rate that can be absorbed by faculty and students. What I am suggesting is more like a 10 year strategy than a strategy to be completed within one year.

There is also the options of not going down this road, of having a token or limited use of technology for very specific purpose, of using technology mainly as an additional activity to face-to-face teaching (and being prepared to live with the extra costs of so doing), or deciding to focus entirely on more traditional approaches. However all these approaches contain high risk as well.

Lastly the question needs to be asked : can this be done ? It could be argued that the 12 strategies require such fundamental changes within a university that the whole enterprise is unsustainable; it may be 'better' to create new institutions from scratch.

My own view is that this underestimates the ability of some of the most intelligent and well-educated people in the world to learn, to change, and to take control of their own destinies. It also underestimates the pressure that is likely to be exerted on universities to change, by governments, by competition, and from within. Lastly, I ask sceptical professors: 'Who is having the most fun in teaching : those struggling to serve increasingly large classes within the conventional system, or those who have embraced technology as a possible solution to increasing demands and reduced resources ?

So while I predict that quite a number of universities will not survive, while others will find alternative routes to survival, many will protect their core activities by improving the quality of learning and the institution's cost effectiveness, and will do this through the intelligent use of technology.

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INTERACTIVE MULTIMEDIA TECHNOLOGY CONTRIBUTING IN SOLVING THE PROBLEM OF NATIONAL EDUCATION

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Abstract

This paper contains three parts : First, the pedagogical advantages of CD-ROM based interactive Multimedia .Second , the comparison of Multimedia and the other public media , such as Internet/Intranet , broadcasting , television.. Last, after determining the demand of the Education-training, the role of CD-ROM, A proposal of national strategy for developing the use of CD-ROM in Education will be suggested.

The report will be concentrated in the following issues:

- *PC based Interactive Multimedia.*
- *Interactive Multimedia and Learning.*
- *Comparison of Multimedia and other Media.*
- *CD-ROM and the application in Distance Education :CD-ROM in class, CD-ROM and Television, CD-ROM and books, CD-ROM and Internet, CD-ROM and Videotape.*
- *The urgent demand of a national program for developing Multimedia application in Education.*

INFORMATION TECHNOLOGY WILL TRANSFORM THE UNIVERSITY

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Universities are in the information business , and technological developments are transforming that industry. University professors from a variety of disciplines have helped create of disciples creates the technology that are forcing many U.S. industries to reinvent themselves, have advised industry leaders on how to adapt, and have analyzed the importance of the changes for society . But it's harder to look inward at the university and to think about whether it might change in dramatic ways. We should remember that although its roots are millennium old, the university has changed before. In the early 19th century it embraced the notation of secular "liberal" education. In the late 19th century it included scholarship as an integral part of its mission. After World War II it accepted an implied responsibility for national security, economic prosperity, and public health in return for federal funding of research. Although the effects of these changes have been assimilated and now seen " natural", at the time they involved profound reassessment of the mission and structure of the university as institution.

Outside forces are always acting on universities. Some of them, notably the political ones, have great immediately and hence get a good deal of attention. For example, university administrators are acutely aware of the current reassessment of the rationale for federal funding of research and the desire for greater " productivity" from the faculty, and so on. As important as these changes may be, I believe that information technology has a far greater potential to provoke fundamental change in our system of higher education. Moreover, I am certain that these changes are much closer than most people realize.

Let me be clear. Higher education will flourish. If anything, the need for advanced education is increasing. A greater percentage of the world's population needs to be educated to be productive in an increasingly technological workspace. The period during which particular skills are relevant is shortening, so the need for lifelong learning are growing. The knowledge and skills necessary to function at the frontier of knowledge are expanding as well, increasing the need for advanced degrees.

Higher education is not in danger. But we would be wise to ask whether the particular quaint way in which universities now do their work will survive the transformation of information technology. It ma , but I don't think so. I expect to see major changes - changes not only in the execution of the mission of universities but in our perception of the mission itself.

Universities historically have changed slowly, but there are times that are more propitious than others for change. The next decade is one such. Because of the speed with which information technology is advancing , decisions are being made now(or more likely, make by default) that will have a material effect on the real and perceived quality of institutions of higher education. In my experience, almost none of the current generation of senior university administrators understand what is happening . They should be confronting two central questions: Are universities like businesses they must adapt to technological change and is the capability of technology used for higher education really going to change all that much?

Universities share many of the attributes of traditional handcraft industries. They are highly labor intensive and depend on the skill of their master craftsmen. They have been regional, requiring collocation of the producer and customer, and have contributed to the prestige of their locales .They have a long tradition. They have evolves powerful guilds to protect the masters. And now they face the prospect of a technology that can perform many of the specialized tasks that have made their work valuable.

Universities also share at least some of the attributes of others vertically integrated industries . They manufacture information (scholarship) and occasionally "reprocess" it into knowledge or even wisdom, they warehouse it (libraries, they distributes it (articles and books).Information technology has already changed each of these processes and future. Like industries that have been overtaken by technology, they need to understand its individual and collective impact on their basic functions. Its not a comfortable thought, but we must at least consider that a change in technology- a change that will facilitate the flow of the university 's essential commodity, information- might provoke a change in the nature of the enterprise.

As for the rate of technological progress, most people still fail to understand the dimensions of the exponential rate of improvement in information technology. For the past four decades, the speed and storage capacity of computers have double every 18 to 24 months; their cost, size and power consumption have diminished at about the same rate. The bandwidth of computer networks has increased a thousandfoul in just the past decade, and the traffic on the network continues to grow at 300 to 500 percent annually. For the foreseeable future, all of these trends will continue; the basic technology to support them exists now.

For a concrete example of what this rate of change means, consider ENIAC the first fully electronic digital computer. A 1949 article in Popular Mechanics raved about what could be expected from computer design: "ENIAC" contains about 18,000 vacuum tubes and weighs 30 tons , but in the future computers will contain only about 1,000 tubes and weigh only one and a half tons."

Thirty-five years later , a typical microprocessor is about 100,000 times more powerful, contains the equivalent of 10 million tubes, and weighs substantially less than an ounce. Imagine the nonoprocesssor of a few decade hence.

To my knowledge, there has never been a similarly rapid, sustained change in technpology, especially one with such broad social application. By comparison, even the industrial revolution seems modest in scope and leisurely in space. Lacking a precedent, we need to work harder to imagine the impact of future computers and networks. Thinking about the current ones, in fact , can be misleading; it's all too easy to assume that something won't change just because just because today's technology doesn't support that change . Instead, it's almost better to hypothesize a change and then ask how soon the technology will support the answer how soon

Don't think about today's teleconferencing technology. But about one whose fidelity is photographic and possibly three dimensional. Don't think about the awkward way in which we access information on the network, but about a system in which the entire world's library is as accessible as my desktop files. Don't think about the clumsy interface with computers, but one that literally listens and talks in your jargon, not mine. Don't think about the storage on today's personal computer, but on one with millions of megabytes, we can 't afford it now, of course but that is the power of the equipment affordable in a decade or so. That is the equipment that will shape the future of the university.

Tapping new capabilities

How we will use this equipment to change education and scholarship? That seems like a simple question, but as both an academic and a computer scientist, I don't know. The ability to process information, the raw stuff of knowledge , sits at the heart of the university mission. A technology that will alter by orders of magnitude our ability to create, store, and communication knowledge will have an impact on how to we fulfill our mission, and possibly on the mission itself. Perhaps as a start we might look at several functions of our vertically integrated information business and note how they have been and might be changed.

Scholarship.

The impact of information technology on science is apparent and pervasive. Scientists now routinely talk of computation as the "third modality" of scientific investigation, on a par with theory and experimentation.

The easy examples are those that simply automate what have been done manually, such as the reduction of data and control of instruments, The profound applications, however are those that lead to whole new areas of research and new methods that lead to whole investigation and thus to science that was not and could not be done before: analyzing molecules that have not been synthesized, measuring the properties of a single neuron by "growing" it on a silicon chip, watching a model of galaxies colliding and letting a scientist feel and the forces as drug docks in a protein . These applications have transformed the nature of scientific investigation ; they have led to question that would not even have been asked before.

Science, however, will not be where we see the most dramatic impact. I say that despite a recent study (in which I participated) by the National Research Council that paints an expansive image of the transformation of scientific research. I believe. I that a more dramatic transformation is about to shake the foundation of scholarship in the liberal arts. Humanists will lead the way to innovative application of the information technology in the university.

The comfortable stereotype of humanists as technophobic is no longer accurate. The availability of text and images in electronic form, coupled with the processing power of modern computers, allow the humanist to explore hypotheses and visualize relation that were previously lost in the mass of information sources. The presentation of humanists' scholarly results in electronic form is moving even faster. Precisely because of the complexities of the relationships they next to present, electronic "hypertext" books and journals are emerging. Indeed, they are emerging faster, with more vigor, and with more effect on their disciplines than are their counterparts in the sciences.

We all expect scientists and engineers to use computer in their research, but the notion that information technology could be central to humanistic scholarship is a bit more startling, at least to me. In large measure, it was talking about the application of computer to historiography and theory of text that opened my eyes to the larger issues that I am trying to raise here.

Textbooks.

I don't know anyone who prefers to read from a computer screen, and besides you can't take a computer to the beach, or so say the nostalgic. They are right, and yet so profoundly wrong.

There are two fallacies here. They first is the assumption that electronic books will contain only text and hence be essentially the same as paper books but in a different package. In reality, it will not be possible to reproduce electronic books on paper . They will not be a simple linear presentation of static information, but will contain animation and sound. They will let you "see the data" behind a graph by clicking on it. They will contain multidimensional links so that you cant navigate through the information in ways that suit your purpose rather than the author's. They won't contain references to sources, but the source material itself; for example, the critique of a play will include its script and performance. They will have tolls that let you manipulate equations, trying them on your own data or modifying them to test scientific hypotheses. They will let you annotate and augment documents for use by later readers, thus making a book a "living document".

They second fallacy is presuming today's technology. We should not be talking about reading these electronic books from to day's screen. Screens with a resolution about the same as good laser printer already exist in the laboratory. Why would anyone lug around several heavy books when something the size, clarity, and weight of a single one contains them all? I mean all: all the ones in the Library of Congress. I will talk my computer to beach!

Libraries

For thousands of years, the focus of libraries has been on the containers of information: books. The information itself was the domain of the library's user, not the library. Information technology turns that premise on its head and with many of the deepest unstated assumptions about the function or library.

Looking back to Alexandria and before, the principal objective of librarians has been to build the collection. But in the future a library will not collect. Electronic information can be communicated virtually instantaneously, so its source location is irrelevant. Instead of a hoarder of containers, the library must either become the facilitator of retrieval and dissemination or be relegated to the role of a museum.

If we project far enough into the future, it's not clear whether there is a distinction between the library and the book. They technology of the bibliographic citation pales by comparison with the hyper-textual link: the ability to gain immediate access to the full referenced source and hence to browse through the context of the referenced. It will take a long time to build the web and especially to incorporate the paper legacy, but the value of a seamless mesh will doom the discrete isolated volume.

As the library and the book merge, it seems clear to me that another merger will accompany it, a merger precipitated by devolving disciplinary boundaries. Knowledge isn't inherently compartmentalized; there is only one nature, only one human record. The division of the sciences into disciplines and sub-disciplines is human imposition, as is the division of the humanities into disciplines such as history, English, and anthropology. For very practical reasons, paper texts have mirrored this artificial division, but those reasons evaporate in the electronic world. Clearly, the "long pole in the tent" will be human rather than technological; disciplines are complex and idiosyncratic social structures that will not easily dissolve. However (and here I can only speak with smallest authority technological disciplines), much of the most interesting work already happening at the boundary of traditional disciplines. That is not new news; Albert Einstein maintained that most of the important science lay at the intersection of the traditional disciplines. What is new is that we have technology that facilitates incremental accretion of knowledge at these intersections.

Finally, books are passive, sitting on shelves waiting for us to read and interpret them. Although there is an intellectual thrill in discovery and interpretation, passivity of the text is not required for that. As MIT's Marvin Minsky said "Can you imagine that they used to have libraries where the books didn't talk to each other?" One of the profound changes in the store for the libraries is that parts of their collection will be software agent collecting, organizing, relating, and summarizing on the behalf of their human authors. They will "spontaneously" become deeper, richer, and more useful.

Teaching.

The notion of computer-aided instruction has been touted for 30 year. Frankly, it has had relatively litter impact, especially at the university level. The reason is obvious: Chalk and overhead projectors have been perfectly adequate technology given the current nature of the scholarship and texts.

If, however, the professors are using information technology in their scholarship and the results of that scholarship can only be exhibited using the technology: the classroom will follow rapidly. How will it follow? Not, I think, by "automated drill" scenario we have come to associate with computer-aided instruction.

These are interesting but mundane applications, mundane in the sense that they do not change the educational process in a deep way. More fundamental is the opportunity to involve students in the process of scholarship rather than merely its results. We like to say that we teach students to think, not merely to learn rote facts, but in truth we mostly limit them to thinking about what has been thought before.

We can't ask them to explore new hypotheses because of the practicalities of access to source and the sheer grunt work of collecting and analyzing data. Information technology eliminates those impediments.

A hint of this kind of change can be detected in a report in the Chronicle of Higher Education about the impact of the release of the Thesaurus Lingure Groece on the scholarship and education in the classics. The report noted that the release of this database, which includes virtually all Greek literature from Homer through the fall of the Byzantium, has enabled undergraduate participation in research.

One cannot leave the subject of teaching without at least mentioning the issue of "productivity," the current code word to capture the public's frustration with the rising cost of college education and the perceived emphasis on the research over teaching. The simplistic solution is to have professors spend more time in the classroom and the less in the laboratory. Particularly given the wrenching restructuring that industry has undergone, the public has ample cause to ask why an elitist academe should be exempt from a reorientation toward greater customer satisfaction.

The irony, of course, is that one of the oldest figures of merit for any school - a low/teacher ratio-is diametrically opposed to the strict definition of productivity as output per worker. Information technology is not going to resolve this tension; for our own children, we want relatively individual attention from the most qualified, intellectual alive professorate possible. Information technology can however, shift the focus on the discussion to the effectiveness and quality of the student/teacher interaction rather than just the number of contact hours.

Indeed, in most modest ways is already has shifted that focus. By removing the barriers of space and time for example, e-mail has given my students much greater access to me than ever before. Involving students in the process of scholarship and giving them

greater access to international authorities are more profound shifts, but I suspect that these are still just pale precursors of what we can do. Part and parcel of rethinking the impact of technology on the university is addressing precisely the issue.

The importance of place

Technological change will even force us to reconsider some of the fundamental assumptions about what a university is. For example, historically a university has been a place. The stone walls of St. Benedict's cloister at Monte Cassino were the bastion that provided defense against the physical and intellectual vandals of the Dark Ages. In colonical times, Jefferson 's Academical Village provides access to scholarly materials as well as collegial interaction by collocation. In contemporary times, scholars flock to scientific instruments and library collections. And , where the scholars assembled, the students followed.

In his influential 19th-century essays on the university, John Cardinal Newman wrote:" If I were asked to describe .. what a university was, I should draw my answer from its ancient designation of a stadium Generale.. This description implies the assemblage of strangers from all parts in one spot. "

Newman then goes on at some length to emphasize that books are an inadequate source of true education and must be buttressed with discourse, which is obviously only feasible if the discussants are collocated. Thus the notion of being in one spot is, to him, essential to the very definition of the university; as he says. "else, how can there be any school at all ?"

But with the possible exception of teaching, to which I'll return in a moment, I believe that information technology obviates the need for the university to be a place. With powerful ubiquitous computing and networking, I believe that each of the university's functions can be distributed in space, and possibly in time. Remote scholarship is the direct analog of telecommuting in the business world, and every bit as appealing. Academics tend to identify more closely with their disciplinary and intellectual colleagues than with their university. Freed from the need to be physically present in classroom, laboratory, or library, grouping by intellectual affinity may be more useful. But even then, physical grouping may be unnecessary.

There are some disciplines that need shared physical facilities, such as a telescope, that suggest the need of a place. But many large scientific instruments such as telescope and accelerators are already run by consortia and shared by the faculty from many universities, and many of these facilities do not require the physical presence of investigator, who could be on-line and have access through the network. Indeed, some instruments , such as those for space physics at Sondre Stomfjord in Greenland, are already accessed on the Internet. The university as place is already irrelevant to at least some scientific scholarship.

As with instruments in the sciences, direct access to archival materials is necessary for some humanistic scholarship but hardly all , and certainly not all of the time. If

anything, the information infrastructure will provide greater access for a much larger set of scholars to archival materials of a quality that's "good enough". Consider the excitement caused by the recent release of the images of the Dead Sea Scrolls, even though the scrolls themselves are not accessible to most scholars.

As for teaching, we don' t really know whether it can be distributed or not . I do know that even asking the question is considered heretical by some good teachers who contend that eyeball-to-eyeball contact is necessary. Others including me, contend that although they need feedback to teach well , there is a threshold of fidelity beyond which one does not need to go; student and teacher probably don't need to smell one another, for example. Thus, there is some finite amount of information required to produce an adequate representation of the parties. If true, when that threshold of fidelity is reached electronically, high-quality teaching will be distributed. The fallacy in Newman's reasoning was only that he could not imagine quality discourse at a distance, but that is precisely what technology will enable.

Uncertainties

Can an institution such as the university, which has existed for a millennium and become and icon of our social fabric, disappear in a few decades because of technology? Of course. If you doubt it, check on the state of the family farm. Will the university as place in particular disappear? I expect not; the reduced importance of place does not imply no place. However, just as farming has been transformed, so will the university be. The everyday life of both faculty and students will be very different

I have more questions than answers as to the shape of the new university. Having now laid the groundwork, let me pose a few of them:

Will universities become mass-market manufacturers or distributors of information or will they be niche tutors to the privileged?

Does it really make sense for every university to support the full complement of disciplines, or should they specialize and share course in cyberspace? This might be a natural consequence of aggregation by disciplinary affinity.

Might professors affiliate with several institutions or become freelance tutors to telepresent students? Indeed, might "tele-itinerant" scholars and tutors give new life to an ancient practice ?

Might some employers (and hence students) prefer a transcript that lists with whom certain courses have been taken rather than where?

What about alumni and sports? Surely the allegiance of alumni to their alma mater has a great deal to do with place. Because the support of alumni is essential to universities, isn't that very human need sufficient to perpetuate university as place? Perhaps. But broad alumni support has become essential to university only in relatively recent times. Moreover, alumni associations and large sports programs were created to support the university as place, not the other war around.

Will university merge into larger units as cooperate world has done or will the opposite happen? I can argue either side of this question. On the one hand, if a university isn't (just) a place, its major remaining function is certification: If certifies the competence of the faculty, programs, and graduates. We don't need thousands of organizations to do that. On the other hand, I can envision many small colleges being empowered to provide a broad curriculum through telelocation while retaining the intimacy so valued in our small liberal arts institution. I don't know anyone that really wants the impersonal ambiance of a mega - university. The current size of these universities seems optimized for the physical infrastructure, not for either education or scholarship.

Might the technology revive the talented amateur participation in the scientific community? Except in a few disciplines such as astronomy, the talented amateur has largely disappeared from scholarly discourse in science and engineering. Surely such individuals still exist, but they isolated from the community of scholars. How can or should the university re-engage them ?

What about the various businesses such as the universitypress that have affiliated with universities. My guess is that each of these will be forced to rethink its principal mission and many will be irrelevant.

Will more (most?) universities serve a global clientele, and how does that square with the publicly supported university in the United States? In particular, will private universities have greater flexibility to adapt to globalization, thus dooming the public universities

Does the function of socializing young adults, which perhaps remains a reason for "place" need to be coupled with the educational function or could it be done better by some form of social service?

