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THE "ORCHESTRATED SYSTEM" APPROACH TO INDUSTRIAL EDUCATION (INDUSTRIAL ARTS - TECHNICAL - VOCATIONAL).

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THIS SYSTEMS APPROACH DETERMINES AND IDENTIFIES ULTIMATE EDUCATIONAL GOALS AND INTERMEDIATE GOALS WHICH PROVIDE THE OPERATIONAL DYNAMICS FOR GOAL ATTAINMENT BY USING MODELS DESIGNED BY SYSTEMS NETWORK ANALYSIS PROCESS, OR SNAP MAPS WHICH ARE SIMPLIFIED FLOW CHARTS, EXPOSING TENTATIVE SOCIAL AND INDUSTRIAL ELEMENTS OF THE INDUSTRIAL ARTS CURRICULUM. THIS PROCESS IS IN CONTRAST TO THE USUAL PRACTICE OF FACTORING OUT ELEMENTS OF INDUSTRY SUCH AS TRADES, CONCEPTS, OR SAMPLE EXPERIENCES. THE ULTIMATE GOAL OF EDUCATION, "THE GOOD LIFE" AND INTERMEDIATE GOALS, OR EDUCATIONAL CURRICULUM AREAS, ARE DIAGRAMED TO SHOW THEIR PURPOSE AND PLACE FROM THEIR POSITION AND RELATIONSHIP IN THE MODEL. "EDUCATION FOR DEVELOPING COMPETENCIES IN COMMUNICATIONS" IS DESIGNED INTO THE INDUSTRIAL ARTS MODEL AS THE KEY GOAL GRADIENT. WHEN THESE COMPETENCIES ARE DEVELOPED, THE STUDENT MAY BEGIN PARALLEL DEVELOPMENT OF OTHER GOAL GRADIENTS, EACH OF WHICH MAY BE SUBJECTED TO THE SYSTEMS MODELING TECHNIQUE IN CONTINUED SUBANALYSIS, EACH REVEALING MORE SPECIFIC CONTENT. THE THEORY OF TEACHING AND LEARNING FOR THIS SYSTEMS APPROACH IS BASED UPON DEVELOPING INDIVIDUAL SELF-MOTIVATION AND SELF-DISCIPLINE AND UPON CREATING A "WHOLE" WHICH THE STUDENT MUST SYNTHESIZE AND RELATE INTO AN UNDERSTANDING OF THE "WHOLE." THIRTY-NINE CHARTS AND SNAP MAPS ILLUSTRATE THE PROGRESSIVE SUBANALYSIS OF THE INDUSTRIAL EDUCATION CURRICULUM ELEMENTS AND THE CONCEPTS OF EDUCATIONAL PLANNING PRESENTED. (EM)

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THE "ORCHESTRATED SYSTEMS" APPROACH TO INDUSTRIAL EDUCATION (Industrial Arts - Technical - Vocational).

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THE "ORCHESTRATED SYSTEMS" APPROACH TO INDUSTRIAL EDUCATION (Industrial Arts - Technical - Vocational)

Introduction

The goal of education for the citizen of the United States should be set forth so clearly and singularly that it becomes easily communicated for every day use. The educator, whether generalist or specialist, needs a "global vision" of education in his society in order that his efforts are supportive and directed as a positive force toward attainment of that goal. Renown educators and professional groups have labored at the task of defining and clarifying educational goals but usually they set forth a series of factors or sub-goals without clearly defining the whole or the singular goal from which the parts are analyzed. If we do not know and cannot describe clearly and precisely the goal for the individual in his society, how can we design an educational system with the dynamics for changing individuals in the right direction? This task of defining the educational goal tends to escape us since it relates so closely with purpose of life. The alternatives we face are to define the goals of life and education or operate educational enterprises on a trial-and-error basis, leading off in all directions. The task seems so tremendous and our comprehension so inadequate that we rather leave it for the experts. In reality expertness may not necessarily abide with good life values. Let us then approach this key problem with humility, faith, and fullness of concern for life, in our search for the ultimate goal.

The problem proposed is the determination and identification of the "ends" or goals of the educational enterprise and the goal-gradients which provide the operational dynamics for goal attainment. Some alternative solutions have been presented for our examination. We are reminded by the publication of the President's Commission on National Goals[1] that the goal of the United States was set forth in the Declaration of Independence. This goal statement focused upon the rights of the individual, supported and insured his development and sought to enlarge his opportunity. The Cardinal Principles of Secondary Education appeared in 1918. Since 1938 the Educational Policies Commission has published statements of position on the purpose of education in American democracy. The Commission's early efforts resulted in re-classification of the Cardinal Principles into four broad principles. The position published in 1961[2] declares the development of the rational powers of man as the central purpose of American education. This position undoubtedly represents a consensus of educational leaders, but the position should be examined for adequacy by each professional teacher, he should believe in it if he accepts it. Goal gradients or intermediate goals are not well defined, but one may assume that the subjects of the school's curriculum serve this function at a level of efficiency which may or may not be effective.

As technology advances new tools of control are evolved to aid man's thinking and action. A new "tool" of great potential for educational thought is the abstract "Systems model". "System" may be defined as the total combination of elements necessary to

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[1] President's Commission on National Goals, Goals for Americans, New York: Prentice-Hall, Inc., 1961.

[2] Educational Policies Commission, The Central Purpose of American Education, NEA: Washington, D.C., 1961.

perform an operational function or as a total "set" of interacting elements. The "Systems model" is a simplified abstract network, or arrow diagram, or flow chart revealing explicit descriptions of all action in sequence and relationship from beginning to completion of the operation or goal. Network modeling is a very creative problem-solving-type activity which demands accuracy of configuration and meaningful relationships of elements. It forces thinking, demands thoroughness and is an effective means of communication. The complicated structure of an atom may be communicated with understanding when its elements are abstracted and shown as a physical network model. Application of this process may be applied effectively in many areas of endeavor and has become recognized as a management tool under a variety of labels. The original label appeared as PERT[1] and was derived from Program Evaluation Review Technique. PERT was developed as a control tool for the complicated contract for construction of the Nautilus Submarine. It proved so successful that it has spread in practice to private enterprise. Many government contracts demand the use of PERT and the supplemental CPM (Critical Path Method). CPM combines with PERT to expose critical paths or "bottle necks" in production plans.

The network modeling process should begin with a flow-line leading from a point-of-departure to a specific terminal result or goal. The theoretical space between these two limits may be considered as containing goal gradients or critical events which separate the point of departure from the terminal results. The problem is thus formulated such that the search for the goal gradients and critical events may be made. The goal gradients or critical events are functions of the terminal results. The process for educational use may be described as Systems Network Analysis Process and identified by the derived term "SNAP". The models may be called SNAP MAPS.

What is the system of education which operates in our society in its "global vision" form as revealed by the abstract systems model? A proposed model is presented in Figure 1. It may be considered here for adequacy.

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[1] Stires, David M., and Murphy, Maurice M., Modern Management Methods - PERT-CPM, Boston: Farnsworth Press, 1962, 294 pp.

NAP MAP OF THE EDUCATIONAL SYSTEM
IN OUR SOCIETY (FIRST LEVEL)

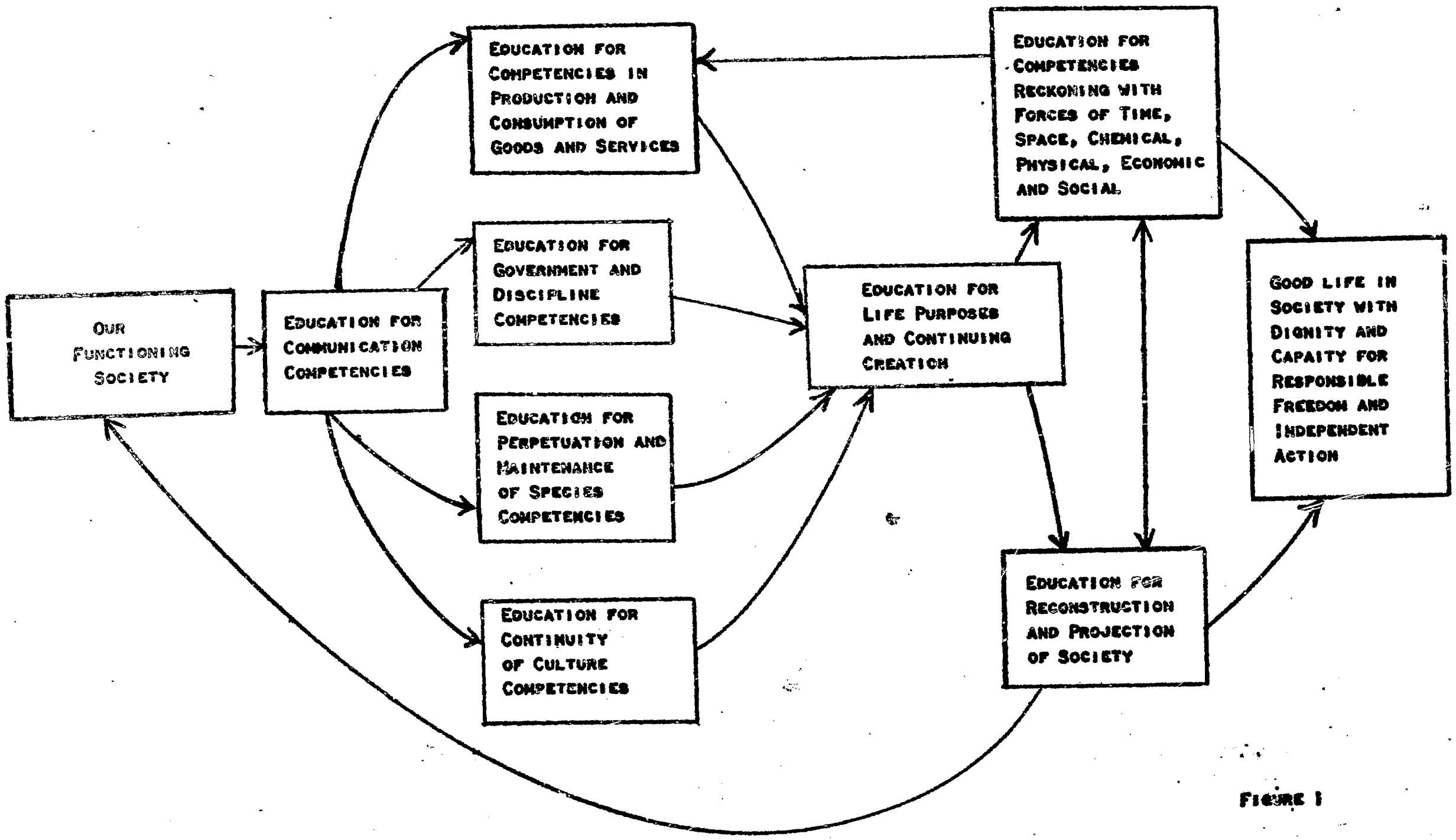

FIGURE I

The Snap Map or model presents a challenge for verification of the goal gradients and for their order and position in the model. A refinement of the model may be a continuous process as the challenge is accepted. Is the "end" or goal of education to move the individual into "good life in society with dignity and capacity for responsible freedom and independent action"? This goal statement encompasses the "development of rational powers" as set forth by the Educational Policies Commission but it is open for further examination.