Some will interpret these questions as threatening; I don't. That there will be a change seems inevitable. But change always implies opportunity; in this case, the opportunity to improve all facets of what we do in the academy. The challenge is to anticipate and exploit the changes.

Recommended reading

To see how much the academic world is already changing, sample these on-line sites in the humanities:

http://jefferson.village.virginia.edu/

http://tuna.uchicago.edu/ARTFL.html

http://dmf.culture.fr.files/imaginary_exhibition.html

http://scalett.libs.uga.edu.darchive/hargrett/mapss/colamer.html

http://sunsite.unc.edu/expo/deadse.scrolls.exhibit/intro.html

SESSION 5

Friday, 16 January 1998

Session 5: Network technology based application

Chair:
Dr. Nguyen Thanh Son, University of Technology, HCMC,Vietnam

5-1.**Distance Education in University of Hawaii**
Dr. David Lassner, University of Hawaii, USA

5-2.**An Approach to Distance Education by using network technology**
Dam Quang Hong Hai, University of Natural Sciences, HCMC, Vietnam

5-3.**About the ways to solve shortage of IP address**
Phan Cong Vinh, Vietnam Post and telecoms Institute of Technology

5-4.**Introdution to a Very Large Database**
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DISTANCE EDUCATION SYSTEM AT UNIVERSITY OF HAWAII

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The term " distance education " and HITS (Hawaii Interactive Television System) have been floating round our campuses for several years. Some people may still be a bit puzzled as to what they really mean or if it should matter to them. Others may even have taught a distance education class using HITS and/or cable television without being aware of what else is possible. Hopefully this article will help clear up the airways a bit.

The term " distance education" usually indicates instruction which occurs when students are physically separated from their instructor. This is most often accomplished with the aid of telecommunications technology. Typically, the instructor is situated in one location, while the students may be in multiple locations (including in their home) on different islands. Distance education has been primary use of the University of Hawaii (UH) video networking systems. However with budget cuts and the ease and effectiveness of telecommunications technology, there have been increased requests for use of the systems for meeting and even accreditation visits. So, what are these video systems? The following are brief descriptions of the technologies currently in use.

SkyBridge- SkyBridge is Maui Community College's (Maui CC) microwave system which serves the three islands of Maui county. SkyBridge provides one channel of 2-way video among Maui CC and its education canters on Moloka'i, Lana'i, and in Hana. This provides residents in these locations with access to Maui CC and other courses taught on that campus. Skybridge was built with support from the Federal government.

HTTS- The Hawaii Interactive Television, uses microwave and IFTF(Instructional Television Fixed Service) transmission technology to provide 4 channels of video and audio communication among the islands. HTTS programs may utilize both 2-way video or 1-way video with return audio only. Since mid-1990, the largest use of HITS has been for the delivery of credit programs between the UH campus. The Hawaii Department of Education (DOE) also makes extensive use of HITS for direct instruction and teacher in-service training programs. In January 1995, stewardship of HTTS was transferred from Hawaii Public Television of Hawaii to the University of Hawaii.

Cable TV- As part of their cable franchise agreement, all commercial cable companies within Hawaii provide access channels which may be used for education programming. Most cable companies can receive live programming via HTTS, thus providing UH and DOE with nearly statewide live cable programming capabilities.

Programs on cable are either reproduced to be shown as a scheduled time or broadcast live with return audio capabilities via telephone.

I-Net(Institutional Network)- Cable franchise agreements mandate that cable companies help the State develop as internal infrastructure by providing fiber optic cables and/or other telecommunication services to specific State locations, usually at cost. Fiber connecting O'ahu campuses allows another option for delivering video between campuses. For example, Leeward Community College (Leward CC) cannot originate live video programming directly on the HTTS system. However, since they are a video I-Net to UH Manoa, where the programs can be switched onto HTTS. The I-Net video system transmit broadcast-quality video, using the same technology Oceanic Cable uses to distribute video around the island.

Compressed Digital Video- UH is now beginning to use compressed digital video, often referred to as videoconferencing technology. This differs from cable TV and the original HITS system in that the video system is digitized and compressed before being transmitted. This permits the transmission of many more "channels" the original analog HITS and SkyBridge technologies. There are two compressed digital video systems currently in use by UH. The VideoConnect pilot project connects eight UH and DOE sites on six islands in order to test this proposed new GTE Hawaii with Tel service. VideoConnect now serves as the primary means to connect UH WestHawai'i with UHHilo and Hawaii Community College. We have also installed videoconferencing equipment (from Compression Labs Inc.,or CLI) at several UH O'ahu sites. This system has been used to provide Leeward CC classes at our Leeward CC at Wai'anae education center. This is the same technology installed by the State of Hawaii for their statewide videoconferencing service.

Satellite - While the systems already described carry video signals within the State, satellite technology is the most common means for receiving programs from outside Hawaii. Satellite teleconferences are generally received on a UH satellite dish and carried using one or more of the above systems to one or more locations where they can be viewed live. Audio interaction with the presenters is usually possible by calling a toll-free telephone number. Many campuses have satellite down-link facilities; most programs are received either on a campus dish or on the down-link facilities of the UH Learning Center (LTRLC) or at Hawaii to the Mainland and Asia/Pacific regions.

During the fall we hope to use additional technologies for video transmission. We will be installing desktop video systems in distance education facilities on different islands to permit more cost-effective small group and individual interaction, such as electronic office hours. We are also testing dialup videoconferencing, as a less expensive alternative to satellite for out-of-state video connection.

In order to improve the UH modems, we are adding 100 additional lines, which will take our total over 250 lines. These will include higher speed modems and an improved management capability which will reduce our staff workload and provide more

options for managing this increasingly scarce resource. We are planning to partition some modems into "express" modem pool to make it easier for people to be able to get in just to check email quickly. Because of the financial difficulties, we will not be able to keep up with the demand for free dialup services. The UH community consists of some 60,000 faculty, staff, and credit students. To serve this population with high quality service, it would require at least a 10-fold expansion of our modem pool, with associated capital and recurring costs. We are pursing several ways to reduce the cost of supporting dialup modems. As an example, at the current market price of about $25/month for unlimited dialup access it would cost $18 million a year for 6000 users. Obviously that 's not the real cost, but it conveys a sense of the scale of the problem we face.

Fortunately, there are now many private ISP who manages their own dialup modem pools and sell services to the public. We are now implementing direct connections with local providers through a project we call the Hawaii Internet Exchange, or HIX. This will provide improved service for any member of the UH community who chooses to buy service from a private provider but still want to reach UH resources. It will also improve connections from UH to campuses to information services hosted by the private provider.

Many universities are giving up and outsourcing dialup access by allowing a private provider to sell access directly to students and faculty. And some are beginning to charge to recover costs. We could ration access by limiting cumulative usage, perhaps to 20 hours per user per month, or we could begin to charge faculty, staff, and students for dialup access. None of these solutions are very appealing, but it is clear to anybody who thinks about it that either funding patterns or expectations have to change. The basic problem is that dialup costs are roughly linear with usage, dialup usage is growing exponentially, and institutional budgets are shrinking.

AN APPROACH TO DISTANCE EDUCATION BY USING NETWORK TECHNOLOGY

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Abstract

Distance Education is now very popular in many countries, almost all foreign universities propose their distance courses. In Vietnam now, universities and colleges begin to set up the distance education. In this paper, we present one method for making distance course by using Network technology which can implemented in the condition of communication technique of Vietnam.

1. Introduction

With the economic development of the country, Vietnamese people pay more intention in education. A large number of people have demand to improve their knowledge by receiving the high education from the Universities or Colleges. Unfortunately, most of them live in far provinces, and the transportation between these provinces and big cities isn't convenient. To solve this difficulty, one solution for solving this difficulty is to make a distance learning courses, which can transmit from the center of education to the student's houses. The Universities of many countries provide their distance learning courses to public by using many media such as video tape, CD-ROM and computer networks like Internet or Intranet. But there is somehow different with Vietnamese environment.

2. Model of Distance Education system

To build a Vietnam Distance Education system, we must solve many difficulties of using Network technology. Some of them may be listed as follows:

- People just begin to use Internet .

- People can't use Internet facility to link with one server in site of Vietnam, they must use the long distance telephone line. If they use the long telephone facility, the price is very high compared with their incomes.

We provide the students a classroom atmosphere on which every student has the communication with the teacher and his friends. Some functions of our system are as follows :

- At first we built the teaching tools for the teachers. By using these tools, the teachers can make up the lesson with their familiar skill. In their lesson the teachers can include their writing speech from many word processing software, such as Word for Windows, Ventura, WordPerfect... and they can make the sample programs in Excel, C++

and include them in the lesson. These tools give the teacher more easy way to bring the same material for the in site students to the students of distance learning. When students receive the lesson they can read the text, test the sample in their computer.

- We build up a database of lecture knowledge, which help the teachers to control their work and use the difference sources of material to their lesson.

- After making the lesson, the teacher can transmit it to the students through the system of servers, which must be established in the University and some other provinces.

- All students who are enrolled in the course must have the student tools in their house and they can access one nearest server of the system by the telephone line. Through this link they can down load the lesson from the server to their computer , put in into the database and use it.

In this approach, we imitate the teaching process in which the teachers transmit their lecture with a lot of visual examples to their students. All this lecture note and those examples can be written in text and some another tools. All of those must be compressed into one file and passed from teacher's computer to student's. In addition, students can give the question to the teacher and receive the answers by the same way.

3. Implementation

When designing the system of distance education using the Computer Network we divide it into three parts , this means that different people need different part of the system.

- Teaching part is for the teacher , which consists of making lesson tool , database system of lessons , tool for reading the questions and answering the questions, communication part. In the teaching part, there are many tools that help the teachers to make their lesson. Lesson can contain the main text part , reference part, quiz part.

- Learning part is for the student , which consists of reading lesson tools , database system of lessons , tool for making the questions and reading the answers, communication part.

- Managing part is for the manager of the distance learning system, which is in the servers and consists of the lesson delivery system, question delivery system, answer delivery system, distance learning management system.

The relation between those parts are as follows.

- When the teachers want to make their lesson they use the teaching part in their computers to put all the information into the lesson then they use the communication part to send this lesson in compressed form to the University server.

- In the University server, the management part would pass this lesson to another servers, in which there are some students of this course and the management part on those severs would deliver this lesson to every student's box.

- When the students want to receive the lesson, they can connect to their server and receive all lessons , which are in their box. After receiving the lesson, the students can read every lesson by their computers as long as they want.

An important issue is how to divide the time for teacher and student. We divide their time into two parts.

- First part of time is the time for reading or writing the lesson .

- Second part of time is time for sending or receiving information .

We recognized that the time for teaching or learning is longer than the time for sending or receiving information . Based on this conclusion, the time for teaching or learning would be performed on computer of user and the communication link is established only on the time for sending or receiving information . Therefore, we can save time for communication

4.Conclusion

This approach satisfies the technical condition of Vietnam, We plan to move our system to the Internet environment. We hope, in the following years, when the price of using Internet services is reduced, we can use the Internet for our distance education system.

ABOUT THE WAYS TO SOLVE THE SHORTAGE OF IP ADDRESSES

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Abstract

*IP addresses are in high demand and short supply, but the shortage of IP addresses is no cause for warning. Net managers have several options for dealing with the queeze, such as **First**, start with subnetting, in which a block of IP addresses assigned to a network is divided and spread out among separate, smaller networks.**Second**, consider private addressing--building a private network entirely out of unregistered IP addresses. **Third**, another possible fix (but one that's geared more toward ISPs and carriers) is classless inter-domain routing (CIDR), an address consolidation scheme that reduces the pressure on the Internet's core routers. **Finally**, there's IP version 6, a protocol upgrade that tackles the shortage head-on by expanding the address space from 32 to 128 bits--thereby vastly increasing the number of available addresses, and delivering enough IP addresses to last through the next millenium.*

1.Introduction

While Internet connectivity and intranets have become corporate networking must-haves, they're also providing businesses with a high-tech lesson in the laws of supply and demand because the IP addresses are in short supply . But the shortage in available IP addresses isn't about to bring the 'Net crashing down. The ISPs (Internet service providers), the InterNIC (the body that assigns IP addresses worldwide), and the IETF (Internet Engineering Task Force) are all addressing the address shortage, and they've come up with some solutions that net managers can put to work today.

- **First**, start with subnetting, in which a block of IP addresses assigned to a network is divided and spread out among separate, smaller networks.
- **Second**, consider private addressing--building a private network entirely out of unregistered IP addresses.
- **Third**, another possible fix (but one that's geared more toward ISPs and carriers) is classless inter-domain routing (CIDR), an address consolidation scheme that reduces the pressure on the Internet's core routers.
- **Finally**, there's IP version 6, a protocol upgrade that tackles the shortage head-on by expanding the address space from 32 to 128 bits--thereby vastly increasing the number of available addresses.

2. The first way : subnetting

The crisis wasn't always so acute. There once was a time when net managers seeking IP addresses could pretty much get what they asked for--typically a Class B network address supporting up to 65,534 nodes. With more than 16,000 Class Bs available, addresses were in plentiful supply.

The explosive growth of the Internet, along with the rise of intranets, has changed all that. Class B addresses are now harder to come by than ever before. Choosing a Class C address--which can handle 254 nodes--is an option, but most networks are larger than that, and cobbling together multiple Class C addresses isn't really the most elegant solution. In other words, there just aren't enough Class Bs left, while Class Cs just aren't enough.

Fortunately, there are ways to deal with the shortage in addressing . The simplest of these is subnetting--subdividing an IP network address to use it in several smaller networks.

Subnetting helps deal with one of the most glaring flaws in the present IP addressing system, which is that once a block of addresses has been assigned, all the host addresses in that block are forever consigned to that block. If some or all of them are never used (which is frequently the case), they're unavailable to anyone else.

Here's how subnetting works. Say an organization receives a Class B address of 172.16.0.0 (this is actually a reserved address, used here for illustration). The organization could split this address into up to 254 subnets by using addresses like 172.16.1.0, 172.16.2.0, and so forth. (In this example, the 0 is used for numbering hosts on that subnet.)

3. The second way : private network addressing

There's another way for net managers to get around the IP address crisis: use the special addresses that are reserved for private networks. IETF RFC (Request for Comment) 1918 sets aside three address blocks for use solely in private networks: Class A network 10.0.0.0, Class B networks 172.16.0.0 through 172.31.0.0, and Class C networks 192.168.0.0 through 192.168.255.0 (the RFC is available at http://www.ds.internic.net/rfc/rfc1918.txt). Originally, these reserved address blocks were intended for use in networks not connected to the Internet, or for isolated test or experimental networks. But the shortage has prompted networkers to use these blocks, hiding the private addresses behind firewalls or packet-filtering routers.

The obvious advantage of this scheme is that it makes the shortage of IP addresses a nonissue. But how these private addresses are translated into public addresses when they're sent to the Internet.

The key is NAT (network address translation), which is defined in RFC 1631 (see Figure 1). A firewall or router using NAT essentially takes all private addresses of outbound traffic (traffic from the internal network to the Internet) and converts the source

address to that of the router or firewall's external interface (or to a series of addresses if there are multiple external interfaces). For inbound traffic, the process works in reverse: The NAT box converts destination addresses to those used by the private network. But address conversion is just one of the advantages of NAT. Security is another: Attackers can't go after machines they can't see--and private addresses aren't visible on the public Internet. Still, coming to bat with NAT means making some trade-offs. Using a firewall or router as a NAT box is a hard-and-fast requirement, and that means added cost, extra administration, and--perhaps--a performance penalty.

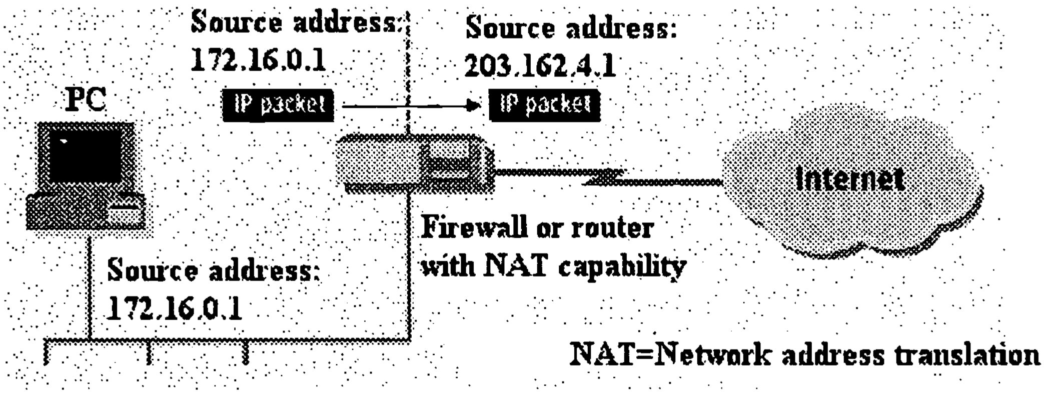


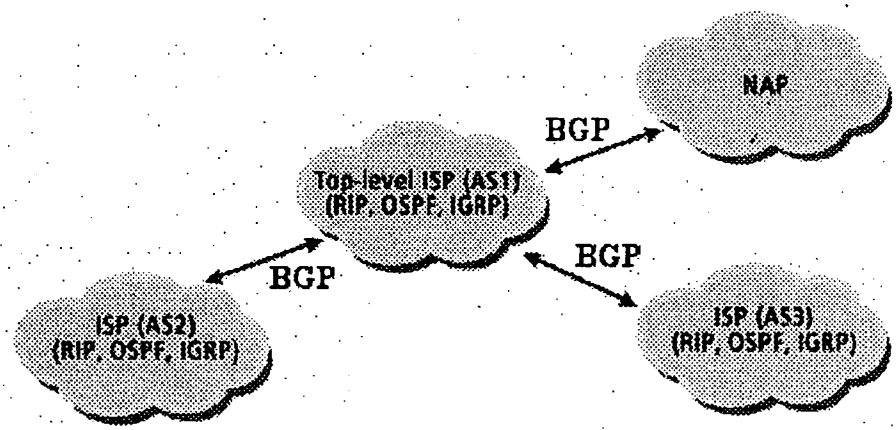
Figure 1

4.The third way: classless inter-domain routing

There's no question that private addressing is a good fix for the address shortage. The problem is that it's an option only for managers of private networks. ISPs face the problem of the addressing issue: keeping track of the huge amount of addresses being snapped up and put into use. National and international ISPs hook up with one another at network access points (NAPs). The routers at these Internet hubs have to know about every network on the Internet--unlike their counterparts lower down in the routing hierarchy, which have to know about just a few networks and can point to default gateways for the thousands they know nothing of. The NAP routers have no such luxury: They are the default gateways. Further, each new IP network added to the Internet requires a new NAP routing table entry. As more and more entries are made, the routing tables may become too large; parts of the 'Net then begin to fall off, rendering those networks unreachable.

That's prompted ISPs to turn to CIDR. Although it's not really a solution to the IP address shortage itself, CIDR reduces the number of routing table entries by consolidating addresses into contiguous blocks. If a range of addresses belongs to one ISP, the routers have to know only the range of addresses served by that ISP, not the individual network addresses. And when NAP routers have fewer table entries, they're likely to perform better and be able to see all the networks attached to the Internet. CIDR, described in

RFCs 1517 through 1520, is "classless" addressing. It replaces Class A, B, and C addresses with a network number "prefix" and a "mask" .Together, the prefix and mask identify a block of IP network numbers. All the addresses within a CIDR block are served by a specific ISP as part of a so-called autonomous system (AS), which usually means the group of routers belonging to that ISP. The ASs use the border gateway protocol (BGP) to exchange routing information with one another (see Figure 2). Within each AS, routers update one another using the same routing protocols they've always used, whether RIP (routing information protocol), IGRP (interior gateway routing protocol), or OSPF (open shortest path first).