The place and purpose or mission of educational curriculum areas become evident from position and relationship in the model. The positions and relationships are not final but proposed changes force critical thinking and thus achieve the purpose of model development.

Education for developing competencies in communications is designed into the model as a key goal gradient toward the pursuit of the "good life". Once communication competencies are developed the individual may begin parallel development of other goal gradients. Progress is not in lock-step fashion but continuous across the network. Life purpose and creative living are viewed as dependent upon development of competencies for continuity of the culture, for perpetuation and maintenance of the species, for discipline and government among individuals, and for production and consumption of goods and services demanded by individual citizens. Once life purposes are established, the concern for betterment and improvement of life and living is stimulated in the form of reckoning with the forces acting upon us. This usually takes the form of scientific search, research and development and leads to the goal gradient of reconstructing and improving the whole society and its processes. There is a system feedback function at this point.

The individual's competencies in each of the goal gradients are important to achievement of the "good life" even though the level of competency may vary greatly with individuals.

Another important consideration as the model is examined is the need for a balanced distribution of individuals who develop vocational and professional competencies in the area of each goal-gradient. Such specialists are necessary for the system operation.

Assuming that the "SNAP MAP of the Educational System in our Society" is adequate and acceptable, each of the goal gradients may be subjected to the systems modeling technique on a second level or sub-level analysis and the process of moving to further sub-levels may be continued to trace the curricular area responsibility from the root foundation to the content framework. This strategy has many advantages over alternative types of analysis. In a society which has become so complex and change so accelerated, the volume of knowledge and techniques has become so great that the educator must have good criteria and means for selecting high priority content. Fortunately, the systems model has inherent in it a dynamic dimension which identifies the high priority content in its proper setting and relationship. Furthermore, it is a guide and determiner of equipment and laboratory design. Team teaching becomes a necessity and individual differences are prized rather than despised. In relation to instructional content, the network model is the skeleton which holds the content "body" in proper place and relationship.

The traditional practice of content inventorying, classifying and developing the complete taxonomy of the discipline may be challenged as being too cumbersome and possibly out of tune with the times. The network model as accepted identifies and delimits the content as the "body" which fits the "skeleton". The model may be changed through direct study or indirectly through study and methods improvements of the elements or goal gradients.

The identification of "systems" and "sub-systems" is an analysis technique and may be considered as an alternative to other bases for analysis. A comparison of various alternative bases for analysis may be useful in evaluating the systems approach and the graphic illustration presented in Figure 2 is suggested for the comparison:

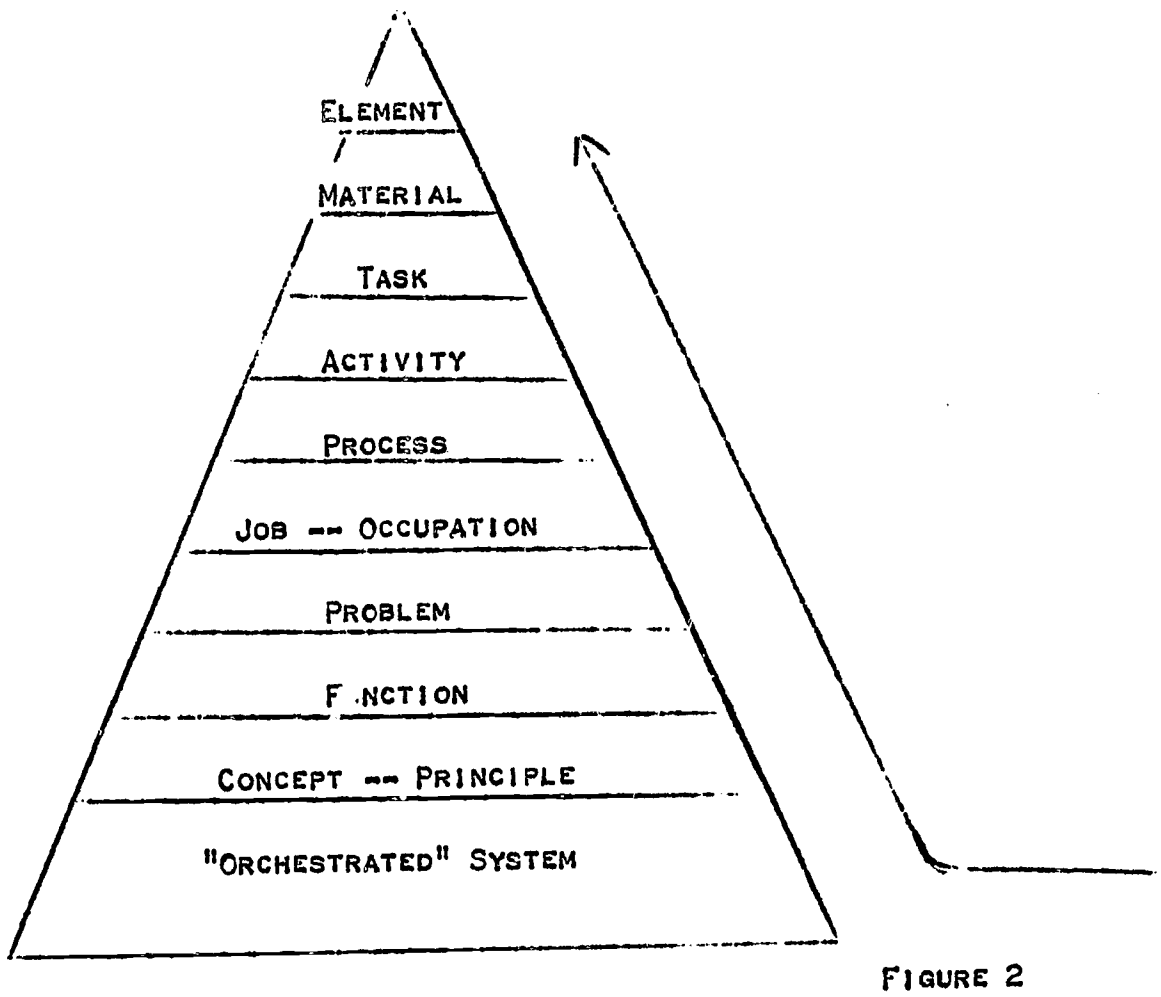

FIGURE 2

The "system" is conceived as a classification unit for analysis which encompasses or includes all other classification units shown on the triangle. The broad base unit for classification has considerable advantage for dealing with the extensive and massive industrial complex. The "system" unit has great potential as an instrument for aiding learning and as criteria for priority selection of industrial experience samples which fit together in meaningful context.

Second Level Systems Models

Moving toward the pursuit and identification of content in meaningful context, the goal gradients from the basic model of Figure 1 may be subjected to the modeling process at the secondary level. Before turning attention to the goal gradient directly associated with industrial education two samples associated with the traditional academic areas were developed for consideration and study. Consider first the systems model for the "communication competencies goal gradient" as designed and presented in Figure 3:

SNAP MAP OF THE COMMUNICATION GOAL GRADIENT
(SECOND LEVEL)

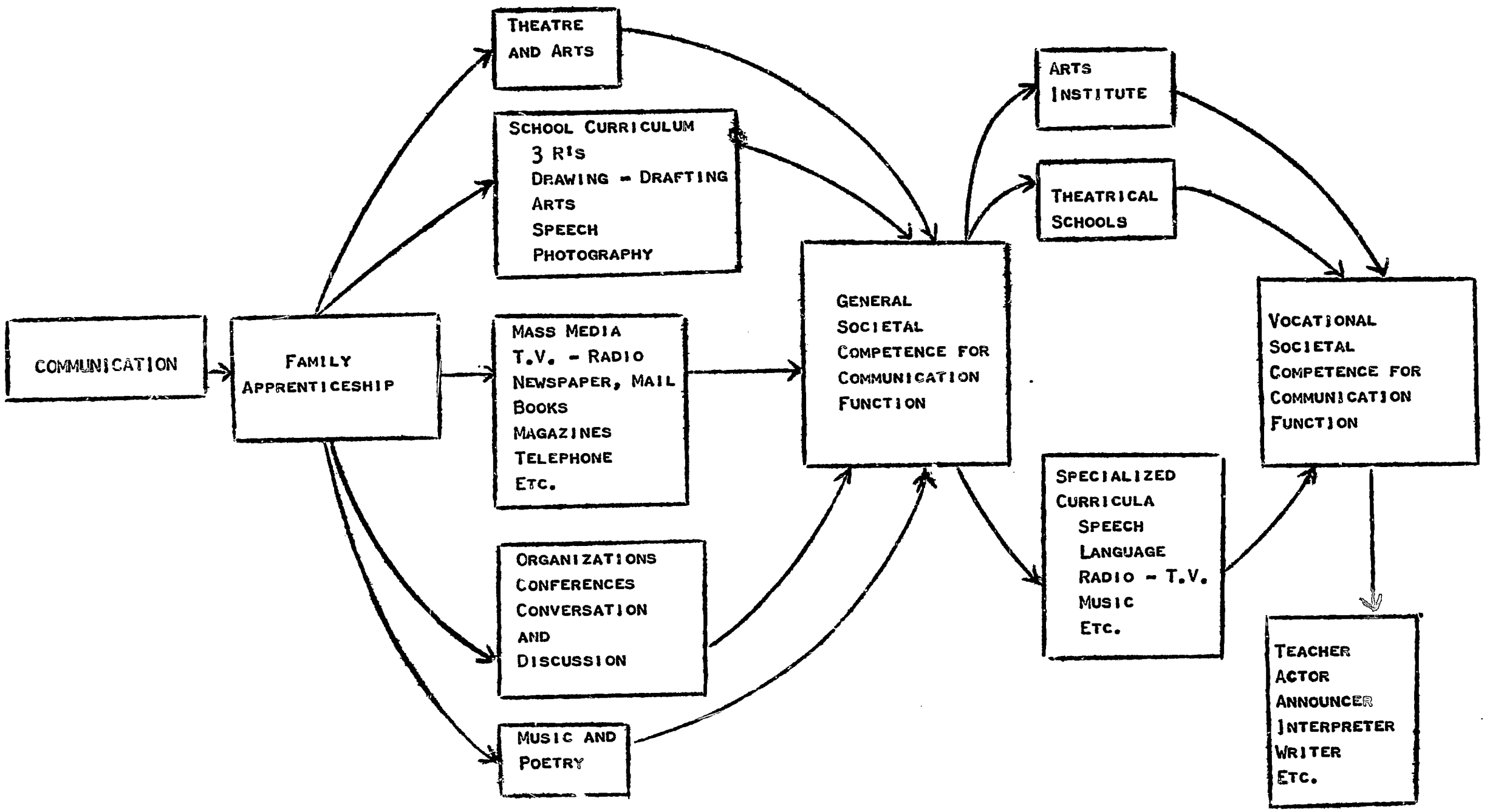

FIGURE 3

The design of the communication model places family apprenticeship type of instruction in the key position. Early and basic communication skills are learned under parental instruction proceeding informally but persistently to gain desired responses from the young. Members of the family of the newly born infant begin the process of instruction by gesture and sound and later by symbol until the school program takes over to supplement and develop the competencies. A gradual expansion of competencies with maturation and education extend the communication competencies beyond crying, smiling, laughing, talking, and writing to reading from the mass media, to the arts, and to higher levels of sophistication in communication until the individual is competent to deal effectively with the varied means of communication employed by his society.

The varied nature of individuals leads some to discover special talents and interests during the process of developing their general competencies. Generally our society has provided these individual opportunities for development of specialized competencies through art institutes, theatrical schools and other specialized schools having curricula for high level vocational or professional competencies in such areas as speech, language, arts, and journalism. These individuals develop vocational competencies and qualifications permitting them to earn their living and make their contribution to their society as teachers, actors, announcers, interpretors, speakers, analysts, or writers.

The models at this secondary level reveal two types of goals, the general competency goal and the vocational competency goal. It may also be noted that the vocational competency goal generates from and builds onto the general competency goal. There is no alternate or direct route to the vocational competency goal. The general design of this model sets the pattern for all other goal gradients of the basic model and the intermodel comparisons may add to critical analysis of the total system.

The "Discipline-Government" goal gradient from the basic model was selected as the second sample for examination. The designed model is presented in Figure 4.

SNAP MAP OF DISCIPLINE-GOVERNMENT GOAL-GRADIENT
(SECOND LEVEL)

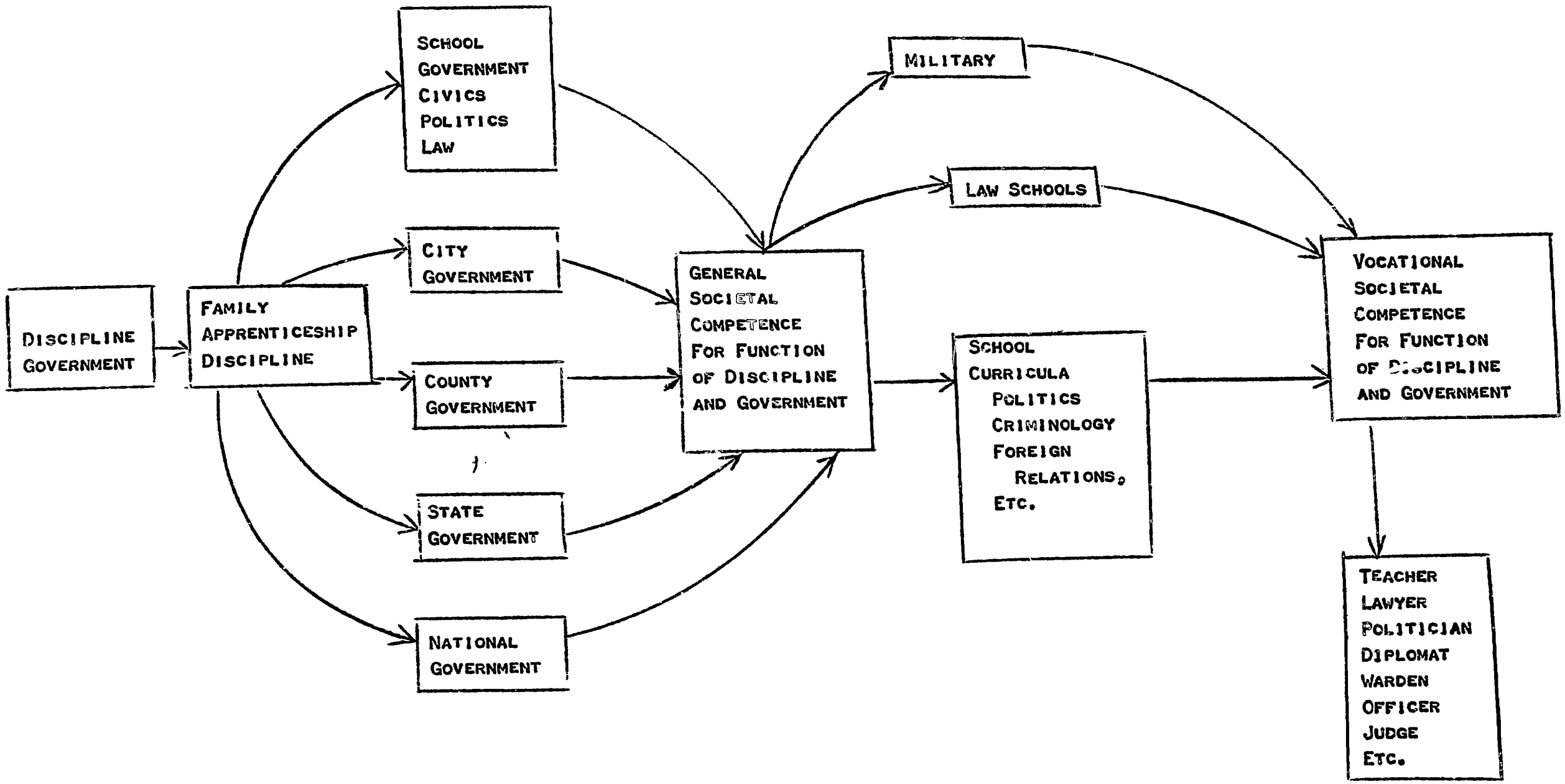

FIGURE 4

The family apprenticeship type of instruction takes the key position again for the responsibility of developing competencies in the discipline-government area. Parental instruction and pressures start early upon the newly born in the interest of conformity to adult discipline standards and customs. Parents are anxious for the young to eat at established meal times, sleep when they sleep, and dress in conformity to custom. This type of discipline is superimposed upon the young until the institutions of society such as school and church take over to further indoctrinate, train, and educate the individual in acceptable forms of discipline and formal governing practices. The individual's circle of contact widens from the home to come under influence and instruction from government units of city, county, state and nation. The experiences provided by the school and the government units serve as goal gradients toward development of the general competencies needed to live the disciplined life expected by society. These developmental experiences also provide opportunity for the individual to discover special interests and talents which stimulate development of vocational competencies through specialized schools and training programs. Specialized vocational talents associated with this model are needed by our society to perform such vocations as teachers, lawyers, politicians, diplomats, judges, wardens, and other public officers.