BGP=Border gateway protocol
CIDR=Classless inter-domain routing
IGRP=Interior gateway routing protocol
ISP=Internet service provider
NAP=Network access point
OSPF=Open shortest path first
RIP=Routing information protocol

Figure 2

So, how does that all result in the reduction of routing table size? Consider an ISP that services 254 Class C network addresses, starting with 204.36.0.0. The addresses start with network 204.36.1.0 and run to 204.36.255.0. The CIDR notation for all of the networks in this block is 204.36.0.0 /16, where "/16" is the CIDR mask. The first 16 bits of the 32-bit IP address--204.36--identify the starting network number of the CIDR block. The remaining bits identify what were formerly considered separate Class C networks.

Eliminating class distinctions gives ISPs more flexibility in handing out addresses. For example, an ISP could elect to subdivide the /16 CIDR block into two /17 CIDR blocks, each with 128 contiguous networks, or into four /18 CIDR blocks, each with 64 contiguous networks. Note that adding a bit to the CIDR mask reduces by a power of two the number of contiguous networks in the block--254 networks with a /16 mask, 128 networks with a /17 mask, and so on.

Regardless, the ISP has just one routing table entry as far as the top-level NAP

routers are concerned. There's no longer any need to know exactly where all of the networks in the 204.36.0.0 address block are located. So when a NAP router sees an IP datagram bound for any address that starts with 204.36.x.x, it locates the single routing table entry for that CIDR block. Then it tosses the packet on the doorstep of the ISP whose AS owns the addresses--leaving delivery up to the provider.Sprint Corp. (Kansas City, Mo.) and some other large ISPs have called for a minimum CIDR block size. Their goal is to restrict the number of routing table entries by forcing customers (usually other ISPs) to aggregate a minimum number of addresses into CIDR blocks. So far (to allow for an orderly transition), some top-level ISPs are doing this on newly assigned IP address space only, starting with /18 CIDR blocks in the 206.0.0.0 address block. Sprint is grandfathering in older addresses, but it and other members of the North American Network Operators Group (NANOG) are pressuring ISPs to use CIDR for previously assigned addresses, too.With the /18 prefix set out as a stipulation, an ISP can announce to Sprint a block of 64 network addresses, but not a smaller block of 32 (/19)--which would be filtered out by Sprint's routers. In other words, Sprint won't know where networks in those smaller CIDR blocks are (because its routers won't list them), which means systems behind Sprint's network won't be able to reach them.

CIDR may not solve IP address exhaustion, but when it comes to allocating the right number of addresses the scheme is a big help.Say a network manager needs network addresses for 10,000 hosts. That normally means applying for a Class B address--a request likely to be denied given how scarce Class Bs are. Even if a Class B were granted, more than 55,000 addresses would go unused (remember, Class Bs support more than 65,000 hosts). But with CIDR, a net manager can apply to an ISP for a block of 64 Class Cs. The CIDR scheme offers plenty of room for growth--a block of 64 Class C addresses supports more than 16,000 hosts--without unduly draining the pool of available addresses. That doesn't mean there are no CIDR downsides. ISPs, for instance, will look to serve only those addresses within their CIDR blocks. A network whose addresses are outside that block might be dropped from some routing tables, cutting it off from other parts of the Internet. Network managers could renumber networks with another address that is part of a CIDR block, but doing so tends to be costly and time-consuming. Still, as long as the public network address used by their routers or firewalls is part of a CIDR block, net managers are unlikely to feel the effects of the CIDR scheme. (There is a method for determining how a network address is announced by core routers. Instructions are available at http://www.ra.net/RADB.tools.docs/.query.html.)

5.The final way: IPv6

But even if CIDR addressing is fully implemented by every ISP in the world, the addresses will simply one day run out. It's inevitable. It's a problem that the developers of IP only dimly foresaw 20 years ago, but now the IETF is moving to counteract the shortage. It has sanctioned an upgrade known as IP version 6 (IPv6), which dramatically expands the number of available addresses by boosting them from 32 to 128 bits.What's more, IPv6 will, through the use of a hierarchical routing scheme, ease the workload of

routers. CIDR blocks can be aggregated on the basis of geographical location or ISP assignment--which enables routers to determine where a network is located by its address. That's a big change from IPv4, under which ISPs and the InterNIC assign addresses at random. Behind this scheme lie new exterior routing protocols--such as the OSI interdomain routing protocol (IDRP)--that promise to improve router performance by carrying CIDR masks as well as IP addresses. The main idea with hierarchical routing is that a site's networks are part of a small CIDR block, which is part of a larger CIDR block from an ISP, which in turn is part of a regional or continental CIDR block. Routers in other regions carry the largest CIDR blocks in their routing tables and use them to forward traffic for any network in the block to NAPs in appropriate locations. However, even with bigger CIDR blocks, there will still be more and more networks--which means bigger, more powerful, and faster routers will be needed.

6.Conclusion

On paper, IPv6 is a great idea. It will relieve the IP address crunch, and it promises to streamline configuration and management of workstations and routers alike. Still, IPv6 poses some daunting questions for net managers. For instance, what's the best way to make the transition while maintaining backward compatibility with all those systems still running IPv4? What about renumbering networks--not to mention buying, installing, and configuring all of that new IP software?

IPv6 advocates say there's no reason to worry. The transition plan calls for 32-bit IPv4 addresses to be embedded in the least-significant-bit positions of the IPv6 address field. This would permit communication between IPv4 and IPv6 systems and would allow a system to run dual protocol stacks until the day IPv4 is officially replaced.

The downside is that this plays into the hands of networkers who don't want to convert to IPv6 at all; instead, they have a workable option for continuing to run IPv4. For network managers who do want to make the move, about the only thing they can do right now is make sure their networks are part of CIDR address blocks. Ideally, all addresses should be part of one contiguous block--but that may not be possible for enterprise nets.

In short, the switch to IPv6 won't come about until the value of a new technology becomes clear and system hardware and software can support it. Today, only a handful of vendors offer production-grade IPv6 products. Net managers will thus continue to wring as much out of IPv4 as they can--until their own systems or the sheer numbers of Internet users forces the conversion to IPv6.

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INTRODUCTION TO VERY LARGE DATABASES

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Abstract

When administering a data warehouse or Very Large Database (VLDB) environment, a number of items must be considered and re-examined in light of the special issues facing a VLDB. The main challenge of a VLDB is that everything is larger and maintenance task take considerably longer. VLDBs provide unique challenges that sometimes require unique solutions to administer them effectively.

Contents

1. What is a VLDB?

Some people, it depends on how you define "very large":

- A fixed size (for example 2G, 20G, 200G, 400G ...) ?
- When database-restore time exceeds a certain threshold.

In general, there's no easy way to quantify the point when a database becomes a VLDB. Here's the preferred definition :

A very large database is any database in which standard administrative procedures or design criteria fail to meet business needs, due to the scale of the data.

In other words, whenever the size of the database causes you to redesign your maintenance procedures or redesign your database to meet maintenance requirements, you're dealing with a VLDB.

2. VLDB Maintenance Issues

VLDBs including these important ones :

1. Time required to perform dumps and loads.
2. Time required to perform necessary database-consistency checks.
3. Time and effort required to maintain data.
4. Managing partitioned databases.

3. Explores These Issues And Provide Guidelines For Implementing Solutions

3.1. Managing Database Dumps and Loads

- Database dumps are necessary to provide recoverability in case of disaster. The main issue with database dumps and VLDBs is the duration of the database dumps; dumps time is proportional to the amount of data in the database.

- If the time to back up a database is excessive, the time to restore it is even more. The ratio between dump and load duration is approximately 1:3.

- VLDB backup/restore procedure :

1. Consider the amount of time you're willing to be "down" while performing a recovery. If you need a database to be recovered within 8 hours, for example, determine the size of a database that can be recovered in that amount of time.
2. Estimate table sizes for your database, to determine partitioning sizes and options:
   - If you have a 40G logical database, for example, you may need to implement ten 4G databases.
   - Are any single tables greater than 4G ?
3. How many tables can you fit in a database ?
   - Are any tables candidates for partitioning, based on this determination alone ?
4. Develop your administration schedule:
   - For every day during a month, determine what periods of time can be dedicated to administrative activities.
   - Are weekends available ?
   - If you determine that you have five hours per night to perform administrative activities, you then need to determine what activities need to be completed and how they can be distributed over your available administrative time.
5. Determine the rate of the dump process
6. Finalize your schedule and document accordingly.
7. Monitor and update the process as needed over time as thing change.

3.2. Checking Database Consistency

Almost Database Server (SQL, ORACLE, DB2,...) provide a systems administration tool that verifies pointers internal to a database and its structures. Remember, this tool should be run prior to any database dump to avoid dumping a corrupt database. The worst time to realize you have a bad page pointer is during recovery of critical database when the load process fails due to inconsistency.

This tool typically lock user tables, indexes, system tables and databases when running. This tool is very I/O intensive. The more I/O required, the longer it takes. These are the main issues with running this tool in VLDBs.

To develop a plan for effectively checking your database consistency in a VLDB, you first need to analyze your tables and rank them in order of importance. For example, where would a corruption have the most serious effects on your system ?

Next, analyze each non-clustered index on your table and rank it in order of importance to determine which indexes are most important to check.

Plan to check your high-activity tables as close to your dump as possible, because thes tables are more likely to encounter allocation problems. Verify the consistency of these tables as close to the dump as possible. Static tables should need to be checked only after data loads.

3.3. Data Maintenance

To performing database dumps and checking database consistency on a VLDB, Usually there are other data-maintenance tools that need to be performed on a database. These include purging and archiving data.

The data in VLDB may grow to a size approaching or exceeding the maximum available database space. At this point, the decision needs to be made either to expand the database or to purge or archive data to free space. Purging of data is often necessary. When purging or archiving data, a number of issues need to be addressed:

1. Locking

One way to avoid locking problems is to perform archival activities when users aren't using the system. Here are alternatives to avoid table-level locks:

- Use cursors to restrict rows being modified to one at a time.
- Use set row-count to affect a limited number of rows at a time.
- Use some other table specific value to limit the number of pages that are being modified to less than the lock-escalation threshold.

2. Logging

Rows being deleted from a table are logged in the transaction log. You determine whether your transaction log is large enough to handle the deletion of a large number of rows in a single transaction. To minimize I/O contention, your log should be placed on a separate disk to distribute the I/O.

Although your transaction log may be large enough to handle a single deletion of 500000 rows from a table, those records remain in the log until they' re dumped. Your purge/archive process should be designed to dump the transaction log after the completion of the purge process, to clear the log for the next purge or normal system activity.

If your log isn't large enough to handle the deletion as a single transaction, break the deletion into multiple transaction, dumping the logs between each transaction.

3. Referential Integrity (RI)

The following are items to consider when dealing with RI:

- If referential integrity is maintained via triggers, cascading delete triggers may exist on a table where data is to be removed. The deletion of rows from one table may cause the deletion of even more rows from a related table. Even

though your log may be able to handle the delete from the first table, the cascading defects could fill your log, causing the purge to fail. It could also lead to exclusive table locks throughout you system.

- If the purge/archive process is a batch job run during administrative periods, you can drop the triggers or RI constraints before running the purge/archive. If the purge/archive is to be conducted during business hours, you probably should leave the triggers on the table.
- If there are cascading delete triggers, you may need to perform deletes in small quantities with regard to the number of rows deleted in each table in the relationship, to avoid table-level locks.

4. Transactional integrity

A transaction is a logical unit of work. All activities in the transaction must complete successfully or they all should fail. During an archive process, you'll likely insert data into a table in different database and remove the data from its current location. If an error occurs that prevents the process from inserting the data into the new database, your archive process mustn't delete the data from its current database. Therefore, the insert/delete activity should be conducted in a transaction.

When archiving data with relationships across multiple tables, the design may require you to write transactions that transfer the data from all the related tables before deleting any of the rows. Make sure that your design considers multi-table relationships.

3.4. Data-Partitioning

- When dealing with VLDBs, it may become necessary to partition the database, due to Database Server size limitation or in order to meet your backup and recovery or data-maintenance requirements. There are two primary ways of partitioning databases: vertical partitioning and horizontal partitioning.

- Vertical partitioning of data is the process of drawing imaginary lines through a database schema and placing individual tables in different databases. It may also involve partitioning individual tables by columns, to separate the frequently accessed columns from infrequently accessed columns, and then placing the resulting tables in the same or different databases.

- Horizontal partitioning of data involves breaking up tables into logical subsets and placing them into the same or different databases.

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SESSION 6

Friday, 16 January 1998

Session 6: Learning machine, Vietnamese based human - computer interface

Chair:
Dr. Phan Viet Hoang, Informatics College, Singapore

6-1.**Knowledge based approach for English Vietnamese Machine Translation**
Hoang Kiem, Dinh Dien, University of Natural Sciences,HCMC, Vietnam

6-2.**A learning algorithm based on genetic algorithms approach**
Nguyen Dinh Thuc,Le Hoai Bac, University of Natural Sciences, HCMC, Vietnam

6-3.**Artificial neural network for color classification**
Tran Cong Toai, University of Technology, HCMC, Vietnam

6-4.**Synthesizing and recognizing Vietnamese Speech**
Hoang Kiem, Nguyen Minh Triet, Luu Duc Hien,University of Natural Sciencs , HCMC, Vietnam

6-5.**On- line character recognition**
Nguyen Thanh Phuong, University of Natural Sciences, HCMC, Vietnam

6-6. **Data mining and knowledge acquisition from a database**

Hoang Kiem, Do Phuc
University of Natural Sciences, HCMC, Vietnam

6-7. **Genetic Algorithm for initiative of neural networks**

Nguyen Dinh Thuc, Tan Quang Sang, Le Ha Thanh, Nguyen Thanh Son
University of Natural Sciences, HCMC, Vietnam

KNOWLEDGE - BASED APPROACH FOR ENGLISH - VIETNAMESE MACHINE TRANSLATION

Hoang Kiem, Dinh Dien
University of Natural Sciences,HCMC, Vietnam.

Abstract

The most difficult point in the machine translation is the elimination of the ambiguity of the natural language. This paper will present an knowledge-based approach to solve the above-mentioned ambiguity and the application of the knowledge base in the English-Vietnamese machine translation. This knowledge base consists of such concepts as things, actions, relations, attributes and so on is organised on the structure of inheritance hierarchy. We have experimented this approach in the English-Vietnamese machine-translation system with the effective solutions to the lexical and structural ambiguities.

1. Introduction

In our current age of the information boom, the techno-scientific information mainly written in English has become more and more diversified and the question of how to be able to keep in touch with that source of information is indispensable to all of us. Therefore, the design of an English-Vietnamese automatic translation plays a practically meaningful role in the present background of Vietnam. This paper will present an effective solution which has been applied in the English-Vietnamese automatic translation to the elimination of the ambiguities in the English source texts in order to create the Vietnamese destination documents of desired quality. Due to the time limit , its first stages have been restricted to the techno-scientific documents only which , however , will be expanded into other fields in the near future without any modification to the original approach .

2. Summary of the English-Vietnamese machine translation system

This is a microcomputer-based program which deals with the automatic translation of the natural language from English into Vietnamese. First of all, the program will be input with grammatically correct sentences or paragraphs which then will be automatically translated into the Vietnamese ones accordingly after a careful analysis in terms of vocabulary, syntax, semantics and so on. Thanks to the derivative rules, the built-in dictionary and the shallow semantic analysis based on the knowledge-base, the program will generate the Vietnamese sentences or paragraphs of equivalent meanings.

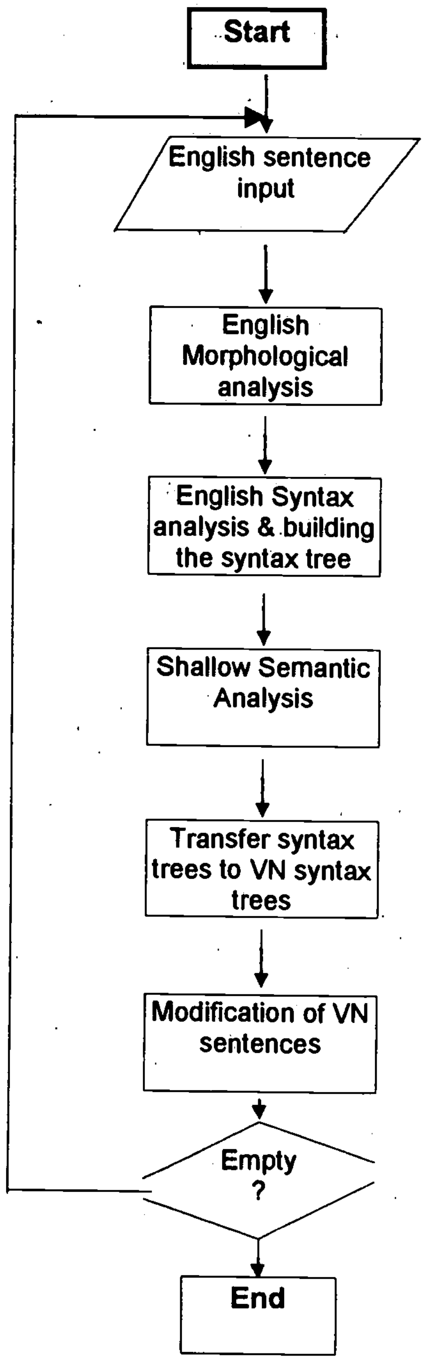

Fig.1 : Flowchart of the program

These English sentences which are referred to as the source ones might be simple or complex ones in all forms, tenses and voices etc. Because a certain word in English as well as Vietnamese may have different parts of speech, meanings depending on its syntactical position in the sentence and the actual context. Therefore, translating the natural language cannot be simply the consultation of dictionaries nor the word by word translation. This notion is more exact with the translation of two languages of such different categories as English and Vietnamese. The main issue is to make the machine understand the source sentence and then, the destination sentence will be created with the desired meaning. Because of this reason, we have to analyse the syntax, semantics of the source sentence and combine the exterior language knowledge input by us. Thereafter, the program will be able to look for the destination sentences which share the most suitable syntax and semantics.

The system has been equiped with the following blocks (Fig.1)

1. Morphological Analysis : to analyse the English morphology of all words of input English sentences.
2. English syntax trees : to analyse the English syntax of an input English sentence for the formation of all possible syntax trees.
3. Shallow Semantic Analysis : to select the optimal syntax tree from several above possible syntax trees based on the context and the meaning of each word .
4. Vietnamese syntax trees : to transfer from English optimal syntax trees to Vietnamese ones with reasonable word orders.
5. Generation and Modification of Vietnamese sentences : to generate and to modify the Vietnamese sentences which arise from the most reasonable syntax tree, mainly based on the contextual properties of the concerned words.

3. The knowledge-based dictionary system

The electronic English-Vietnamese dictionary of this system consists of approximately 10000 most frequently used root words, 2,000 phrases and idioms (based on the frequency dictionary) together with 1,000 terms used in the computer science. All of them are classified in accordance with grammatical characteristics (such as : parts of speech, sentence patterns, their positions and functions in the sentences), their approriate conceptual attributes (such as : *human beings* or *things, space* or *time, quick / slow, good / bad, negative / positive*, and their related fields, etc.).

3.1. The conceptual tree

Concepts are considered as an aggregate of instances which can be divided into various hierachical classes. The instances of each class always share the similar features which are fully inherited from the higher classes .In addition, all the instances of the same class are in logical relation with each other. These relations might be similarity, contrast or interdependence, agent and so forth .The parents classes contain all the common features

for the lower ones belonging to them. For example, in the classes of the living things, there are zoology and botany, in the zoology, there exist human beings and animals which will be sub-divided into mammals, reptiles, birds etc.