Industrial education is concerned primarily with the basic goal gradient "Production and Consumption of Goods and Services" and its relation to achievement of the "Good Life" but it shares this responsibility with other subject areas such as agriculture, business, and home economics. The abstract model of the "Production and Consumption" goal gradient is presented in Figure 5:

SNAP MAP OF PRODUCTION AND CONSUMPTION OF GOODS AND SERVICES
(SECOND LEVEL)

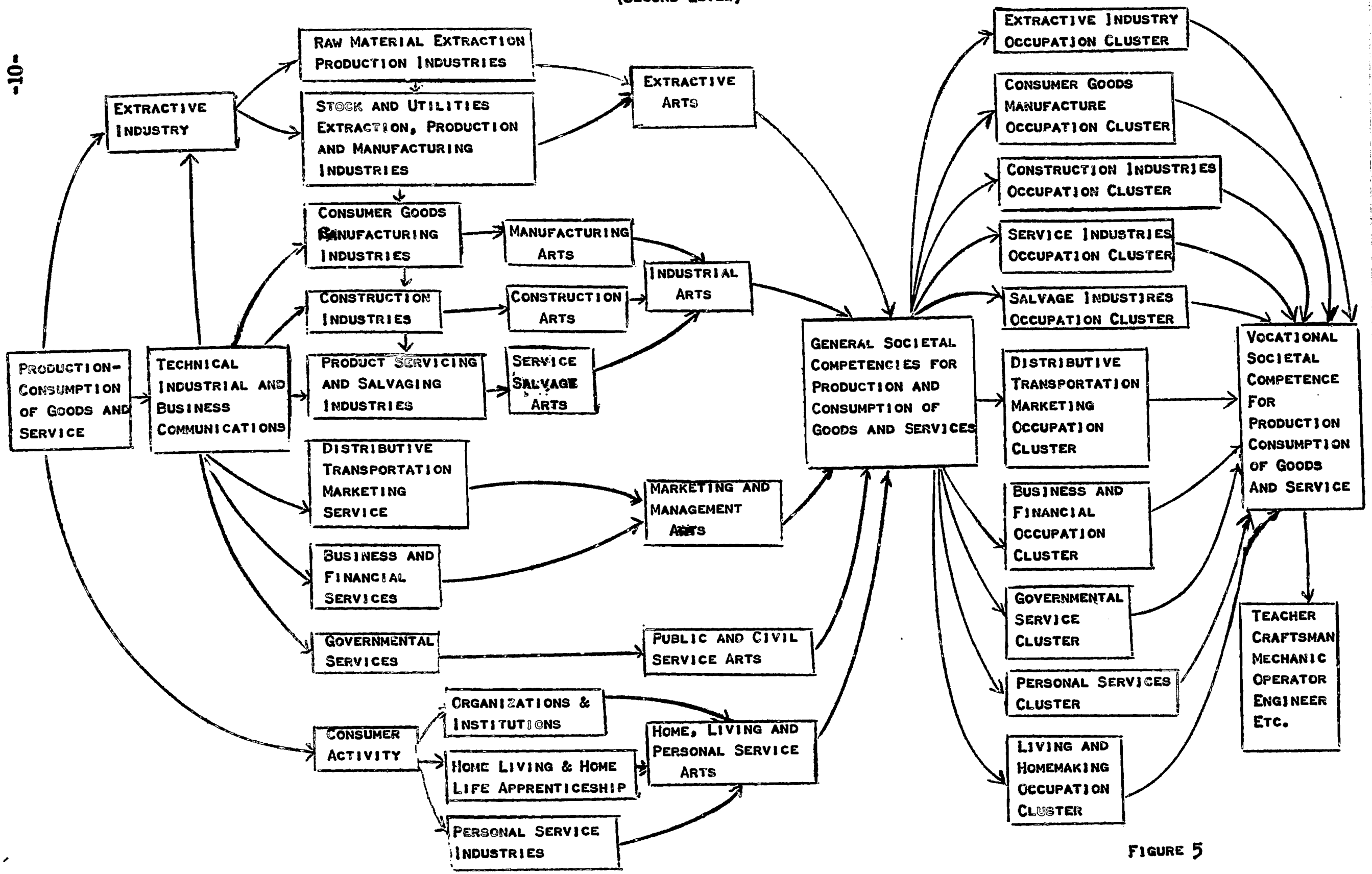

FIGURE 5

It is important to notice that the family-type apprenticeship has practically disappeared from its key role of preparing individuals with competencies in this area. Traces of this apprenticeship remain in the areas of homemaking and agriculture. The apprenticeship-type preparation disappeared as we changed from an agrarian society to an industrialized urban society. This change places greater responsibility upon the school programs to communicate the information and experience that individuals need to deal and think effectively with this goal gradient.

To serve the student or individual member of society, the school program should include opportunities to gain knowledge and experience from the variety of productive activities employed by society to produce the needed goods and services.

The second level model reveals those areas of general competencies which all members of our society should develop. In respect to the general competencies and to the vocational competencies this model is identical to the previous two examples but some important differences do appear.

Apprenticeship experiences disappeared in the process of change from an agrarian society to an urban industrialized society. As a result of this change much greater responsibility rests with the school and its educational programs designed to communicate and transmit this aspect of the culture.

The search for goal gradients in the area of the model between the general societal competencies goal and the production and consumption of goods and services joint-of-departure revealed many types of industrial, business, governmental, and technical communication activities between the processes of extracting materials and consumption of them. Technical industrial and business communications as a goal-gradient performs a key role in all industrial and business activities. The extractive industry goal-gradient is identified in a key position leading to further goal-gradients which follow a product from its raw material status to its full consumption. Raw materials are obtained by extractive processes to get valued materials. Generally, the raw materials are converted to an intermediate form of stock materials which add value to the original raw material. The two goal-gradients including raw material extraction and production; and stock and utility extraction, production and manufacture were conceived as leading to an educational need identified as Extractive Arts Education. This broad area of responsibility is quite neglected in our present educational programs and it seems that our present agricultural programs could be expanded to encompass the total responsibility. Agriculture is identified here as one of the extractive arts along with such others as forestry, mining, quarrying, drilling, and others.

The path of motion leading from the key extractive-industry goal-gradient may also be analyzed in terms of economic value and nature of action as illustrated in Figure 6.

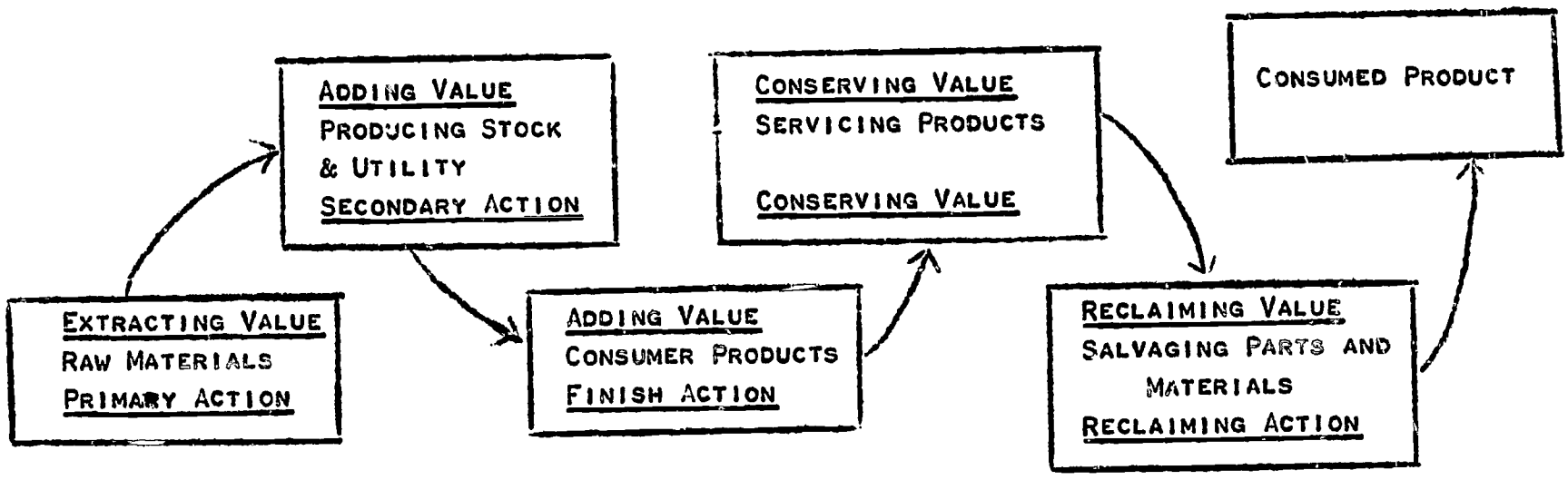

FIGURE 6

This simplified model reveals areas of responsibility for education and may be used as a cross-check on the model presented in Figure 4. The flow of action represented by this model represents the general pattern but our analysis and thinking must take into account many variations from the general pattern dependent upon the raw material and the circumstances. Some raw materials may go directly to the consumer but it is conceived that the general pattern holds major educational significances. Industrial and technical developments in our society have contributed to the differential action identified. Basic and heavy industries have become quite easily identified as stock producing industries. An intermediate type of industry can also be identified quite easily as the consumer products producing industry. Both of these industries add value to the original raw material.

Product servicing industries have developed as an economic activity which conserves the value in the consumer product and finally at full consumption of the consumer product the salvage industry takes over to reclaim remaining value from parts and materials.

The four goal-gradients including consumer goods manufacture, construction industries, product servicing industries, and product salvaging industries with their respective aspects of technical industrial communication were conceived as constituting an educational need and they were embodied in the goal-gradient Industrial Arts Education (Figure 5). Thus the Industrial Arts Education is delimited to a unique responsibility within the total network of our society's educational responsibility.

The Industrial arts educational responsibility was the focal point of this portion of the investigation but other aspects of the model in Figure 5 should be examined to identify other unique areas of responsibility which relate to the Product and Consumption goal-grad gradient.

The service producing industries, businesses, and government were identified separately and distinguish from the product servicing industries. Product servicing was included as a unique responsibility within the industrial arts educational program but other service producing industries and businesses were excluded. The model in Figure 5 is quite helpful for study of this responsibility. This delimitation was carefully considered in order to isolate high priority responsibilities in relation to the limited time given to industrial arts education.

Two major goal-gradients including Distributive, Transportation and Marketing Services; and Business and Financial Services were designed to lead toward the educational goal-gradient identified as Marketing and Management Arts.

The Governmental Services as a goal-gradient is probably a neglected area in the educational program. Little attention is given to the public and civil services which include police, firemen, conservation, warden, and other similar activities.

The family unit is probably our primary consumer unit but organized groups including cooperative, retirement homes, and other corporations are becoming important units of consumer activity. The Consumer Activity goal-gradient was designed with three sub-goal-gradients including Organization and Institutions; Home Living and Home Life Apprenticeship, and Personal Services Industries as basic to the educational goal-gradient identified as Home, Living, and Personal Services Arts.

The model of Figure 5 illustrates a rather comprehensive array of experiences and understanding important for the individual as competencies for dealing with aspects of production and consumption of goods and service. For those individuals who discover personal interests and talents in this area, provision for development of vocational competencies are shown in a re-designed approach to occupational preparation through ten major occupational cluster goal-gradients.

Third Level Systems Models

Each of the goal-gradients of Figure 1 may be analyzed by the abstract modeling technique to reveal the unique place and purpose of all subject or content areas. However, instead of proceeding further with these areas, attention will be focused upon the Production and Consumption of Goods and Services goal-gradient by moving to the third level of model development with the delimited area of Industrial Arts. This delimited area of five goal-gradients includes Technical Industrial Communication, Consumer Goods Manufacturing, Construction Industries , Product Servicing Industries, and Product Salvage Industries. The third level model for Technical Industrial Communication is presented in Figure 7.

SNAP MAP OF TECHNICAL COMMUNICATION ARTS
(THIRD LEVEL)

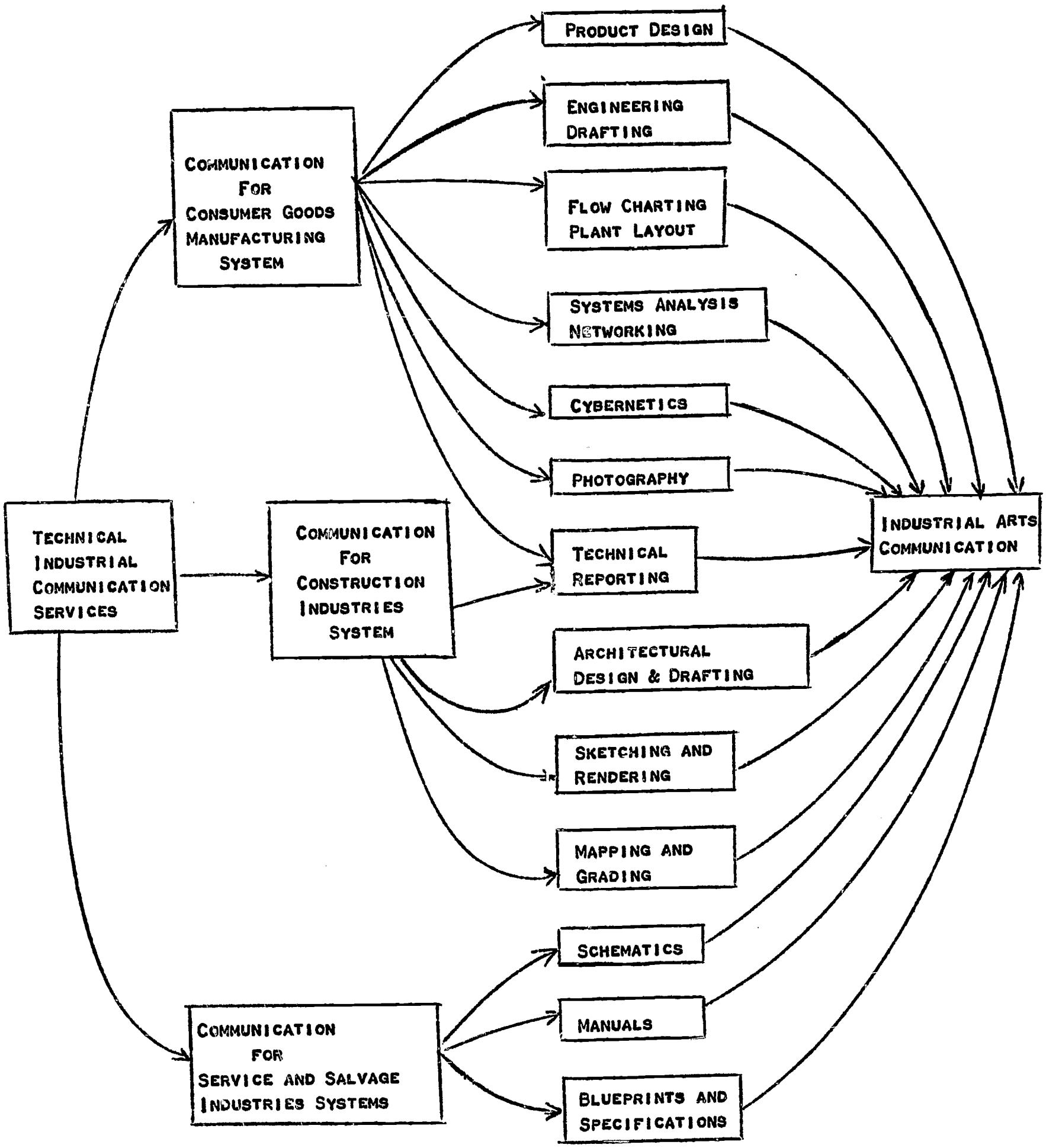

FIGURE 7.

Technical Industrial Communications serves all goal-gradients of the second level model in Figure 5 but Industrial Arts Communications delimits the scope to three areas including communication services for the manufacture of consumer goods, for the construction industries and for servicing and salvaging of consumer products. This model delimits the responsibility to thirteen separate goal-gradients which lead to adequate understanding and competency with Industrial Arts Communication.

The Consumer Goods Manufacturing goal-gradient was designed as a third level model and is shown in Figure 8.

SNAP MAP OF MANUFACTURING ARTS
(THIRD LEVEL)

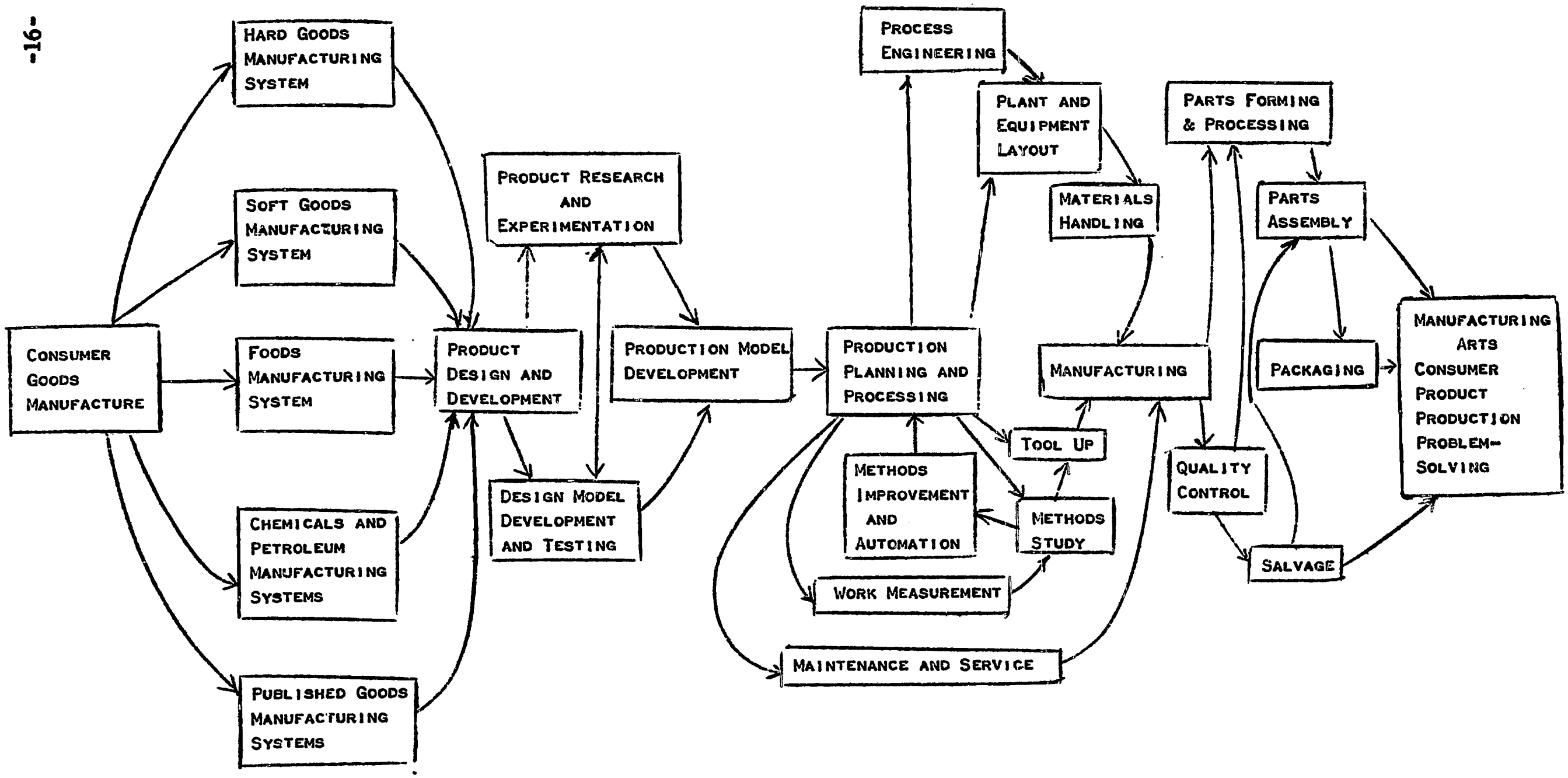

FIGURE 8

This model design identifies five basic systems of manufacture as the representative sample manufacturing experiences for adequate understanding and competency with consumer goods manufacture. The five systems lead to the common goal-gradient identified as Product Development and Design and the goal-gradients which follow are also generally common to all five systems. Instruction content and fundamentals underlie each of the goal-gradients. Experience and understanding in these areas are important for all members of society if full potential of mental capacities and individual fulfillment are to be directed toward greater progress and greater efficiency in our productive efforts. The model at this third level also serves as guide for the manufacturing arts laboratory development. The laboratory must be equipped to provide the functions identified as goal-gradients in the model.