These conceptual attributes have been well-organised in the structure of inheritance trees, thanks to which most of the ambiguities will be solved in a relatively complete manner. These concepts are structurised in the Entity - Relation model, which is to say: the concept of *zoology* includes such sub - strata as : *human beings* and animals ,the stratum of *human beings* is then divided into *masculine* and *feminin* or into the *time - related* attributes of *the old* and *the young* and so forth ; the next stratum inherits the whole attributes from the parents one. This detailed classification serves to clarify the ambiguities, such is shown in the phrase : *old man and children* which can be analysed to be of these four syntax trees:

a. (Old man) and children

b. Old man and old children

* c. (Old human beings) and children

d. Old human beings and old children

In this case, thanks to the *young* attribute in *children* which is opposite to the *old* attribute in the *old - young* relation which finds itself in the *time* stratum, we omit sentences b and d. Next, thanks to the *masculine* attribute in *man* which isn' t parallel to the *neutral* attribute in *children* in the *gender* relation, we omit sentences a. Whereas, in the sentence *old man and woman* we will choose b due to the balance priority in a phrase with the conjunction *and* :

a. (Old man) and woman

* b. Old man and old woman

c. (Old human beings) and woman

d. Old human beings and old woman

These concepts may be the conditional attribute for a certain meaning or may be the consequentional one for which determines the choice of a certain word. All the poly - semous words are contextually analysed in a systematical manner for their their respective meanings.

* *For example, the word he may be:*

- *that old person* in case it falls on the attribute of *old* and *respect.*

- *that old guy* in case it falls on the attribute of *old* and *non-respect.*

- *that young person* in case it falls on the attribute of *young* and *respect.*

- *that young guy* in case it falls on the attribute of *young* and *non-respect.*

* *For example, the word save may be :*

- *Save* as a verb means *help* in case its object is a noun related to *human beings* (such as : *life, soul,* etc.).
- *Save* as a verb means *economize* in case its object is a noun related to *money* or *time*.
- *Save* as a verb means *cut down* in case its object is a noun related to an abstract concept such as : *difficulties, tiredness*, etc.
- *Save* a a verb means *preserve, store* in case its object is a noun related to the *data* in computers.

3.2. Codification and dictionary consultation

The tree structure is used for the insertion of all the roots, for example : The words : *a, abort, an, and, ant, as, ass* are stored as follows :

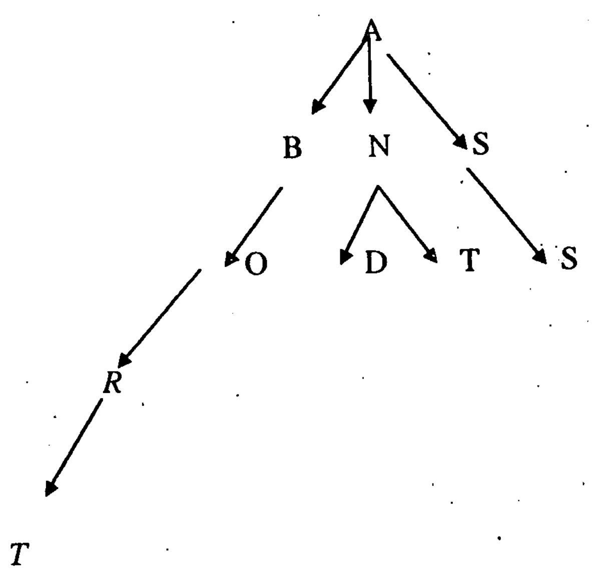

Fig.2 : representation of : *a(bort,n(d,t),ss)*

Each node will be one of following 5 cases

1. The word has not yet been completed and still continued
2. The word has been completed and still continued
3. The word has not yet been completed and branched
4. The word has been completed and branched
5. The branch has been ended

In case the node has a matching end (matching the consulted word) the pointer will be pointed to the equivalent information area of that word in the file containing its full details In case it has been consulted to the node end or no more route to be further consulted the translator considers that word as non-existent.

3.3. Analysis of the morphology

Morphological Analysis : to analyse the English syntax of an input English sentence for the formation of possible syntax trees. In this step, we make use of the anlysis table of Earley. That is, every word / phrase will be at the same time grammatically analysed for all the possible cases which gradually diminish and in the end exist only the acceptable candidates. Thereafter we apply the rules of contextual analysis for the most suitable

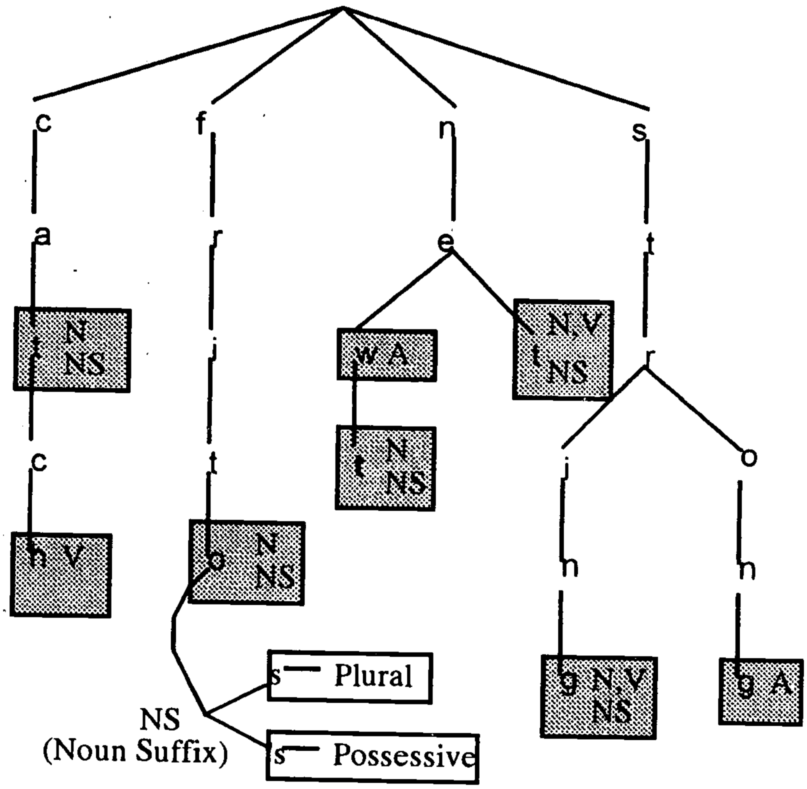

Fig.3. Morphological analysis of "*fritos*"

To minimize the dictionary size, we enter only the roots and their derivatives are treated as deleting such subbordinate ones (affix) as: prefixes, suffixes, terminason conjugations (-ed, -ing, - ly, etc.) until the roots are left (in formity with the transformation rule) to be consulted with, after which the meanings of the roots and the transformed ones will be combined together. Such exceptional cases (as irregular verbs, abnormal noun plurals, etc.) are stored in the dictionary as the roots.

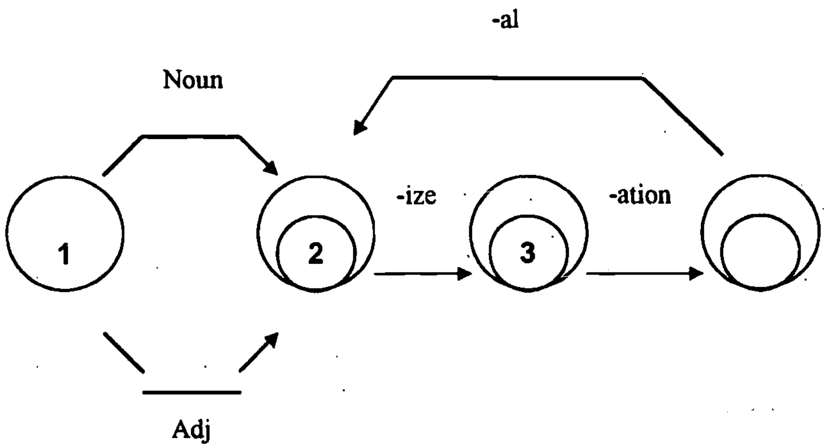

Fig.4 : transition diagram of *computerizational*

3.4. Grammatical Analysis of English sentences

In this step, we make use of the anlysis table of Earley, that is, every word / phrase will be at the same time grammatically analysed for all the possible cases which gradually diminish and in the end exist only the acceptable candidates. Thereafter we apply the rules of contextual analysis for the most suitable. In case more than one syntax tree can be chosen, we have to refer to the complementary clues in the neighboring sentences for the best. In the worst case that no choice is possible, the frequency thumb will be resorted to for the most frequent. In case that no syntax tree is obtained after the grammatical analysis, we have no choice but apply the word-by- word translation of which the result is naturally not so much perfect.

3.5. Generating Vietnamese sentences

The source syntax tree of English then will be translated into the destination one of Vietnamese (in applying the rules of order, grammar, etc.) to be matched with the meaning of each node for a complete Vietnamese sentence. In the course of translating the syntax tree, special words will possess their own special attributes to inform the program to adjust destination syntax trees. For example, the order n the English sentences is usually known as the demonstrative adjectives stand in front of nouns, such as : new book, however, general election or nothing new.

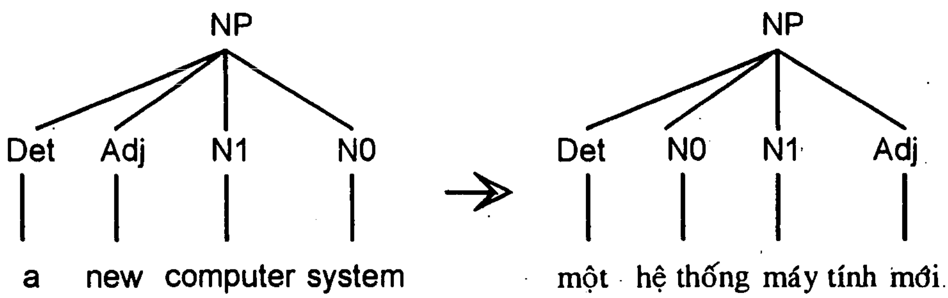

Fig.5. Modification of Vietnamese syntactic tree.

4. Results

So far, this system is fully able to solve most of the ambiguities in the aspects of semantics and lexicology as follows.

1. Parts of speech

There are words such as "love" which might be a verb and a noun will certainly be easily distinguished by our Machine Translation System.

For example : *He loves her with an absolutely faithful love.*

That excellent student can program a lot of very complicated programs.

The contents of this abstract is very abstract .

2. Semantics

There are the words which have the same parts of speech but completely different meanings such as "to be", "old", "ask", "field" and so on.

Ex : *He is scolded by his wife but he is praised by his lover.*

I will lend that old man this old book.

Our company asks that customer to arrive at our office to ask several matters.

I eat rice, plant rice and export rice.

The word order in Vietnamese can be modified to reach the suitability of 90 per cent. Our program is capable of synthesizing the new words based on the

meanings of the root morphemes. From *normal*, we can derive new words such as *normalize*, *normally*, *normalization*, *non-normal* etc.

For example : *Normally, I always normalize non-normal problems.*

In addition to the translation of the technical and scientific documents in the fields of Informatics, Electronics, Mathematics, Linguistics, this system is capable of translating other conventional documents. Please refer to the enclosed annexes.

In next stage, this system will connect to the character recognization system in order to translate texts automatically.

At present, this system is able to translate English sentences into Vietnamese ones (in the Computer Science field as well as other conventional sentences) based on the 25 verb patterns of A.S. Hornby at the rate of 0.6 s for every sentence and roughly 15s for every text page with the exactness of 60% - 70%.

- It can handle all types of sentences (e.g. : complex as well as simple ones in any tense, voice, form, etc.) and various kinds of ambiguity (e.g. : the appropriate syntax-based part of speech , the context-based meaning , etc.)

- The system can be used as a spelling checker. Its consultation speed has reached 100 words/ 3 seconds on AT-386DX 40MHz, in the DOS medium.

Acknowledgement

During the course of the realisation of this work , we have received numerous valuable supports and encouragements from various persons and organizations . Especially , We would like to express our heart-felt gratitude as well as our sincere thanks to :

- Mr.Eduart Hovy who has granted us with his useful recommendations and instructive documents.
- and other professors who have been granting us with their disinterested assistances and advice.

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A LEARNING ALGORITHM FOR FEATURE SELECTION BASED ON GENETIC APPROACH

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Abstract

In this paper, we present a genetic algorithm for feature selection. The algorithm chooses relevant features from a set of given features. The selection based on the correlation among the features and correlation between every feature and given target curve. The proposed algorithm is used for a real application, the classification rate could be increased by about ten percent.

1. Introduction

The choice of features as input variables for data analysis systems is a very important tast and difficult. If meaningful and relevant features are used, the error of the system decreases while the recognition rate and the classification abilities increase. Various methods can give a clue on the relevant features for a data analysis system. They are mostly based on *linear relations* like the correlation, *the principal component analysis, the Fisher disciminant analysis* (see [Pernot and Vallet, 1991] and [Battiti,1994]). Somes other methods based on *neural network* also useful (see [Krisnapuran and Lee, 1992]. The general problem of *"feature selection"* can be stated as follows:

"Given an initial set F of N features, find the subset S (F of k < N features that maximizes correlation of each chosen feature with the target curve and minimizes correlation among the chosen features themselves"

In this paper, we present a procedure based on genetic algorithms to solve this problem. The algorithm chooses relevant features *S* from a set of given features *F*. The basis for these calculations is the correlation among the features and the correlation between every feature and a given target curve.

2. Genetic algorithm and selecting feature

2.1 Genetic algorithm

Genetic algorithms are powerful direct search optimization tools designed in imitation of some principles of genetics and natural evolution, name reproduction, crossover, mutation and selection (see [Goldberg, 1989] and [Holland,1992]). The idea of genetic algorithms is to use a population of possible solutions, which are changed by reproduction and mutation and selected for the next generation according to their fitness. So various paths to the optimum are investigated at the same time and information about

these paths can be exchanged. This is called the implicit parallelism of genetic algorithms (see [Goldberg, 1989]).

The four major steps in preparing to use the genetic algorithm on fixed-lenght strings to solve a given problem:

(1) determining the presentation schema,

(2) determining the fitness measure,

(3) determining the parameters and variables for controlling the algorithm. The primary paramaters for controlling the genetic algorithm are the population size and the maximun number of generations to be run,

(4) determining the way of desgnating the result and the criterion for terminating a run.

Once these steps for setting up the genetic algorithm have been completed, the genetic algorithm can be run.

The three steps in executing the genetic algorithm operating can be summarized as follows:

(1) Randomly create an initial population of individual fixed-lenght strings.

(2) Iteratively perform the following substeps on the population of strings until the termination criterion has been satisfied:

(a) Evaluate the fitness of each individual in population.

(b) Create a new population of strings by applying at least the first two of the following three operations. The operations are applied to individual string(s) in the population chosen with a probability based on fitness.

- Copy existing individual strings to the new population.
- Create two new strings by genetically recombining randomly chosen substrings from two existing strings.
- Create a new string from an existing string by randomly mutating at one position in string.

(3) The best individual string that appeared in any generation is designated as the result of the genetic algorithm for the run. This result represent a solution (or approximate solution) to the problem.

2.2 Genetic algorithm for optimal feature selection

To use genetic algorithm for optimal feature selection, the individuals in the algorithm are bitstrings of lengt N, where each bit represents a feature. A value *"zero"* means that the feature is not used and a *"one"* says that the correspongding feature is used. The number k of chosen features may be fixed in the first step, as we did in the

contribution. But it may also be variable and hence be optimized by the genetic algorithm in order to find the best number of features.

Various authors have proposed fitness functions (see [Klir and Yuan, 1995] and [Pal and Bezdek, 1994]). In this paper, we consider fitness function studied by Lars A. Ludwid and Adolf Grauel (see [Ludwig and Grauel, 1996]).

Suppose, we have given the feature vector:

$$f = (f_1, f_2, \ldots, f_N)$$

and, a target curve g have also given.

The idea is to maximize the correlation between the chosen features and target curve and at the same time to minimize the correlation among the chosen features. Therefore, on the one hand the correlation among the features f_i and f_j

$$R = (R_{ij})$$

which is a $N \times N$ matrix, shall be calculated. On the other hand the correlation between the feature fi and the target curve g

$$r = (r_i)$$

which is a vector with N components, shall be computed.

Now, fitness function is defined as follows:

$$F(X) = (\sum_{i=(1,N)} (x_i\, r_i^2\,)) / k - 2((\sum_{i=(1,N)} (x_i \sum_{(j<i)} x_j\, R_{ij}^2)) / k(k-1)$$

where $X = (x_1, x_2, \ldots, x_N)$; $x_i \in \{0,1\}$ is an invidual of population in genetic algorithm.

3. Application: Analizing medical data

We successfully implement artifical neural network for bone data classification. In this case, a three-layer neural network [Hoang Kiem and Nguyen Dinh Thuc, 1995] is used, which is trained by backpropagation with 30 training patterns. This data set have derived from [Peingold, Nelson and Partiff, 1992]. The data are to be classified in one of 12 classes, so the network always has 12 output neurons. The number of input neurons depends on the type of pre-proccessing.

In our application, we calculated 13 different features and wand to choose the five best features from all. The proposed feature selection algorithm is used. With this optimal features the classification rate of neural network increased from 87.5% to 96%. The results are showed in tables 7.1 and 7.2.