The Construction Industry goal-gradient as a third level model design is presented in Figure 9.

SNAP MAP OF CONSTRUCTION ARTS
(THIRD LEVEL)

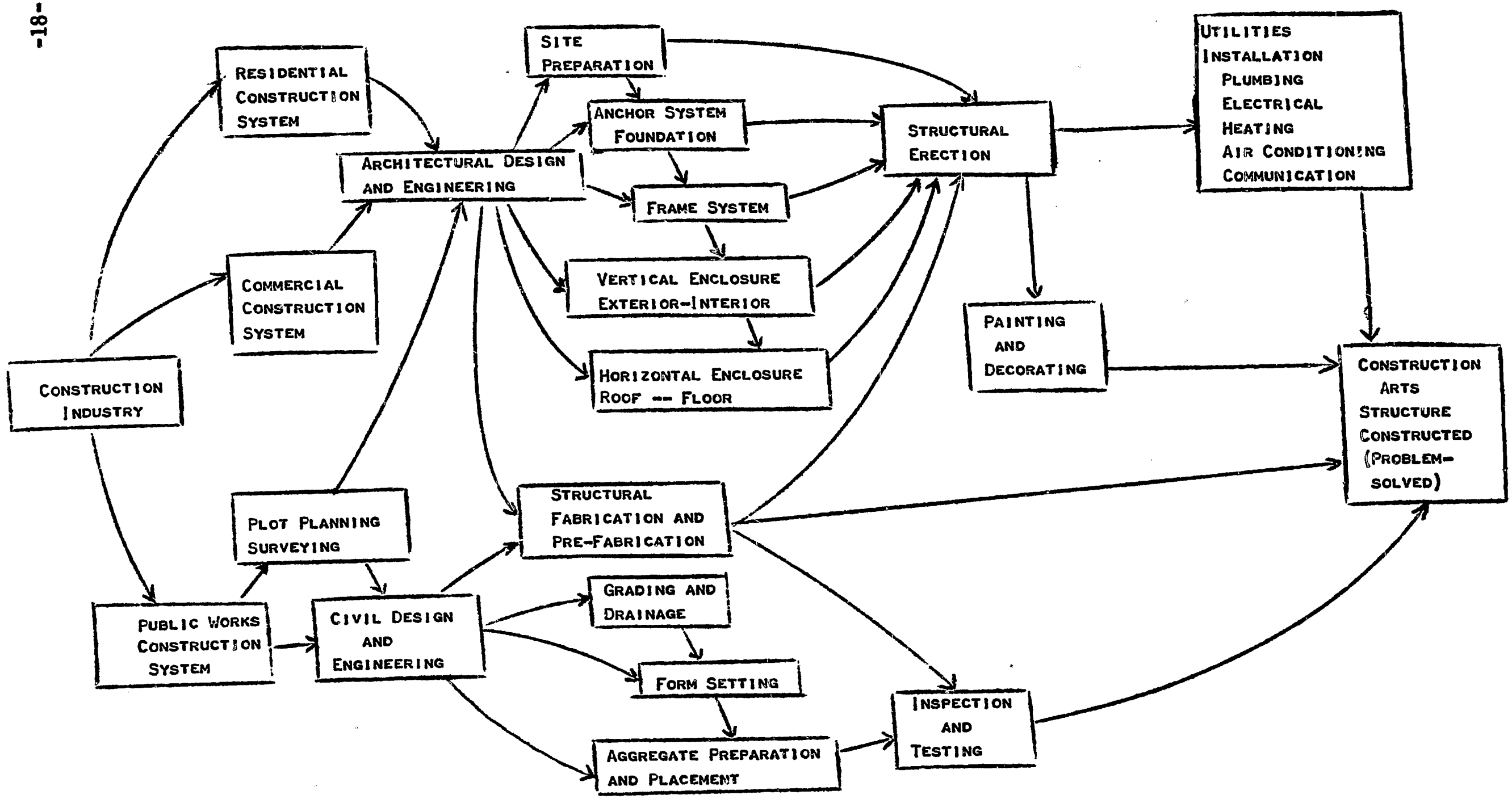

FIGURE 9

The construction industry may be considered as progressing through three major goal-gradients including construction for residential use, for commercial use, and for public works. The flow-out of additional goal-gradients reveal areas for further development of instructional content which hold importance for comprehensive knowledge and understanding of the construction industry. The goal-gradients identified in Figure 9 are quite different from those of the manufacturing model and provide the framework for the unique contribution of the construction arts to the total framework of the industrial arts.

The third level model for the Product Service-Salvage Arts goal-gradient is presented by Figure 10.

SNAP MAP OF PRODUCT SERVICING AND SALVAGE
(THIRD LEVEL)

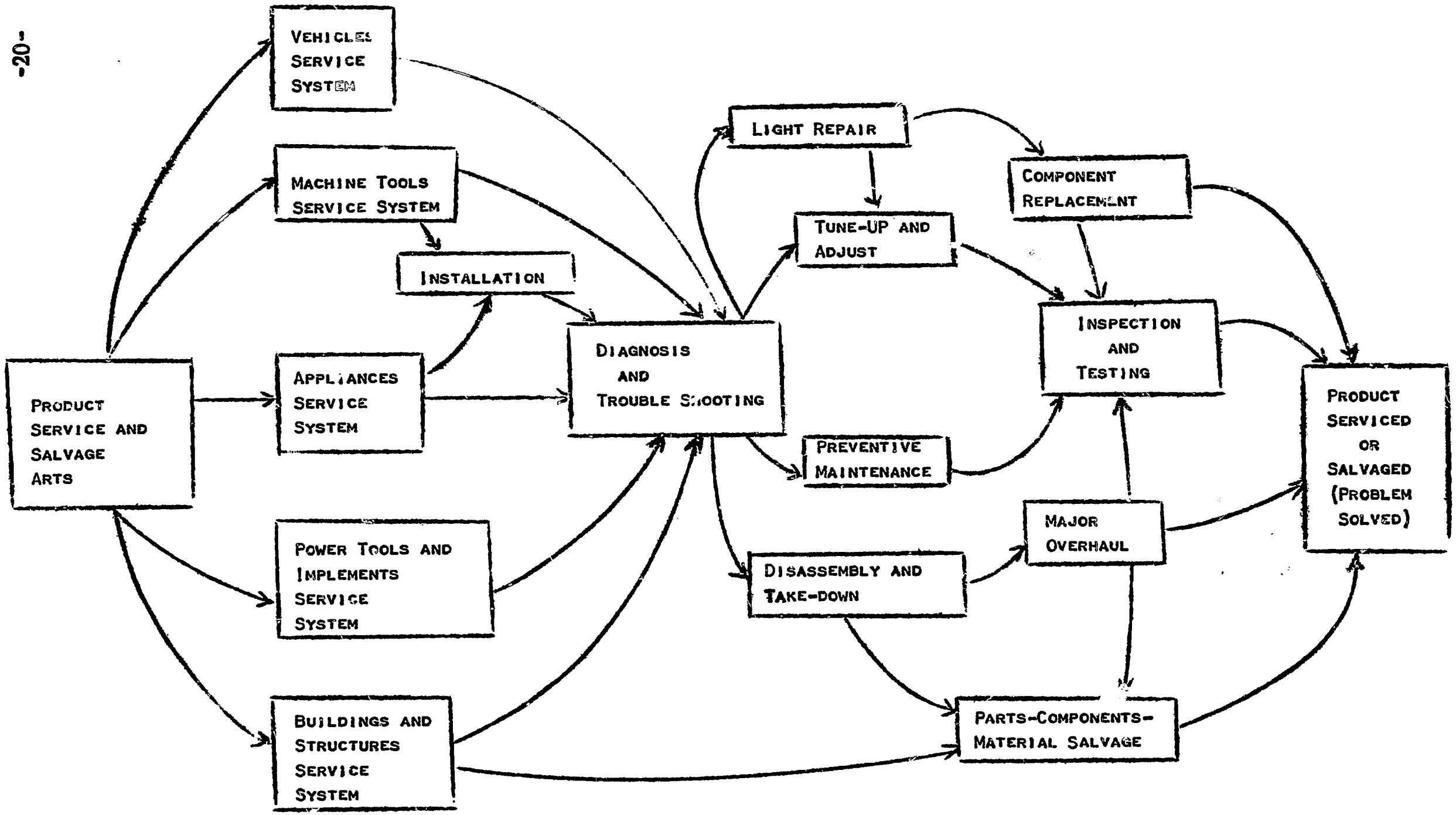

FIGURE 10

Product Servicing and Salvage was modeled with flow of experiences in five major areas or goal-gradients and including vehicles, machine tools, appliances, power tools and implements, and buildings and structures. Diagnosis and trouble shooting was seen as a common goal-gradient for all and with installation having importance for machine tools and appliances. Diagnosis and trouble-shooting holds a key-relation to the succeeding goal-gradients which include light repair, tune-up, preventive maintenance, and disassembly and take-down. Inspection and Testing also holds a key position in the final stages of product servicing and may follow the action goal-gradients of Component replacement, Tune-up and Adjustment, Preventative Maintenance, and Major Overhaul. Parts, components, and material salvage generally follow disassembly and take-down or major overhaul as shown by the model. The model shows general flow of action and it should be recognized that many variations and deviations may occur.

Fourth Level Systems Models

The four third-level systems models presented in Figures 7 through 10 represent the framework and boundries for industrial education instructional content in meaningful context and give direction for the type of facility or laboratory. The content framework at this level is common to industrial arts, industrial vocational, and industrial technical education. The fourth-level models begin to identify the specific content and to reveal the difference important to industrial arts, industrial vocational, and industrial technical education. A tremendous volume of content may be identified at this level, therefore, the Manufacturing Arts model of Figure 8 was selected as a sample to illustrate development of the fourth-level models.

The Hard Goods products manufacturing sub-system represents one sample from the total consumer goods manufacturing system. Considered as a goal-gradient leading to Product Design and Development, the model was designed and presented in Figure 11.

SNAP MAP OF HARD GOODS MANUFACTURE
(FOURTH LEVEL)

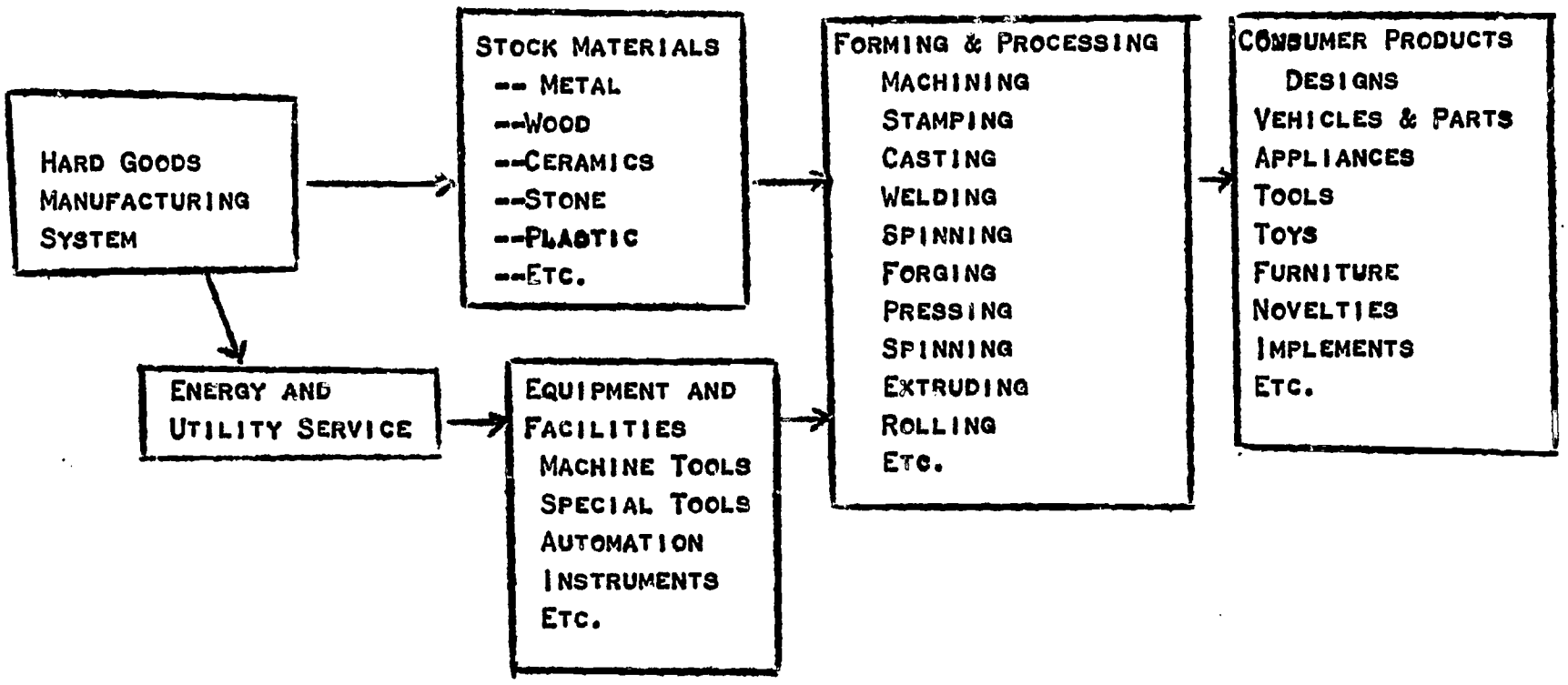

FIGURE 11

The hard goods manufacture to the point of consumer product design involves identification of stock material which combines in parallel relationship with energy and equipment into some form of processing suitable to the material. Resources of these goal-gradients are important for product design. The four additional consumer product manufacturing systems identified in Figure 8 are identical in model design and are therefore presented in succession in Figures 12 through 15:

SNAP MAP OF SOFT GOODS MANUFACTURE
(FOURTH LEVEL)

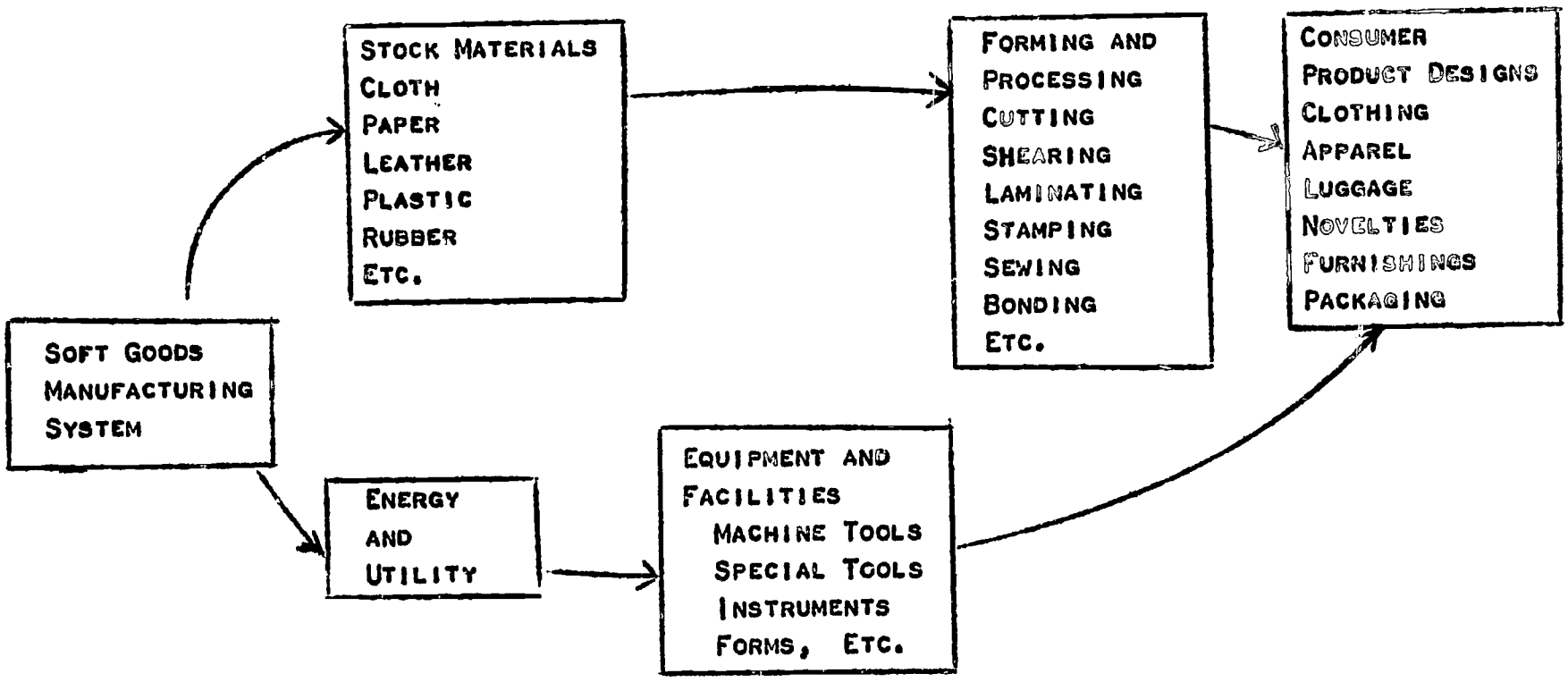

FIGURE 12

SNAP MAP OF FOODS MANUFACTURING
(FOURTH LEVEL)