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Table 7.1

stt	lsbmd			NeuralNet's output			fmbmd			NeuralNet's output		
1	0	1	0	0.12	0.88	0.1	0	1	0	0.119	0.881	0.1
2	0	1	0	0.089	0.911	0.1	0	1	0	0.12	0.88	0.1
3	0	1	0	0.103	0.896	0.1	0	1	0	0.12	0.881	0.1
4	0	1	0	0.114	0.886	0.1	0	1	0	0.106	0.895	0.1
5	0	1	0	0.1	0.9	0.1	0	1	0	0.129	0.871	0.1
6	1	0	0	0.909	0.091	0.1	1	0	0	0.909	0.091	0.1
7	0	1	0	0.096	0.905	0.1	0	1	0	0.089	0.911	0.1
8	0	1	0	0.13	0.869	0.101	0	1	0	0.132	0.869	0.101
9	0	1	0	0.104	0.895	0.1	0	1	0	0.099	0.902	0.1
10	1	0	0	0.862	0.138	0.1	1	0	0	0.876	0.124	0.1
11	0	1	0	0.093	0.907	0.1	0	1	0	0.124	0.876	0.1
12	0	1	0	0.103	0.897	0.1	0	1	0	0.13	0.87	0.1
13	0	1	0	0.11	0.89	0.1	0	1	0	0.117	0.883	0.1
14	1	0	0	0.913	0.086	0.1	1	0	0	0.895	0.105	0.1
15	0	1	0	0.098	0.902	0.1	0	1	0	0.12	0.881	0.1
16	0	1	0	0.073	0.927	0.1	0	1	0	0.066	0.934	0.1
17	1	0	0	0.944	0.056	0.1	1	0	0	0.944	0.056	0.1
18	0	1	0	0.097	0.902	0.1	0	1	0	0.112	0.889	0.1
19	0	1	0	0.095	0.905	0.1	0	1	0	0.135	0.865	0.1
20	0	1	0	0.097	0.903	0.1	0	1	0	0.112	0.888	0.1
21	0	1	0	0.069	0.931	0.099	0	1	0	0.074	0.925	0.099
22	0	1	0	0.108	0.892	0.1	0	1	0	0.135	0.865	0.1
23	0	1	0	0.097	0.903	0.1	0	1	0	0.12	0.88	0.1
24	0	1	0	0.097	0.904	0.1	0	1	0	0.139	0.861	0.1
25	0	1	0	0.099	0.901	0.1	0	1	0	0.108	0.893	0.1
26	0	1	0	0.079	0.921	0.1	0	1	0	0.073	0.927	0.1
27	1	0	0	0.862	0.138	0.1	1	0	0	0.866	0.134	0.1
28	0	1	0	0.1	0.9	0.1	0	1	0	0.129	0.871	0.1
29	0	1	0	0.103	0.898	0.1	0	1	0	0.109	0.891	0.1
30	0	1	0	0.093	0.906	0.1	0	1	0	0.104	0.896	0.1
31	0	1	0	0.104	0.896	0.1	0	1	0	0.15	0.85	0.1
32	0	1	0	0.096	0.904	0.1	0	1	0	0.099	0.901	0.1
33	0	1	0	0.11	0.89	0.1	0	1	0	0.114	0.886	0.1
34	0	1	0	0.102	0.898	0.1	1	0	0	0.141	0.859	0.1
35	0	1	0	0.099	0.901	0.1	0	1	0	0.127	0.874	0.1
36	0	1	0	0.103	0.897	0.1	0	1	0	0.108	0.892	0.1
37	0	1	0	0.095	0.905	0.1	0	1	0	0.106	0.894	0.1
38	0	1	0	0.1	0.9	0.1	0	1	0	0.113	0.887	0.1
39	0	1	0	0.101	0.9	0.1	0	1	0	0.14	0.86	0.1
40	0	1	0	0.096	0.904	0.1	0	1	0	0.128	0.872	0.1
41	0	1	0	0.083	0.917	0.1	0	1	0	0.077	0.923	0.1
42	0	1	0	0.114	0.885	0.1	0	1	0	0.093	0.908	0.1
43	0	1	0	0.102	0.898	0.1	0	1	0	0.117	0.883	0.1
44	0	1	0	0.1	0.9	0.1	0	1	0	0.129	0.871	0.1
45	0	1	0	0.103	0.897	0.1	0	1	0	0.145	0.855	0.1
46	0	1	0	0.099	0.901	0.1	0	1	0	0.141	0.859	0.1
47	0	1	0	0.123	0.877	0.1	0	1	0	0.175	0.824	0.1
48	0	1	0	0.1	0.9	0.1	0	1	0	0 129	0.871	0.1
49	0	1	0	0.107	0.893	0.1	0	1	0	0.146	0.854	0.1
50	0	1	0	0.108	0.892	0.1	0	1	0	0.135	0.865	0.1

Table 7.2

stt	trbmd			NeuralNet's output			wtbmd			NeuralNet's output		
1	0	1	0	0.302	0.692	0.1	0	1	0	0.1	0.908	0.092
2	0	1	0	0.34	0.66	0.1	0	1	0	0.1	0.886	0.114
3	1	0	0	0.861	0.14	0.1	0	1	0	0.1	0.906	0.094
4	0	1	0	0.014	0.986	0.1	0	0	1	0.1	0.123	0.877
5	1	0	0	0.947	0.053	0.1	0	1	0	0.1	0.904	0.096
6	1	0	0	0.998	0.002	0.1	0	1	0	0.1	0.908	0.092
7	1	0	0	0.898	0.098	0.1	0	0	1	0.1	0.094	0.907
8	1	0	0	0.894	0.109	0.101	0	1	0	0.101	0.898	0.102
9	1	0	0	0.652	0.354	0.1	0	1	0	0.1	0.892	0.108
10	1	0	0	0.966	0.032	0.1	0	1	0	0.1	0.906	0.094
11	1	0	0	0.914	0.087	0.1	0	1	0	0.1	0.898	0.102
12	1	0	0	0.914	0.086	0.1	0	1	0	0.1	0.909	0.092
13	1	0	0	0.958	0.041	0.1	0	0	1	0.1	0.096	0.904
14	1	0	0	0.896	0.11	0.1	0	1	0	0.1	0.892	0.108
15	1	0	0	0.946	0.055	0.1	0	1	0	0.1	0.902	0.098
16	0	1	0	0.024	0.976	0.1	0	1	0	0.1	0.91	0.09
17	1	0	0	0.815	0.18	0.1	0	1	0	0.1	0.895	0.105
18	1	0	0	0.919	0.083	0.1	0	1	0	0.1	0.901	0.099
19	1	0	0	0.749	0.249	0.1	0	1	0	0.1	0.891	0.109
20	1	0	0	0.928	0.074	0.1	0	1	0	0.1	0.899	0.101
21	1	0	0	0.949	0.051	0.099	0	1	0	0.1	0.898	0.103
22	1	0	0	0.863	0.136	0.1	0	1	0	0.1	0.909	0.091
23	1	0	0	0.945	0.056	0.1	0	1	0	0.1	0.903	0.097
24	1	0	0	0.784	0.213	0.1	0	1	0	0.1	0.892	0.109
25	1	0	0	0.884	0.119	0.1	0	1	0	0.1	0.896	0.104
26	0	1	0	0.083	0.919	0.1	0	0	1	0.1	0.102	0.898
27	1	0	0	0.966	0.034	0.1	0	1	0	0.1	0.902	0.098
28	1	0	0	0.922	0.079	0.1	0	1	0	0.1	0.906	0.094
29	1	0	0	0.841	0.156	0.1	0	0	1	0.1	0.106	0.894
30	1	0	0	0.938	0.065	0.1	0	1	0	0.1	0.894	0.106
31	1	0	0	0.922	0.076	0.1	0	1	0	0.1	0.901	0.1
32	1	0	0	0.775	0.225	0.1	0	1	0	0.1	0.896	0.104
33	1	0	0	0.962	0.037	0.1	0	0	1	0.1	0.091	0.909
34	1	0	0	0.928	0.071	0.1	0	1	0	0.1	0.905	0.096
35	1	0	0	0.944	0.056	0.1	0	1	0	0.1	0.904	0.096
36	1	0	0	0.861	0.137	0.1	0	0	1	0.1	0.102	0.898
37	1	0	0	0.928	0.075	0.1	0	1	0	0.1	0.896	0.104
38	1	0	0	0.85	0.15	0.1	0	1	0	0.1	0.9	0.1
39	1	0	0	0.927	0.073	0.1	0	1	0	0.1	0.902	0.098
40	1	0	0	0.878	0.122	0.1	0	1	0	0.1	0.895	0.105
41	0	1	0	0.179	0.824	0.1	0	0	1	0.1	0.098	0.902
42	0	1	0	0.236	0.767	0.1	0	1	0	0.1	0.88	0.12
43	1	0	0	0.893	0.108	0.1	0	1	0	0.1	0.902	0.098
44	1	0	0	0.942	0.058	0.1	0	1	0	0.1	0.907	0.093
45	1	0	0	0.939	0.06	0.1	0	1	0	0.1	0.901	0.099
46	1	0	0	0.875	0.124	0.1	0	1	0	0.1	0.897	0.103
47	1	0	0	0.866	0.131	0.1	0	1	0	0.1	0.892	0.108
48	1	0	0	0.929	0.071	0.1	0	1	0	0.1	0.905	0.095
49	1	0	0	0.927	0.071	0.1	0	1	0	0.1	0.905	0.095
50	1	0	0	0.791	0.205	0.1	0	1	0	0.1	0.91	0.09

ARTIFICIAL NEURAL NETWORK FOR COLOR CLASSIFICATION

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1. Introduction

Undoubtedly, the best color classifier is the human being. However applications which require on - line classification of color and selective color adjustments, such as would be the case for color television signals, a substitute to the human classifier would be needed fortunately, a group of classifiers modeled after the biological brain (artificial neural networks) have been developed and studied for years. The hope was to achieve human like performance . We have yet to achieve such a goal. The challenge is to understant how these various neurons interact to achieve the ability of ision, hearing, touch, movement, etc ... One such application, which will be introduced in the forthcoming sections, is color classification. In this option we shall examine several neural network model, their learning schemes, and their effectiveness in color classification.

2. The Perceptron

Figure 1 shows what is believed to be a mathematical model for a single neuron. The node sums N weighted inputs, applies some threshold value θ , and passes the result through a nonlinearity. The output can be either 1, representing the firing of a neuron, or 0 (-1 can also be used). The nonlinearity functions commonly used are the sigmoid function and the limiter (Threshold logic)

The structure in Fig.1 is known as the perception, and is basically a linear classifier that is able of separating two disjoint classes as shown in fig 2. The output of the perceptron can be written as.

$$y = f(\alpha) \qquad (1)$$

where

$$\alpha = \sum_{i=0}^{N-1} w_i x_i + \theta \qquad (2)$$

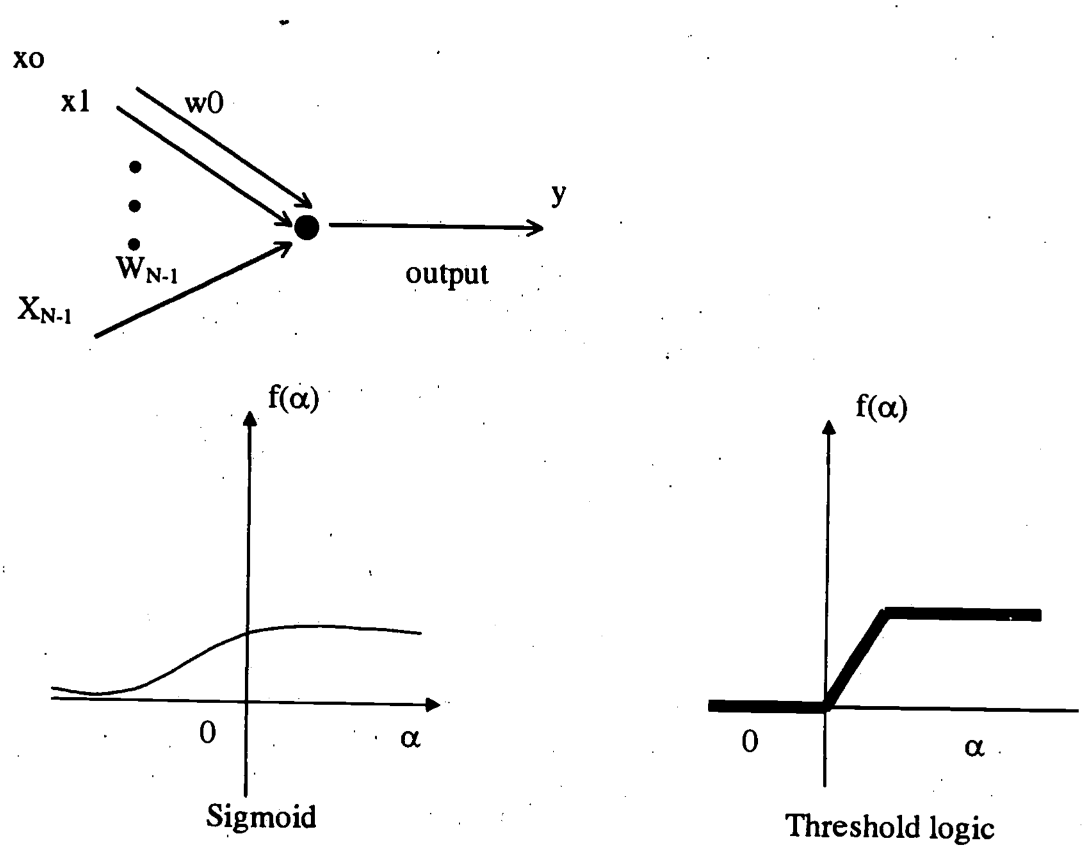

Figure 1: Computational element of a neural structure

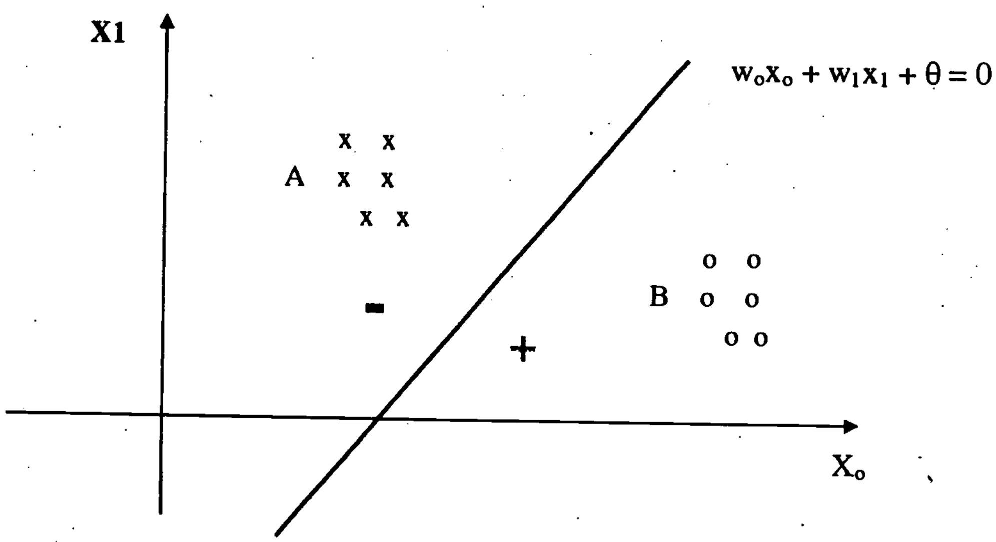

Figure 2: A simple decision Function of two classes

A scheme that determines the weights $\{wo, w1, ..., w_{N-1}\}$ such that $f(\alpha)$ separates the two classes A and B is, not surprisingly, called a learning scheme. θ is called the threshold, and is usually a fixed number between 0 and 1.

To derive a learning scheme we shall consider for now a perception with just two inputs:

$$\alpha = w_o x_0 + w_1 x_1 + \theta \quad (3)$$

x_o could represent the color feature x of the chromaticity diagram and x1 the color feature y. If we wish the perceptron to separate two color, A and B , then we should expect an output of, say 1 if (xo, x1) belonged to color A and o if the inputs belonged to color B. Alternatively, one can write.

$$\text{if } (x_0,x_1)_p \in A \qquad dp = 1$$

$$\text{if } (x_0,x_1)_p \in B \qquad dp = 0$$

Where the subscript p denotes a pattern reading for (x_0,x_1) and dp denotes the desired output for that pattern. If (w_0,w_1) are known then the actual output y can be calculated from Eq (1). The error for that pattern reading can be given by

$$Ep = 1/2\ (dy - yp)^2 \qquad (4)$$

The problem then becomes the minimization of Ep with respect to wo and w1for all pattern input (x_0,x_1)p such that Eq. Provides the correct separation between the two classes as seen in Fig.2. Ep is a nonlinear function of the variables wo and w1, and hence nonlinear schemes need to be used to minimize it.

If y is given by the sigmoid function

$$y = f(\alpha) = \frac{1}{1 + e^{-\alpha}}$$

Then by differentiating Ep with respect to wo we get

$$\frac{\delta\, Ep}{\delta\, Wo} = -\,(dp - yp)\, yp\, (1 - yp)\, x_{op}$$

and with respect to w_1 we get

$$\frac{\delta\, Ep}{\delta\, w_1} = -\,(dp - yp)\, yp\, (1 - yp)\, x_{1p}$$

The steepest descent algorithm can be used to obtaim the values of the weights as follous:

a. Set the weights (w_0,w_1) and θ to small random values. At iteration K:

b. Present an input value (x_0,x_1) and specify the desired output: 1 if it belongs to one class and 0 if it belongs to the other.

c. Calculate the actual output y

d. Calculate

$$\delta = (d - y)\, y\, (1 - y)$$

e. Calculate the gradients:

$$\nabla E = \left| \frac{\delta E}{\delta W_o} \quad \frac{\delta E}{\delta W_1} \right| = [\ -\delta x_o - \delta x_1]$$

f. Adjust the weights using the recursive equation

$$W^{(k+1)} = W^{(K)} - \eta \nabla E^{(K)}$$

where $W^{(K)} = [w_0,w_1]^{(K)}$ = weights at iteration K and η is a positive fraction less than 1.

g. Present new value of input or, if data has all been read, recycle same set of data. Go to step 2 and repeat until the weights stabilize, ...

$$\left| wi^{(k+1)} - W^{(k)} \right| \leq \varepsilon \qquad i = 0.1$$

Convergence is sometimes faster if a momentum term is added and weights are smoothed by

$$W^{(k+1)} = W^{(K)} - \eta \nabla E^{(K)} + \alpha (\nabla E^{(K)} - \nabla E^{(K-1)})$$

where $0 < \alpha < 1$

The above algorithm is known as the delta rule, and has been used extensively in the literature. Althought the algorithm can produce weights for the classifier, it requires a large number of iterations to converge. The choice of the two parameters α and η seems to be rather arbitrary. To allow you to examine the performance of the delta rule algorithm we present next a C program designed for a perception with two inputs.

- **Program TO.C**

```
# include <stdio.h>

# include <stdlib.h>

# include <math.h>

# include <conio.h>

# include <io.h>
```

```
# define eta 0.8
# define alpha 0.2
void main()
    {
    unsigned int d[200];
    unsigned int N, ind, iter, I;
    float W[z], x[2], x1[200], x2[200], net, E;
    float dEp[2], sum, y, theta, dEpold[z], delta ;
    File * fptr;
    Char filename[14];
        clrscr() ;
        N = 0
        iter = 0;
        gotoxy(1,1);
        printf (" Enter file name containing data") ;
        scanf ("%S", filename);
        fptr = fopen (filename, "r");
        if (fptr == NULL)
            {
             printf (" file%does not exist ", filename);
             exit(1);
            }
        while(fscanf(fptr, " %   d ", &X1[N], &X2[N], &d[N])! = EOF))
            N++ ;
        fclose (fptr);
            srand(1) ;
        W[0] = (float) rand () / 32768.00 ;
            srand(2) ;
        W[1] = (float) rand() /32768.00 ;
```

```
        theta = 0.1 ;
        i= 0;
        sum = 0.0 ;
        ind = 1 ;
        gotoxy(1,10);
        printf (" Press esc to exit before convergence") ;
while (ind)
        {
        X[0] = X1[i];
        X[1] = X2[i];
        gotoxy (1,3) ;
        printf (" Iteration # %5d", iter);
        Net = W[0] * X[0] + W [1] * X [1] + theta ;
        if (net >= 20)  E = 0.0  ;
        else E = EXP (- (double)net);
        y = 1.0/ (1.0 + E);
        delta = (d[i] - y ) * y* (1.0 - y) ;
        dEp[0] = X[0] * delta ;
        dEp[1] = X[1] * delta ;
        if (I = = 0)
                {
        w[0]+ = eta * dEp[0];
        w[1]+ = eta * dEp[1] ;
        dEpold[0] =  dEp[0] ;
        dEpold[1] = dEp[1];
        }
        else
                {
                w[0]+ = eta * dEp[0] + alpha * (dEp[0] - dEpole[0]) ;
```

```
                        w[1]+ = eta * dEp[1] + alpha * (dEp[1] - dEpole[1]) ;
                        dEpole[0] = dEp[0];
                        dEpole[1] = dEp[1];
                        }
                Sum+ = fabs (( double) (d[i] - y)) ;
                I ++
                if (I >= N)
                {
                gotoxy (1,6);
                printf (" Square error = %f", Sum);
                I = 0; Sum = 0 ;
                iter ++ ;
                }
        if (d[i] = = 1)
        gotoxy (1,4) ;
        else
        gotoxy (1,5) ;
        printf (" %d %f", d[i], y) ;
        if (( I = = N) && (Sum < = 1.0 e-1)
                {
                gotoxy (1,7) ;
                printf (" \n W[0] = %f  W[1] = %f", W[0], W[1]);
                exits(1);
                }
        if (Kbhit() ! = 0)
                {
                gotoxy(1,7) ;
                if (getch() = = 27)
                {
```

```
printf ("\n W[0] = %f W[1] = %f" , W[0], W[1]);
exits (1);
}
}
}
}
```

Available on the accompanying disk is a data file TO. DAT obtained from the chromaticity diagram. Using $\eta = 0.8$ and $\alpha = 0.2$ it took almost 200 iterations for the square error to drop from ~ 28 to ~ 9.55. After 15.000 iterations the error reached a lecel slightly less than one, and wass still decreasing, ... convergence was not reached yet. Changing $\eta = 0.2$ và $\alpha = 0.8$ slowed down the convergence. Before we discuss better techniques for teaching a perceptron we will have to provide you with a tool for collecting data.

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SYNTHESIZING AND RECOGNIZING VIETNAMESE SPEECH

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Abstract

Nowadays, the art and science of speech recognition and synthesis have been researched in the information technology world-wide. Each country has its language. It is the purpose of this paper to present some algorithms applied successfully in Vietnamese isolated word recognition and Vietnamese synthesis. In recognition part, we show some fundamental concepts of signal processing used as a pre-processing step. The next step is spectral feature extraction which are Linear Predictive Coding coefficients and Ceptral coefficients. We discuss two methods of recognition: pattern matching and vector quantization. The algorithm composed from time normalization and dynamic time warping theories applied in matching two difference-duration utterance is also reported.

RECOGNITION

Introduction

Sound, one the oldest means of communication in human being, has been the complex automatic processing problem in natural man-machine interface. It has taken a lot of time to input the data and control the system by keyboard and now computer is an indispensable tool in many business.

Recently, existing speech recognition technologies has been proven and shown adequate for simple tasks involving small vocabularies (tens or hundreds of words) and suitable for limited applications (typically, recognition of a set of digits or commands). This paper is intended to be an introduction to the theories and approaches applying a Vietnamese speech recognition system, both practical and experimental. The fundamental structure of the Vietnamese isolated word recognition system is depicted in fig. 1.

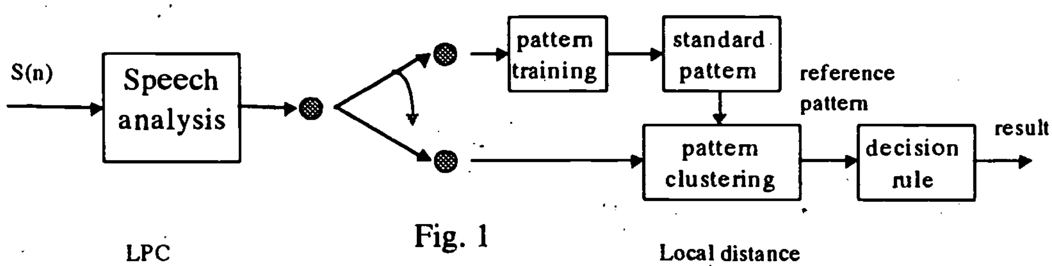


Fig. 1

Pre-processing

There are four step in preprocessing. Initial, these algorithm was tried in the 386 DX PC and 8 bit Sound Blaster Card. The signal was sampled at the rate 8 kHz. First, the signal is cut to reduce the segments at which the value is zero. These segments occur et the beginning and end of the signal. That is the time no sound before and after a word pronounced. Second, we use quantization method to quantize the amplitude of signal by 8 bit to 3 bit. In experiments, it is proved that the sound still keep its quality and saves much computational time. 256 values in squeezed to 8 values by logarit transfer function:

3 bits	0	1	2	3	4	5	6	7
8 bits	0	13	28	44	62	81	103	127

Then the signal is preemphasized in order to flatten the speech signal and reduce computational instabilities:

$$S'(n) = S(n) - A.S(n-1)$$

We use A = 0.95.

Finally, as usual, Hamming window is utilized to limit the segment of signal that is concentrated of spectral energy.

$$S''(n) = S'(n).W(n)$$

where

$$W(n) = \begin{cases} 0.54 + 0.46\cos(\frac{\Pi n}{N}), |n| \le N \\ 0, else \end{cases}$$

Feature extraction

Linear Predictive coding method is applied in this step. The order of the analysis system in autocorrelation analysis is chosen as

$$R(m) = \sum_{n=0}^{N-1-m} S(n).S(n+m) \quad , m=0,1,...,p$$

The feature set F = {R(0),...,R(p)} is autocorrelation coefficients.

Then LPC coefficients are converted from autocorrelation coefficients by Durbin's method. The Ceptral coefficients $\{C_k\}$, $1 \le k \le M$, were then computed recursively by using the following relations:

$$c_k = -a_k - \frac{1}{k}\sum_{n=1}^{k-1}(k-n)c_{k-n}a_n$$

Where $\{a_k\}$ are the LPC coefficients.

In experiments, we use the Euclidean distance, LPC distance proposed by Itakura, Spectral distance, and Mahalanobis distance. In these, the last one, Mahalanobis, gave the best results in time and accuracy

Time alignment

One of the problems of measuring the distance of the two vectors is the different duration. This is similar to putting a point in n-dimension space into m-dimension space (where $m \neq n$). It is solved when the dimension of one vector is contracted or expanded relative to the other. In this domain, Linear time Alignment method and Dynamic time Warping were used. But in experiments it was found that the linear time alignment alone did not give accuracy. As well, the dynamic time warping method consumed much of time because of the recursive algorithms. An algorithm based on the idea of the Dynamic time warping together the Linear time alignment method was developed as follow:

We suppose T and R are the test and reference pattern:

$$T = \{ T(1), T(2), \ldots\ldots, T(NT) \}$$

$$R = \{ R(1), R(2), \ldots\ldots, R(NR) \}$$

where NT and NR are the dimensions of vector T and vector R

Linear time alignment is defined as follow:

$$m = w(n) = (n-1)\frac{(NR-1)}{(NT-1)} + 1$$

Applying the function w(n), the element w(n) of the vector R correspondent to the element m linearly is determined, but, in experiment, it was found that this m element did not express the real value respectively. So the neighbour elements will be considered by measuring the distance from them to element m of the vector R. The element which has the minimum distance to m' will be selected. Then the element m of the vector R will be matched with the element i of the Vector T, where i satisfy:

$$i = \min(d(m,j)), \qquad j = w(n)-J, \ldots, w(n)+J$$

where J is selected by experiment. It depends on the order of the autocorrelation method. J=10 was used. The greater J is, the greater is the cost of time the algorithm consumes.

Training

In this step, an algorithm that is not training but selecting is built. The pattern is selected from N patterns by the method that we call Dynamic Average. First, the distance for the first pattern to the second one is measured. This measuring is repeated to the rest (N-1) of the patterns. Then the average of these distances is computed. The work will be done again for every pattern in the training set. At the end, every pattern has an average

distance of its own. We then obtain the new average value, DAVG, by computing these N average distances. Finally, the pattern whose average distance is nearest to the DAVG will be considered as the standard pattern of the class:

$$DAVG(c) = \frac{\sum_{i=1}^{n} AVR(i)}{n}$$

where

$$AVR(i) = \frac{\sum_{i=1}^{n} D(P(i), P(j))}{n} \quad , i = 1, ..., n$$

where D is the distance measurement between two pattern.

The pattern that is nearest to the DAVG will be chosen as the standard stored in the speech dictionary with maximum of 20 words:

$$P(s) = \{ P(i) , i = (1,n) \mid P(i)\text{-}DAVG < P(j) - DAVG \quad \forall j \in (1,n) \}$$

Decision rule

We use Bayes rule :

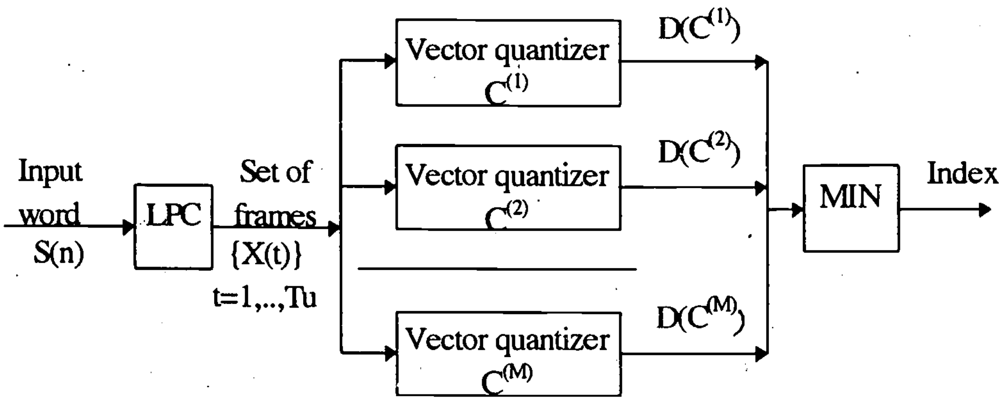
$$P(t/s) = \max_t(P(t/s)) = P(t).P(s/t)/P(s)$$

whenever there is more than one pattern nearest to the test pattern, the Bayes rule and KNN rule are applied.

Vector quantization

The result of the LPC analysis is a seri of vectors characteristic of the time-varying spectral characteristics of the speech signal. For convenience, we denote the spectral vector as v_l , l=1,2,...,L, where each vector is a p-dimensional vector.

Vietnamese speech recognition system is contructed by the following diagram:



Where

* $C^{(1)}, C^{(2)},..., C^{(M)}$ are M codebooks, each codebook responds to a word in the dictionary.

* $D(C^{(i)})$ is a average distortion score which is computed in formula:

$$D(C^{(i)}) = \frac{1}{Tu}\sum_{t=1}^{Tu} d(x_t, \hat{x}_t^{(i)})$$

with

$$\hat{x}_t^{(i)}) = \arg(\min(d(x_t, \hat{y}_j^{(i)}))$$

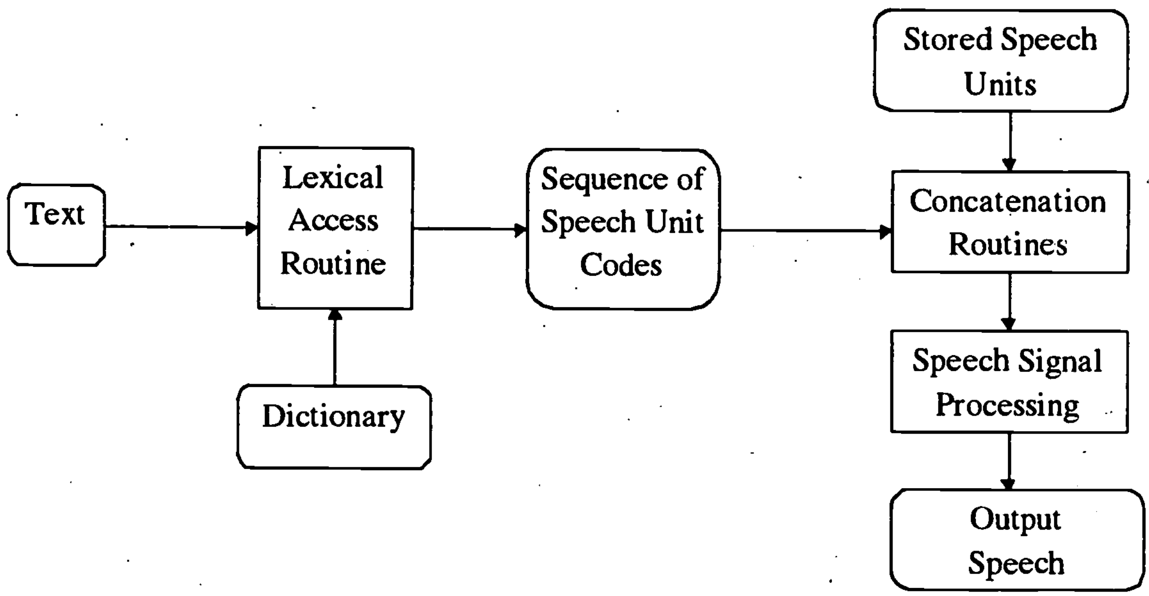
The important problem is how to built a codebook. In practice, we choose 64 entries for a codebook. For each word, we record some samples. After feature analysis by LPC, we obtain a spectral vector including some frames from each sample. Each frame is called a training vector. Then gathering all of frames from the samples of a word, we have a set of training vectors used to build a codebook for that word, We apply the Isodata clustering algorithm to cluster the set of training vectors into a set of 64 entries for the codebook.

SYNTHESIS

Introduction

Speech synthesis involves the conversion of an input text into speech waveforms

Speech synthesis can be characterized by the size of the speech units they



Block diagram of the speech synthesis

concatenate to yield the output speech as well as by the method used to code, store and synthesize the speech. Using large speech, such as phrases and sentences, can give high-quality output speech but requires much memory. Efficient coding methods reduce memory needs but often degrade speech quality. So it is important to choose the speech unit size and method of synthesis.

Vietnamese speech synthesis system based on word concatenation

As discussed above, the main problem in a synthesizer is to choose an appropriate size of the speech unit. For choice, we not two elements:

- The size of the set of units (size of stored dictionary).

- The naturalness of the output speech.

In the Vietnamese synthesizer, we choose words as speech units. It word respond to a waveform recorded from a person. Thus, the Vietnamese synthesizer will need the dictionary including about 6800 entries, approximately 28 MBs. This approach solve the second element: the naturalness of the output speech. However, to yield an output speech smoothly, we need to analyze intonation, rhymth in each sentence of entire text.

RESULTS AND APPLIES

After improving and completing several algorithms, the quality of " Recognizing and systhesizing system" is upgrade obviously. Here by ,there are some applies :

Recognition:

* Recognition Vietnamese speech:

- Previous system: recognize number from 0 to 9 only , manually and consequently.

- Improved system: can recognize from 20 to 50 words, directly and continually. User can speech 4 to 5 words continually and in consequently.

* Morever, Morse Code recognizing is also built:

The system can be recognized directly and continually, or indirectly and inconsequently.

System can also confirm what kind of signal(Signal are typed by hand or machine.)

Synthesis

Building a perfect system which can produce not only northern but southern female voice as well.

Applies which have been put into use:

Our group have applied in many branches.

1. In 116/108 operator: (Automatically answering)

- Problems: the number of operator is very high (appr. 180) -> there are a demand of automatically answering system.
- Solving: build an interactive programme in synthesis and tone-tpuch recognization.
- System will look for database and answer automatically to satisfy user demand.

2. Military applies

- Organition: Researching Institude of Department of Defence and so on.
- Problems: the demand of confirming coordinate of planes in the sky: solders input the coodinate into the computer which control the rockets (a set of coordinate includes 3 parts).
- Solving: establishing an automatically number recognition (from 0 to 9). The accurateness is 99.5%

3. Training and education applies

Setting up a system which trains foreigners in studying Vietnamese.

4. Morse code

Building an automatically Morse Code recognition.

5. In controlling and computing branch

Setting up a system which is controlled by speech, especially in Vietnamese.

Future developing project and short-term project

1. Complete all applies which have been put into use.

2. Widen applies: recognize 20-50 words continualy; synthesis female voice.

3. Studying and improving the ability of recognition about 100 words and synthesis female, adult, child voice and so on.

ON-LINE CHARACTER RECOGNITION

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Abstract

This abstract presents a real-time handwriting character recognition system based on a structural approach. After the preprocessing operation, a chain code is extracted to represent the character. The most important operation is using a processor for string comparison. The average computation time to recognize a character is about 0.25 to 0.35 seconds. During the learning step, the user define 26 characters and 10 digits to be recognized by the system. The experimental test shows a high accuracy (~99%).

1. Introduction

At present, most computer applications solely use the keyboard as a means of entering data or the mouse as a means of pointing to objects. The digitizer, however, enables the user to combine writing, pointing and drawing in a very natural way. The digitizer with a reliable recognition software is the best choice for laptops and palmtops which have energy limit and inadequate space for a keyboard.

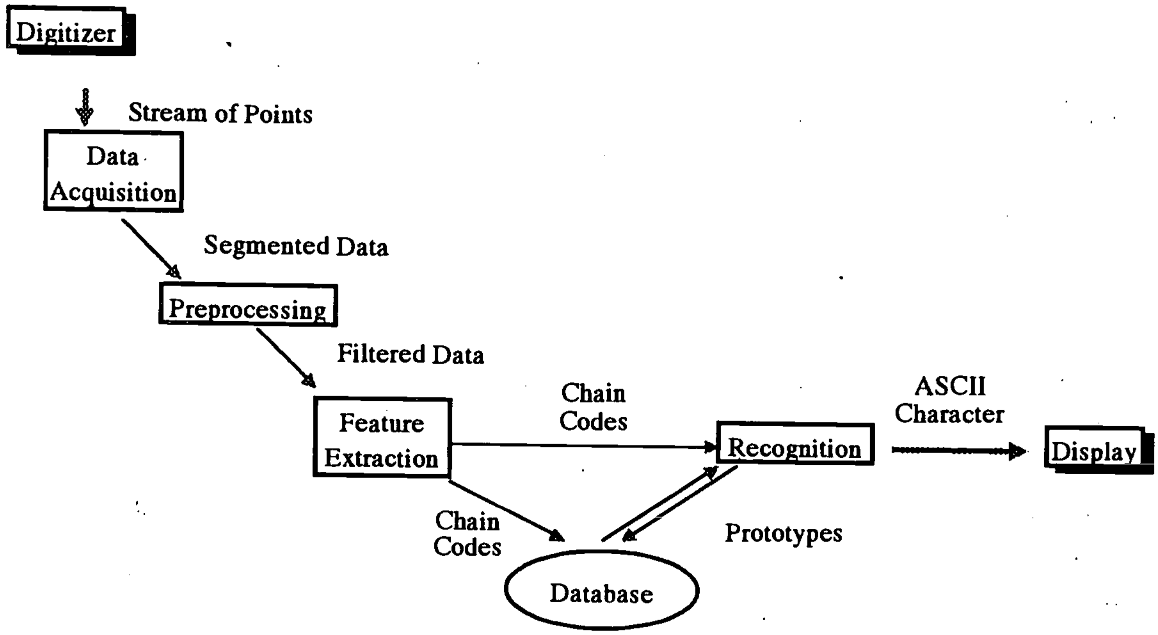
For these reasons, our automatic handwriting recognition system has been developed with the following exclusive goal: to isolated character recognition which entails a number of difficulties, the most important of which is variability. The same character can be written in many distinct ways by different writers, or even by the same writer.

A recognizer must be able to recognize isolated characters without the use of boxes. Many applications will not use boxed–input (the use of boxes to separate characters). Box–input makes the users uncomfortable with the process.

Isolated character recognition is performed by a specialized processor that compares a chain code with those in a database and selects the best matches. A personal database is defined for each user. Thus, the user does not have to respect any constraints and can use the system with his own natural handwriting.

A data flow diagram of the system is shown below. Firstly, the data corresponding to the character is digitized and stored. Next, a number of preliminary process are applied to the data in order to prepare it for feature extraction. If the character is processed during

the learning operation, its chain code is stored in the database. If the character is recognized, its chain code is compared to those in the database and the system provides the result.



2. Acquisition, segmenting and preprocessing

The digitizing device used in this study is a graphic tablet ("EasyPainter"-Genius Co.) and the resolution is up to 1016 LPI. The pen driver can report the location of the pen at least 100 times per second. This rate ensures that the true path of the pen is reported accurately enough to support the recognizer.

2.1. Segmenting

A segmentation process is applied to isolate the different characters. We use two methods for this process. The first one is based on temporal information. When a given time has elapsed since the last pen contact with the table surface, the acquisition is considered to be completed. It provides a fairly natural process for printing, recognizing and then continuing with more text entry. The second is spatial segmentation. User must write every character disconnected from another character. The strokes used to write each character must be adjoining (< threshold δ) or overlapping strokes.

2.2. Smoothing

The smoothing operation eliminates noise caused by the tablet, trembling while writing, etc. We use two methods for smoothing.

Method 1: this method uses an averaging formula to transform the point coordinates X_i and Y_i to suitable positions, according to the following equation:

$$X_i = (X_{i-3} + 3X_{i-2} + 6X_{i-1} + 7X_i + 6X_{i+1} + 3X_{i+2} + X_{i+3}) / 27$$

$$Y_i = (Y_{i-3} + 3Y_{i-2} + 6Y_{i-1} + 7Y_i + 6Y_{i+1} + 3Y_{i+2} + Y_{i+3}) / 27$$

When the distance and the deviation between points are not considerable, this averaging formula obtains a good result.

Method 2: this method is to reduce high deviation which may influence the feature extraction process.

$$X_{i\_new} = \frac{X_{i\_old} + X_{(i\_old)+1}}{2}$$

$$Y_{i\_new} = \frac{Y_{i\_old} + Y_{(i\_old)+1}}{2}$$

Through this process, with normal rate of handwriting, the deviation is much reduced. For points retained in regions of great curvature, changes are not considerable.

2.3.Spatial Filter

The special filter has 3 functions:

- To eliminate overlapped points.
- To eliminate continuous points with distances (d) less than a fixed threshold (δ).
- To add automatically one or more points if the distance between two original points is more than $n \times \delta$ ($n \geq 1$).

The formula for calculating the new coordinates is :

$$\boxed{\begin{array}{l} X = X_{i-1} + n \times \delta \times \sin\phi_i \\ Y = Y_{i-1} + n \times \delta \times \cos\phi_i \end{array}}$$

where $n = 1 \rightarrow (d / \delta)$ and ϕ_i is calculated by the following formula:

$$\boxed{\phi_i = \tan^{-1} \frac{Y_i - Y_{i-1}}{X_i - X_{i-1}}}$$

However, the consecutive points at cups and corners must be retained at high density. Therefore, we do not use the above formulas when the following condition is true:

$$\min(360-|\phi_i-\phi_0|,|\phi_i-\phi_0|)\geq\phi$$

where ϕ_0 is the tangent angle for the last point retained

ϕ_i is the tangent angle for the current point.

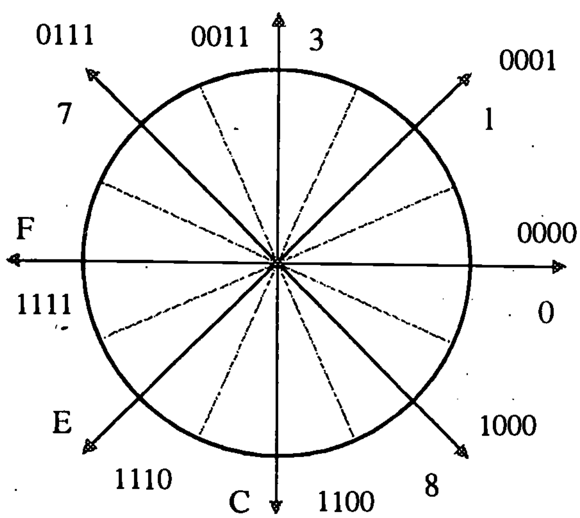
ϕ is a threshold.

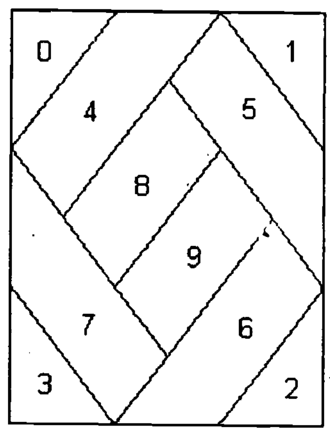
Thus, the spatial filter process eliminates the dynamic information (velocity, acceleration, etc.). In other words, this process renders the system completely independent of the rate of writing.

3. Feature extraction

The most important problem in recognition of handwritten characters is that of extraction of features which are barely affected by handwriting distortion. The following conclusion (derived from paper "Model of Handwriting Process and its Analysis" by S. Kondo and B. Attachoo, Tokai University, Japan) affirms that "the stroke-structure of a character is a quite important factor in the handwriting process". The theory of feature extraction from our study is based on that conclusion.

The structure chosen for feature representation is a string. A character is coded as a string of direction and position symbols, which belong to a basic descriptive alphabet. In fact, if a character has many strokes then each stroke of the character will be described by a component chain code. Thus, the character will be represented by the set of its consecutive component chain codes.





The basic descriptive alphabet (Φ) comprises 8 direction symbols and 10 position symbols.

$$\Phi = \{0_{dir}, 1_{dir}, 3_{dir}, 7_{dir}, 8_{dir}, C_{dir}, E_{dir}, F_{dir} ;$$
$$0_{pos}, 1_{pos}, 2_{pos}, 3_{pos}, 4_{pos}, 5_{pos}, 6_{pos}, 7_{pos}, 8_{pos}, 9_{pos}\}$$

The direction symbols are extracted as follow. Two points (X_i, Y_i) and (X_{i+1}, Y_{i+1}) define a vector. A vector's slope is given by:

$$\Omega = \tan^{-1} \frac{Y_{i+1} - Y_i}{X_{i+1} - X_i}$$

where $\Omega \in \{0_{dir}, 1_{dir}, 3_{dir}, 7_{dir}, 8_{dir}, C_{dir}, E_{dir}, F_{dir}\}$

The character is surrounded by a rectangle. The starting point of a vector on a fixed cell means that the position symbol is a code from 0_{pos} to 9_{pos}.

A unit of a chain code comprises 2 components: (Position, Direction).

In the coding algorithm, not every primitive object is changed into an equivalent vector. If the latter vector has the same position and direction as the previous one, then only one vector is retained in the chain. This retains the accuracy of the data while overlapping data has been eliminated.

Moreover, with the above algorithm, every character regardless of size, is equally coded. In other words, the recognizing process is completely independent of character size.

4. Learning

Everyone has his own handwriting. The same character can be written in many distinct ways even by the same writer. Each user is required to make his own personal database (Learning phase of the system). Thus, the writer does not have to respect any constraints and can use the system with his own natural handwriting.

The user must write 10 specimens of each character he defines. To enhance the system's operation (rate, storage, accuracy, ...), the user is advised to train the system with his most common way of writing.

5. recognizing

This is the decisive stage. The recognition problem has become the comparison between two strings, which is not simpler but clearer.

The personal database had been loaded into memory before the recognition process. Two characters with the same strokes (one is in memory, another is being recognized) will be compared with each other. This operation reduces the searching field during the comparison phase. Thus, calculation time and recognition errors are reduced.

Matches will be produced one by one after each comparison and the ten highest ones will be retained and updated every time. After the database is inspected, a set of characters correspondent to those matches is produced. The system calculates the sum of the score corresponding to each character and selects the candidate with the highest sum as the classified result.

Elastic matching algorithm:

The conception of string comparison, therefore, is relative (rarely strings have the same length and conventional linear order). In other words, there is no algorithm which is able to produce absolutely exact results in every case, but generally the results are achieved at a relative degree of accuracy. The matter now is to define how high the relative accuracy is. Besides, the algorithm must prove itself flexible and elastic to an object whose variability is instinctive.

Based on the idea:"In the case of the same characters, when a given time has elapsed since the first pen contacts with the tablet surface, the spot of pen on the generated character must approximate the equivalent spot on the standard character", the algorithm is established on the following fundamental:

"During the comparison process, the n^{th} code in the A string will be searched in the B string, from $(n^{th} - \delta)$ to $(n^{th} + \delta)$" where δ is a coefficient of oscillation.

On processing, the primitive chain code is not used directly. It is transformed into a new one by gathering the codes with the same position symbol into a sub chain which starts with that position symbol, followed by direction symbols.

The calculation of matches is made on the following standard:

```
If the same position (symbol):
    Comparing the subchain of direction symbols for resulting the "Res1_dir"
    Res = Res + Res1_dir
Else
    Res = Res – 1
```

"Res1_dir" is calculated as followed:

```
Res1_dir = Res1_dir + Max(–1, Res2_dir)
```

"Res2_dir" is calculated as followed:

Using logical operator "XOR" against a pair of direction symbols

The result	= 0	→	Res2_dir = 1
	=1,2,4,8	→	Res2_dir = 0.75
	Otherwise	→	Res2_dir = −1

The final result of recognition is calculated by:

Result = Res / Max(Length of String A, Length of String B)

6. Experimental test

The following figure shows the set of 36 characters used in our experiments:

A	B	C	D	E	F	G	H	I	J	K	L	M
N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9			

The data mentioned below represents the results of 5 participants. For each character the system is trained under 10 specimens and written 100 times in the test. Totally, each participant is required to write $(36 \times 10 + 36 \times 100) = 3960$ characters. A test takes about 3 hours per writer.

Writer	Alpha character (%)	Digit character (%)
1	99.31	99.60
2	99.31	99.90
3	99.31	99.50
4	98.92	99.30
5	99.27	(no test)

The next page shows detail recognition results for each character. In each column, we indicate the number of times the character is assigned to each class. Each alpha character was written 500 times and each digit 400 times.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	0	1	2	3	4	5	6	7	8	9
A	500																																			
B		484		11														5																		
C			484									16																								
D		2		498																																
E					500																															
F						500																														
G							499						1																							
H								500																												
I									498											2																
J										496										4																
K											500																									
L												499														1										
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N														499						1																
O															480						17	3														
P				6												494																				
Q																	500																			
R											1		2			1		495					1													
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V												3										497														
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2																													397					3		
3																													1	397				1		1
4																															399	1				
5																																400				
6																																	400			
7																																		400		
8																											1			1					398	
9																														2		3				395

Comparison of some systems*

Authors	Type of characters	Features	Classification	Number of writers	Number of characters per writer	Number of prototypes	Recognition results
Loy & Landau	Alphanumeric	• Direction • Position	Syntactic - statistic	1	2656	18 per way of writing	98.8
Lu & Brodersen	Alphanumeric and others	• Direction • Velocity	Elastic matching processor	4	500	1	96
Mandler	Alphanumeric	• Direction • Position • Height/width of character	Elastic matching	12	780	3	96.2
Noubound & Plamandon	Alphanumeric and others +, −, (,), ...	• Direction • Position	String comparison processor	15	1770	16	96
Tappert	Alphanumeric and others +, −, (,), ...	• Direction • Position	Elastic matching	9	1441	3	97.3

* Data is derived from the paper "A Structural Approach to On-Line Character Recognition: System Disign and Application" by F.Noubound and R.Plamondon - International Journal of Pattern Recognition and Artificial Intelligence Vol. 5, No. 1 & 2 (1991) 311-335.

Through the test, we have some observations as follows:

The rate of errors on each character (if any) ranges between 1% and 3%; it is up to 7% → 10% for several characters (which came from 2 of the 5 participants).

The errors are generally due to careless writing, divergency from specimens or ambiguity of characters. Those due to the interruption of adjoining (inadvertent occuring during writing process) are not mentioned in the result. Some have an unidentified cause.

The greater the difference between the specimens, the higher the accuracy of the recognition.

7. Conclusion

From the high degree of accuracy (approximately 99%) of the experimental test result, we ascertain that the theory of handwriting recognition in this abstract is convincing. It can be considered as foundational for the next developments of the system.

The use of contextual information, perhaps, will help to solve the problem of the classification of ambiguous characters.

Besides the feature extraction techniques, the elastic matching algorithm must be improved as well as the problem of the inadvertant interruption of adjoining. These are subjects for future study.

Acknowledgements

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DATA MINING AND KNOWLEDGE ACQUISITION FROM A DATABASE

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Abstract

Data mining is the discovery of interesting relationships and characteristics that may exist implicitly in database. In this paper, we consider how to use multi-dimensional data model (MDDM) for mining rules in a large database. These rules will help us to develop the knowledge for deductive applications [6]. We will create a MDDM and the operations for processing it. After that, we develop two applications for discovering the interesting patterns and the association rules in a database.

1. Introduction

MDDM is a multi-dimensional data model that were used popularly in statistical field, such as the ANOVA method for analyzing the variance among factors. This model is very convenient for mathematical operations [3][5] and in some applications, MDDM can reduce the data redundancy. In temporal databases, MDDM with 3 dimensions are used in modeling the database with the time attribute in the third dimension. Many papers and works related to this fields [1][2][3][5] have proved the efficiency of MDDM in calculation.

In this paper, we will mix the ideas from the above methods .We will define MDDM, database and mathematical operations for MDDM and after that we use MDDM for mining the interesting patterns from data in a decision tree structure and the association rules from a database. Our interest is to discover special relationships and patterns in database, such as :

There are 67% of patients who have concurrently the following characteristics :

"Flu = Yes and Headache=yes and Temperature = very_high", or

There are 59% of customers that buy product X also buy product Y .

There are 67% of customers that buy product X then buy product Y next week.

2. MDDM

In traditional relation database, a relation can be visualized as a two dimensional data structure, one dimension for attributes and another for the tuple of database. This model is not suitable for the statistical and mathematical operations [3][5]. In order to utilize the power of statistical and mathematical methods for discovering interesting patterns and association rules in a database, we define a mixed MDDM as follows:

Let D1,D2,....Dn be the sets of discrete values .

X1,X2,....Xn are the variables ,

D1=Dom(X1) , D2=Dom(X2) ,...., Dn=Dom(Xn).

We consider MDDM as a mapping f(X1,X2,.....,Xn) from B to U :

f : B ----------> U

(X1,X2,...Xn) y = f(X1,X2, ... Xn)

where B = D1xD2x......Dn is the Cartesian product of D1,D2,.....,Dn

U is a subset of R (real number set).

We call D1xD2x,..Dn is the domain of definition, U is the value set of MDDM f .

We consider (X1,X2,....Xn) as the coordinate and f(X1,X2,.....Xn) as the value of cell. The number of cells in MDDM will be Card (D1)*Card (D2)* ....*Card(Dn) . MDDM is totally defined by giving the domain of definition and the value set of f(X1,X2...,X4).

3. Some database operations in MDDM

Based on the theory of relational database and statistics, we define some database operations, such as projection, selection, filtering, aggregation ....

3.1. Filtering

Filtering FT(f,g,T) with threshold T and MDDM f,g is a database operation for creating another MDDM g(X1,X2,....Xn) from f(X1,X2.....,Xn) as follows :

$$g(X1,X2,....Xn) = \begin{cases} f(X1,X2,..........Xn) & \text{if } f(X1,X2,...........Xn) > T \\ 0 & \text{elsewhere} \end{cases}$$

After filtering FT(f,g,T) , g and f have the same domain of definition .

3.2. Projection

Project PT(f,g,c) where f ,g are MDDM and c is the projection condition.

PT(f,g,c) is defined as follows :

Let f(X1,X2,......X3) be a MDDM and

D1=Dom(X1) , D2=Dom(X2) = ,... Dn=Dom(Xn).

Let D1' $\subseteq$ D1, D2' $\subseteq$ D2... Dn' $\subseteq$ Dn. D1',D2', ...Dn' will contain the values of D1,D2,... Dn that meet the condition listed in parameter c of PT(f,g,c).

We create a MDDM g as follows :

g : D1' x D2' x ....Dn' -----------> U'

where

$$g(X1,X2,...Xn) \quad = \quad f(X1,X2,....Xn)$$

for each $(X1,X2,...Xn) \in D1' \times D2' \times ....Dn'$

The content of cell (X1,X2,...Xn) will be equal the content of cell (X1,X2,...Xn) for each $(X1,X2,...Xn) \in D1' \times D2' \times ....Dn'$.

The domains of definition of f and g are different, but their dimensions are equal..

4. Some mathematical operations of MDDM

Because the value of f(X1,X2,....Xn) is a real number , we can do mathematical and statistical operations. We define two kinds of operations : global for the whole MDDM and local operation for a part of MDDM.

4.1. Global operation[5][3]

We can do global mathematical operations to the content of all cells of f .For example we can divide the content of all cells of MDDM f by a number r <> 0 and create a new MDDM g that has the same domain of definition with f :

$$g(X1,X2.....,Xn) = f(X1,X2.....,Xn) / r$$

for each $X1 \in D1$; for each $X2 \in D2$....., for each $Xn \in Dn$

Besides of division, we can do multiplication ,addition, subtraction or another statistical operations .

We can create a MDDM h that has the same domain of definition of g(X1,X2.....,Xn) and f(X1,X2.....,Xn) , the value set of h will be defined as follows :

$$h(X1,X2.....,Xn) = f(X1,X2.....,Xn) \oplus g(X1,X2.....,Xn)$$

for each $X1 \in D1$; for each $X2 \in D2$....., for each $Xn \in Dn$

where $\oplus$ is a mathematical operation such as +,-,* , / .

4.2 Mathematical operations by freeing one dimension of MDDM

In this kind of mathematical operations, we free one dimension that means we fix n-1 dimensions of MDDM by assigning n-1 particular values to n-1 variables of these dimensions and extract a one dimensional table. MDDM. If we fix n-1 variables X2 = X21 ; X3 = X31.. Xn=Xn. and extract a MDDM g, as follows :

$$g(X1) = f(X1, X2 = X21 ; X3 = X31.. Xn=Xn1.)$$

where g(X1) is an one dimensional table.

We can calculate the sum ,average, maximum, minimum all the cell contents in this table, the result of this operation will be a real number.

We denote SF for summing operation ,AF for average ... and in this example we have :

$$SF(f, X1=all ,X2=X21,... Xn=Xn1) = \sum X1 \quad \text{for each } X1 \in D1$$

where the value "all" of X1 means " for each value of X1 in D1 = Dom(X1) ".

4.3. Local mathematical operations by freeing two dimensions of MDDM

If we free 2 dimensions of MDDM f by fixing the value of n-2 variables of MDDM such as, X3= X31;X4=X41......Xn=Xn1 , we can extract a function g from f defined as follows :

$$g(X1,X2) = f(X1=all,X2=all\ X3=X31,...Xn=Xn1)$$

where g(X1,X2) is a two dimensional table.

Because g(X1,X2) is a two dimensional table, we can do mathematical operations along the dimension X1or X2. For example , we can create an one dimensional table h(X1) from g by summing along the dimension X1 , that means:

$$h(X1=a) \doteq SF(g,X1=a,X2=all) \text{ ; for each } a \in Dom(X1)$$

or we can create MDDM k :

$$k(X2=b) = SF(g,X1=all,X2=b) \text{ ; for each } b \in Dom(X2)$$

We can calculate the sum ,average, maximum, minimum the content of all the cells in this table.

We can free m variables ($2 < m < n$) and define another MDDM that has m dimensions where n is the dimension of the original MDDM. From the new MDDM, we can define the mathematical operations based on the operations defined in item 4.

5. Using MDDM for mining interesting patterns in a database

5.1. Application to discovering pattern from data in a decision tree structure

In this application, we use MDDM for extracting the interesting patterns from data in a decision tree structure. The induction learning from decision tree is a good model for implementation. MDDM will be used for modeling the decision tree and we used the above mathematical operations for discovering the interesting patterns. Our application depends on the number of instances that has the same attribute values. We hold that the more number of instances of a particular pattern we have ,the more belief we get about this pattern. We use the joint probabilities of the attribute values in a pattern to discover the interesting pattern. We also study the R measure [4] for implementing our methods. The methods listed in [4] base on the numbers of instances that have a specified values .From these numbers , we can infer the probabilities related to the occurrence of instances

and classes. In the following sections, we use MDDM for calculating these numbers. Our MDDM also satisfies the measure of Gini that was based on the theory of entropy and the methods that use probabilities and statistics for data classification.

The information table for mining the patterns might be as follows [4]:

Instance	Temperature	Headache	Flu	Number of Instances
e 1	normal	yes	no	n1
e 2	high	yes	yes	n2
e 3	very_high	yes	Yes	n3
e 4	normal	no	No	n4
e 5	high	no	No	n5
e 6	very_high	no	Yes	n6
e 7	high	no	No	n7
e 8	very_high	yes	Yes	n8

where

n1 is the number of instances X(Temperature = normal, Headache = yes ,Flu = no) in DB

......

n8 is the number of instances X(Temperature = very_high, Headache = yes ,Flu = yes)

From this table , we define D1 for Temperature ,D2 for Headache ,D3 for Flu as follows :

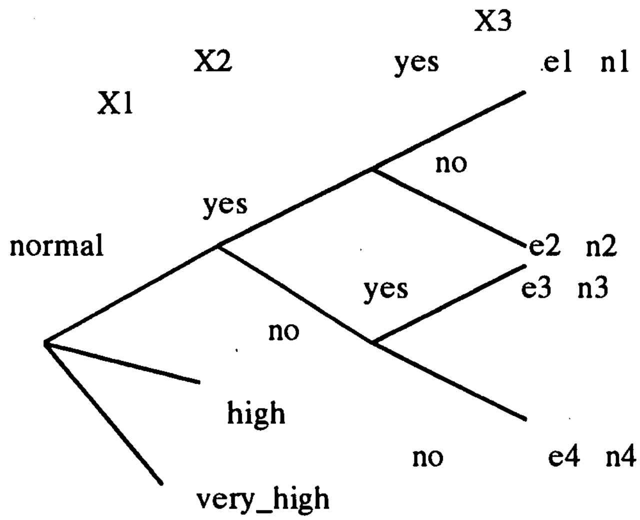
D1 = {normal,high,very_high} D2={yes,no} D3 = { yes , no }

The domain of definition of MDDM f will be D1xD2xD3.

The value set of MDDM will be U={n1,n2,n3,n4,n5,n6,n7,n8} .

Let n be the sum of n1,n2 ..... n8 ; n is also the number of tuples in the data table.

Our MDDM is a good tool for modeling the decision tree structure .From the data table, we can create a tree that a part of this tree is depicted in the following figure:



Based on the Bayesian classification method, the probability of e1 will be calculated as follows:

p(e1) = p(X1=normal)*p(X2=yes/X1=normal)*p(X3=yes/(X1= normal ,X2=yes)

We calculate the following probabilities based on conditional probability and Bayesian classification method:

p(X1=normal)= v1/n where v1 is the number of instances that have X1=normal

p(X2=yes/X1=normal) =v2/v1 where v2 is the number of instances that have X1=normal and X2=yes.

p(X3=yes/(X1= normal ,X2=yes) =n1/v2

That means : e1(X1,X2,X3) will be :

P(e1) = (v1/n)*(v2/v1)*(n1/v2) = n1/n.

We use our global mathematical operations for calculating the value n and divide all cell of f by n to create a new MDDM g. The content of cell in MDDM g will be the occurrence probability of a particular instance. If we want to extract only the interesting patterns that have the probability higher that T, we can use the filtering operation defined in item 3.1. After filtering with the threshold T equal to 50%, we can extract some interesting patterns as follows:

There are 55% of patients who have Flu=yes ,Temperature = High , Headache = Yes

There are 15% of patients who have Flu=no ,Temperature = Normal , Headache = Yes

We can change the threshold T for filtering the necessary concepts.

If we want to calculate the value v1 (the number of instances that have X1=normal), we can use local mathematical method mentioned in 4.2 by freeing two variables X2,X3 or you can free X3 for calculating the value v2 (the number of instances that have X1=normal and X2=yes).

5.2. Application to mining the association rules

In this application, we will use MDDM for mining the association rule. One association rule might be

"There are 80% of customers that buy product X also buy product Y" ,or

"There are 10% of customers that buy product X then buy product Y next week"

.We use MDDM for extracting these patterns. The following information table will contains the TID and Items of customers, as follows :

TID	Item
100	1
100	2
101	3
101	1

TID is transaction Id and Item is the Item number .In TID 100 , there are Items 1,2 ; In TID 101 , there are Items 1,3 .One TID might contain many items.

From this information table, we create a MDDM f that has the domain of definition as follows:

$$D1 = \{100,101\} \ ; D2 = \{1,2,3\}$$

In this case, MDDM will be a two dimensional table. If we have the time attribute, MDDM will have three dimensions.

The value set of f will be {0,1} .The content of cell (TID,Item) will be 0 or 1 ; 0 means that TID does not contain this Item ; and 1 if yes .

	Item		
TID	1	2	3
100	1	1	0
101	1	0	1

We use template matching method for counting the number of TIDs containing a group of particular Items .We create a MDDM p (Item); p is a pattern that have items {1,3}.The domain of definition of p will be D2 ={1,2,3} .We defined p as follows :

$$p(X) = \begin{cases} 1 & \text{if } X = \text{Item 1 or 3} \\ 0 & \text{elsewhere} \end{cases}$$

That means p(1)= 1 ; p(2)=0 ; p(3) =1.

The template matching is defined as follows :

$$f3(X1) = \begin{cases} 1 & \text{if} \quad \Sigma f(X1,X2)*p(X2) >= n \\ & \qquad \text{for each } X2 \in Dom(X2) \\ 0 & \text{elsewhere} \end{cases}$$

for each $X1 \in Dom(X1)$

where * is a multiplication and n is the number of non zero cells of p .Then we apply the global mathematical operations for summing the content of cell in f3(X) , The result of this summing operation will be the number of TIDs that contain Items 1 ,3 .

6. Conclusion

The MDDM with the facilities of mathematical and database operations has proved the power of organizing and processing data for mining the interesting patterns and rules in a database. This model is very easy for mathematical calculations and implementation.

Besides of these above applications, we already applied this model for mining the sequential pattern in a temporal database. We continue to study the conversion from relational database model to MDDM, the application of MDDM for discovering the fuzzy rules in a fuzzy system, the joining MDDM with the neural network model for classifying or clustering data in data mining field [3].

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GENETIC ALGORITHM FOR INITIATIVE OF NEURAL NETWORKS

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Abstract

In this paper, a procedure for initiative of neural networks based on genetic algorithms is presented. The basis of the calculations is the correlation between every weight and error function. In an examplary real would application for the proposed procedure, the classification rate could be increased by about ten percent.

1. Introduction

Most neural network learning systems use some forms of the back-propagation [1,2]. In practice, however, the back-propagation algorithm encounters tow main difficulties: (1) its rate of convergence is very slow and (2) it does not always guarantee the global minimum to the error function [3,4]. The back-propagation algorithm is based on the steepest descent approach for minimization of the error function. With this approach, the weights are modified in the direction in which the error function decreases most rapidly. This direction is determined by the gradient of the error function at the current point in the weights space. There are two situations in which the steepest descent might result in a slow rate of convergence. The first is when the magnitude of the conponents of the gradient vector very small. The second is when the direction of the gradient vector may not point directly toward the minimum of the error function.

Genetic algorithms are implicit parallism algorithms and powerful direct search optimization tools. To use the genetic algorithm, we must:

(1) Determining the presentation schema;

(2) Determining the fitness measure;

(3) Determining the parameters and variables for controlling the algorithm;

(4) Determining the way of desgnating the result and the criterion for terminating a run.

Once these steps for setting up the genetic algorithm have been completed, the genetic algorithm can be run.

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The three steps in executing the genetic algorithm operating can be summarized as follows:

(1) Randomly create an initial population of individual fixed-lenght strings.

(2) Iteratively perform the following substeps on the population of strings until the termination criterion has been satisfied:

(a) Evaluate the fitness of each individual in population.

(b) Create a new population of strings by applying at least the first two of the following three operations. The operations are applied to individual string(s) in the population chosen with a probability based on fitness.

- Copy existing individual strings to the new population.
- Create two new strings by genetically recombining randomly chosen substrings from two existing strings.
- Create a new string from an existing string by randomly mutating at one position in string.

(3) The best individual string that appeared in any generation is designated as the result of the genetic algorithm for the run. This result represent a solution (or approximate solution) to the problem.

2. Genetic algorithm for initiative of neural networks

We tried to build up a learning algorithm for neural network based on genetic algorithm. In this algorithm genetic, each individual represents a weight vector. It is a bit string of length N, where each bit represents a weights. The fitness function is the error function of the neural network.

Various authors have proposed the procedures for the main operations of genetic algorithm, In this paper, we consider the procedures studied by De Jong [5]. These procedures are represented as following:

Crossover

Input: L_1,L_2 - two weight vectors;

Output: L - a new invidual;

(0) $i \leftarrow 1$;

(1) Randomly_choose(L_1,L_2,W_1,W_2);

(2) $L[i] \leftarrow$ create(W_1,W_2);

(3) $i \leftarrow i+1$;

(4) If (i<N) Then Goto (1)

Else Return L;

Mutation

Input: L - a weight vector;

Output: L' - a new individual;

For i←1 to N Do

L'[i] ←L[N-i+1];

3. Application: Analyzing chemical data

We succesfully implement artifical neural networks for data classification and apply to analyzing chemical data (Phenol) (see Bang1, Bang2, Bang3). In this case, a three-layer perceptron [2] is used. The network has 26 input neurons, 22 hidden neurons and 1 output neuron. To compare, this network is trained by back-propagation using weight matrix that initated by proposed genetic algorithm and using randomty weight matrix. After the 4000th iteration, the error of the network using proposed algorithm is 0.00017 and the error of the network without using this algoritm is 0.0021.

The network is trained with 73 training patterns. Then, this network is used to classify patterns, The result of the classification is showed in the appendix table.

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Table 1:

n	logp	sigma	char_1	char_2	char_3	char_4	char_5	char_6	char_7
1	1.48	0.00	-0.253	0.078	-0.213	-0.092	-0.166	-0.097	-0.157
2	2.12	-0.17	-0.254	0.080	-0.152	-0.092	-0.163	-0.100	-0.155
3	2.56	-0.15	-0.256	0.084	-0.152	-0.091	-0.164	-0.099	-0.157
4	2.64	-0.15	-0.255	0.086	-0.153	-0.089	-0.165	-0.098	-0.158
5	3.36	-0.01	-0.256	0.095	-0.044	-0.095	-0.176	-0.088	-0.219
6	1.63	0.06	-0.237	0.046	0.068	-0.135	-0.140	-0.106	-0.191
7	2.20	0.23	-0.245	0.092	-0.150	-0.085	-0.159	-0.094	-0.152
8	2.35	0.23	-0.245	0.112	-0.256	-0.067	-0.165	-0.083	-0.159
9	1.85	0.78	-0.204	0.149	-0.172	-0.034	-0.178	-0.047	-0.232
10	1.60	0.66	-0.241	0.126	-0.104	-0.054	-0.171	-0.072	-0.165
11	2.07	0.42	-0.252	0.122	-0.204	-0.040	-0.180	-0.061	-0.230
12	2.08	0.50	-0.255	0.133	-0.234	-0.047	-0.181	-0.067	-0.178
13	0.65	-0.66	-0.269	-0.010	0.112	-0.201	-0.107	-0.159	-0.160
14	0.81	-0.37	-0.249	0.066	-0.007	-0.169	-0.131	-0.127	-0.133
15	2.19	0.45	-0.215	0.141	0.147	-0.036	-0.186	-0.054	-0.236
16	0.49	0.00	-0.256	0.073	-0.149	-0.076	-0.167	-0.094	-0.161
17	0.44	0.00	-0.253	0.080	-0.163	-0.066	-0.168	-0.095	-0.159
18	2.12	-0.07	-0.253	0.082	-0.217	-0.031	-0.165	-0.094	-0.161
19	2.65	-0.07	-0.253	0.082	-0.220	-0.027	-0.164	-0.095	-0.161
20	3.36	0.06	-0.252	0.078	-0.205	0.013	-0.156	-0.009	-0.153
21	9.53	0.00	-0.253	0.082	-0.221	-0.026	-0.165	-0.095	-0.161
22	1.91	0.34	-0.247	0.105	-0.256	0.129	-0.202	-0.073	-0.172
23	2.48	0.37	-0.248	0.089	-0.212	-0.023	-0.160	-0.089	-0.156
24	2.89	0.35	-0.248	0.076	-0.125	-0.230	-0.134	-0.095	-0.197
25	1.85	0.71	-0.246	0.096	-0.157	0.060	-0.193	-0.073	-0.221

Table 2 :

n	area3	area4	area5	area6	area7	energy	homo	lumo	igc
1	34.72	39.70	39.91	40.04	38.02	-1419.9194	-9.11457	0.39772	-0.43
2	76.43	33.24	39.91	39.91	37.41	-1702.2584	-8.99656	0.37040	-0.27
3	112.37	29.76	40.18	40.14	37.55	-1983.1092	-8.99670	0.38613	0.18
4	135.61	31.28	40.08	39.77	37.58	-2129.3567	-9.02080	0.35021	0.35
5	173.40	23.33	39.10	39.77	33.03	-2622.2650	-8.58464	-0.21799	1.09
6	45.15	36.90	39.91	39.91	43.31	-1429.6447	-9.19489	0.04553	0.28
7	68.20	34.65	39.57	39.91	37.62	-1403.3284	-9.25947	-0.02966	0.28
8	80.59	32.96	39.37	39.91	36.67	-1388.8362	-9.30252	-0.04923	0.50
9	87.80	31.28	39.91	39.91	33.91	-1593.4948	-9.95399	-1.01354	0.67
10	76.54	34.38	40.04	39.91	37.62	-1619.8617	-9.55649	-0.50910	0.03
11	80.96	31.82	40.11	39.70	34.79	-1681.3539	-9.50049	-0.43367	0.48
12	117.00	29.12	39.23	39.91	36.74	-1957.9220	-9.39398	0.45833	0.08
13	67.49	34.28	39.37	39.91	34.11	-1584.8574	-8.01997	0.62018	0.94
14	51.67	34.72	39.37	39.91	37.55	-1523.5630	-8.88516	0.29692	0.75
15	94.87	30.27	40.18	38.83	34.18	-1796.3698	-9.50781	-0.45712	-0.62
16	136.58	21.64	38.89	39.84	37.82	-2131.3311	-9.04435	0.32572	NESd
17	92.41	29.39	39.57	39.91	37.01	-1803.8812	-9.04486	0.34418	-0.95
18	27.30	81.81	32.70	39.70	37.75	-1702.6365	-9.02546	0.38971	0.23
19	26.36	118.73	22.92	39.57	37.89	-1983.0629	-9.01597	0.40417	0.23
20	19.35	176.70	24.00	39.77	37.75	-2625.8289	-8.79831	-0.34179	1.35
21	26.70	509.83	22.32	40.04	37.95	-5648.7091	-9.01942	0.40101	NESd
22	33.64	47.78	38.42	39.91	37.95	-1431.9258	-9.31854	0.04191	0.47
23	29.66	74.35	34.45	39.07	37.95	-1403.7806	-9.30041	0.03908	0.96
24	29.46	98.30	32.09	39.91	34.51	-1376.7021	-9.35918	-0.06962	1.12
25	35.32	91.59	26.03	39.70	34.92	-1617.1112	-9.47541	-0.42754	0.51

Table 3:

n	volu_1	volu_2	volu_3	volu_4	volu_5	volu_6	volu_7	area1	area2
1	71.21	239.74	277.90	204.29	95.82	1087.77	371.33	48.72	57.63
2	56.88	319.43	336.27	382.76	285.81	123.38	1607.93	39.40	47.90
3	125.73	344.52	380.07	432.68	324.86	157.44	1751.66	34.48	41.67
4	78.60	288.80	369.02	325.41	164.79	1760.52	599.73	33.85	40.43
5	211.38	739.48	475.40	455.30	586.77	67.75	24.80	34.32	42.42
6	71.58	863.73	381.76	318.53	275.47	204.29	95.37	48.08	57.19
7	72.72	291.51	479.40	275.01	95.55	201.33	1211.85	42.01	51.12
8	333.59	239.69	648.52	241.83	19.03	180.57	1085.73	33.06	49.23
9	88.47	880.67	436.93	395.88	348.73	258.56	121.06	39.82	48.93
10	47.28	416.72	415.15	295.08	180.60	87.27	293.04	42.10	51.00
11	88.47	880.62	382.98	392.91	349.19	259.61	121.62	41.58	50.48
12	83.99	109.11	1004.44	589.08	559.66	499.41	361.75	30.34	37.83
13	87.01	308.92	1125.21	119.26	257.93	351.44	396.89	43.07	52.18
14	80.34	298.82	313.82	313.34	231.67	107.13	1344.01	45.30	54.61
15	58.06	394.62	359.81	1600.59	286.78	131.24	387.63	39.98	48.48
16	134.50	355.48	447.18	380.73	308.98	160.80	1632.10	38.73	46.22
17	107.82	326.92	370.27	350.73	270.98	132.54	1487.72	39.40	47.90
18	96.40	888.55	364.47	416.60	111.24	220.20	392.15	48.93	58.04
19	114.67	936.82	274.48	336.58	356.20	424.13	446.12	48.66	57.37
20	156.10	374.26	567.83	434.10	350.24	185.94	1902.12	48.77	57.68
21	456.47	1248.61	1187.04	1021.76	398.56	841.04	1295.49	49.71	58.21
22	70.64	289.74	352.54	261.88	96.22	201.33	1211.99	48.88	57.99
23	71.25	863.40	97.38	362.84	307.49	349.50	374.33	49.04	58.15
24	71.45	863.60	368.94	695.31	274.12	204.29	97.59	49.04	58.15
25	88.55	880.70	461.24	335.76	345.10	258.35	121.23	49.71	58.01
26	80.12	872.27	413.46	407.11	315.56	231.67	109.78	49.04	57.95

Bộ dữ liệu Phenol 2.1

	Kết xuất trong		
Stt	mẫu	mạng	
1	0.334211	0.33	ok
2	0.376316	0.433	
3	0.494737	0.459	ok
4	0.539474	0.53	ok
5	0.734211	0.728	ok
6	0.521053	0.521	ok
7	0.521053	0.486	ok
8	0.578947	0.599	ok
9	0.623684	0.635	ok
10	0.455263	0.477	ok
11	0.573684	0.533	ok
12	0.468421	0.464	ok
13	0.694737	0.697	ok
14	0.644737	0.573	
15	0.284211	0.29	ok
16	0.197368	0.232	ok
17	0.507895	0.539	ok
18	0.507895	0.501	ok
19	0.802632	0.804	ok
20	0.571053	0.541	ok
21	0.7	0.675	ok
22	0.742105	0.751	ok
23	0.581579	0.574	ok
24	0.428947	0.437	ok
25	0.468421	0.482	ok
26	0.347368	0.381	ok
27	0.305263	0.317	ok
28	0.276316	0.313	ok
29	0.228947	0.297	
30	0.410526	0.378	ok
31	0.434211	0.48	ok
32	0.597368	0.518	
33	0.502632	0.502	ok
34	0.573684	0.577	ok
35	0.615789	0.614	ok
36	0.615789	0.633	ok
37	0.810526	0.791	ok
38	0.452632	0.452	ok
39	0.592105	0.604	ok
40	0.626316	0.621	ok
41	0.671053	0.689	ok
42	0.955263	0.866	
43	0.618421	0.605	ok
44	0.584211	0.545	ok
45	0.518421	0.487	ok
46	0.423684	0.44	ok

	Giá trị	
Stt	thực	dự đoán
1	0.815789	0.826
2	0.692105	0.454
3	0.542105	0.516
4	0.894737	0.852
5	0.763158	0.713
6	0.915789	0.873
7	1	0.884
8	0.784211	0.813
9	0.986842	0.912
10	0.784211	0.796

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