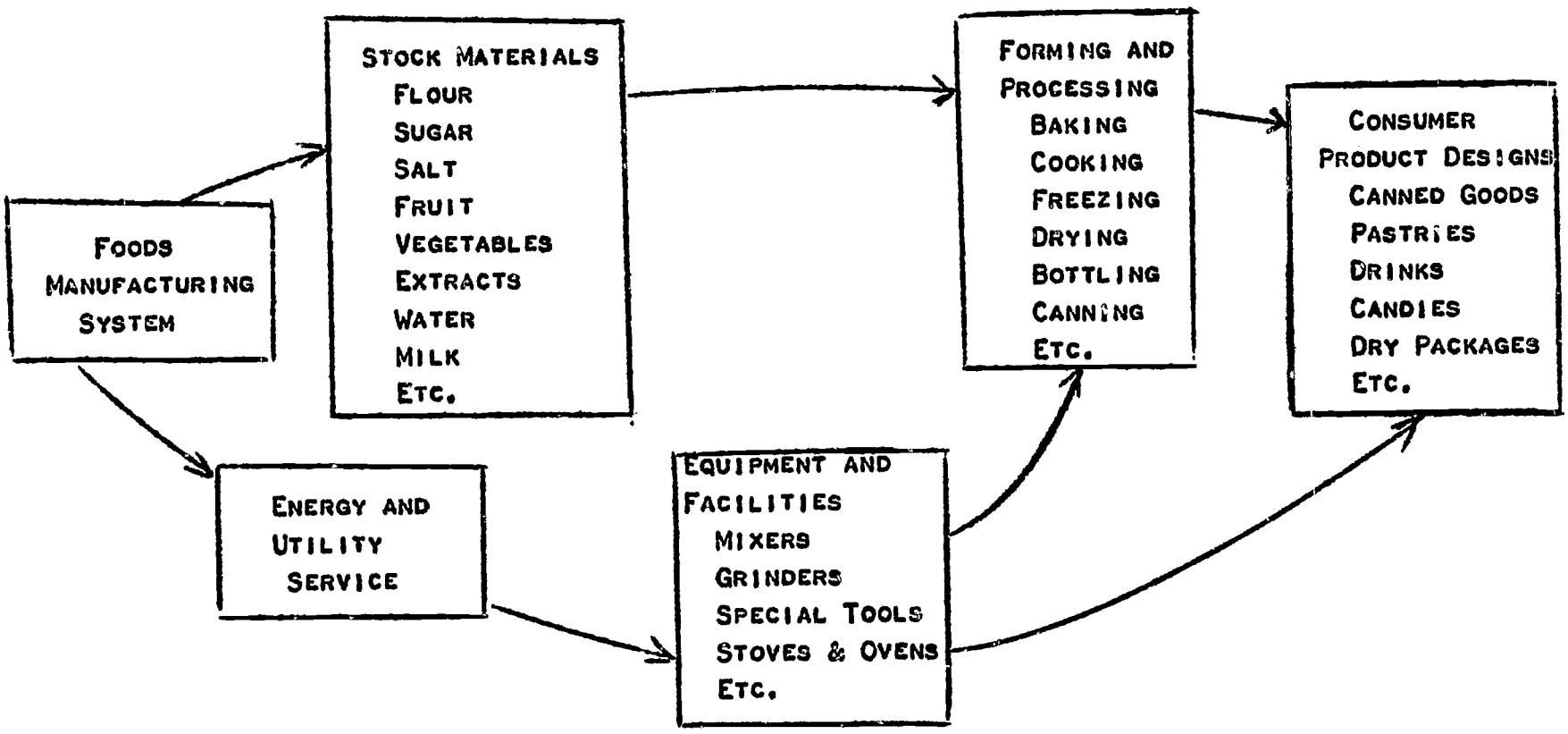

FIGURE 13

SNAP MAP OF CHEMICAL AND PETROLEUM MANUFACTURE
(FOURTH LEVEL)

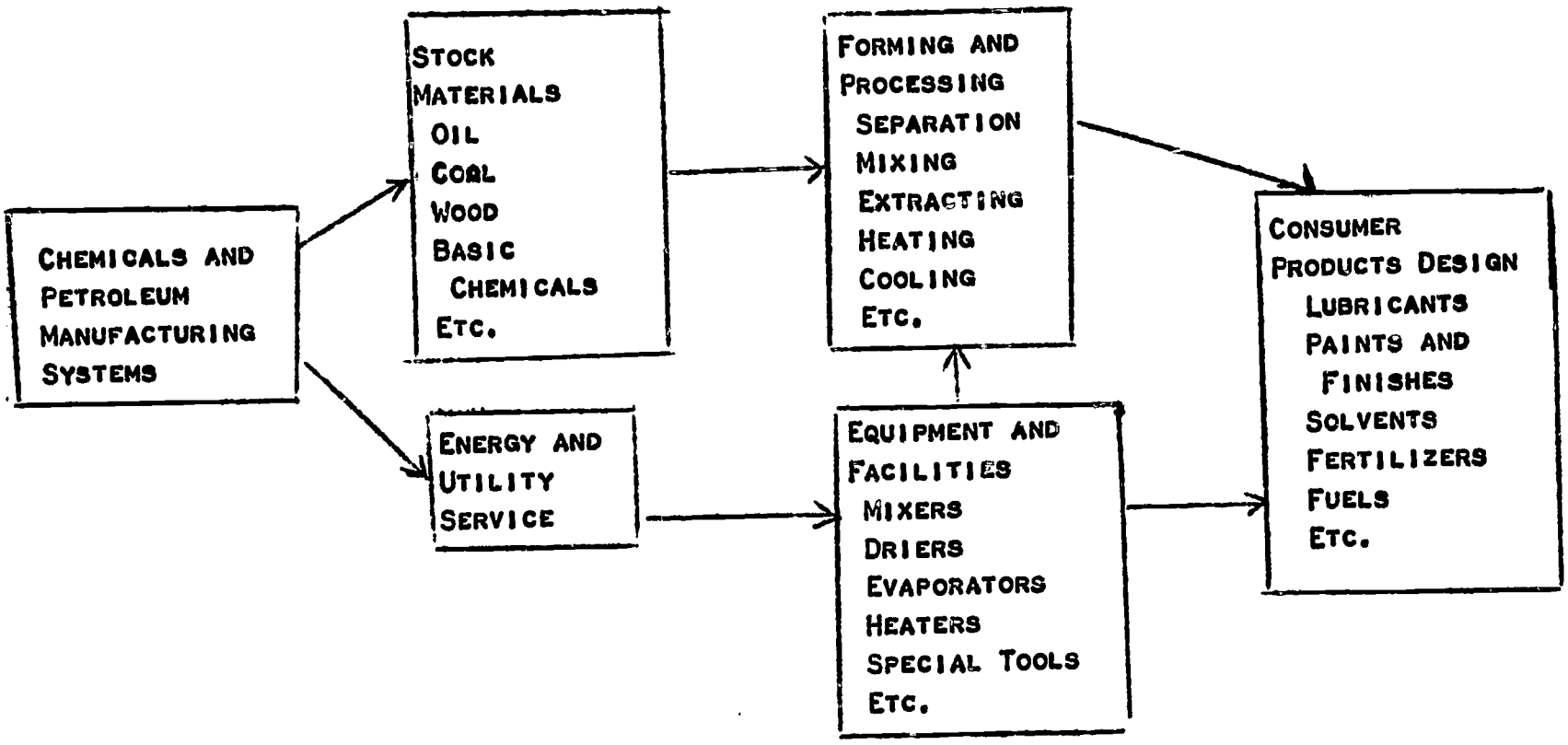

FIGURE 14

SNAP MAP OF PUBLISHED GOODS MANUFACTURE
(FOURTH LEVEL)

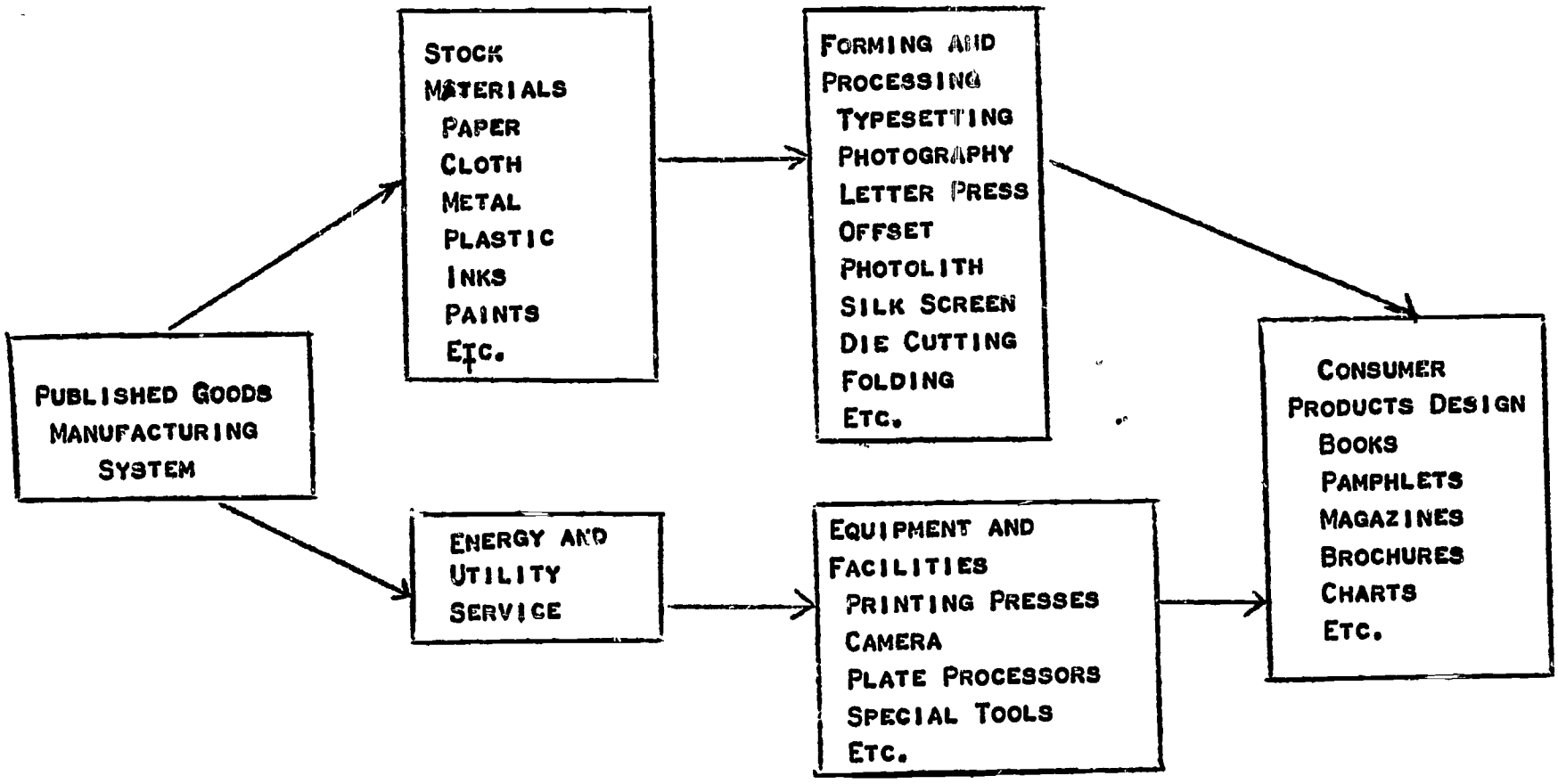

FIGURE 15

The five manufacturing sub-system models are presented and proposed as adequate samples for experience and understanding and general competency in regard to manufacturing processes of producing goods in our society. Goal-gradients of the models are not complete but may be considered as areas for research to develop comprehensive resources. Considerable work contributing to these areas is underway by various groups and individuals.

Product Design and Development is the next goal-gradient for development from Figure 8. The model is presented in Figure 16:

SNAP MAP OF PRODUCT DESIGN AND DEVELOPMENT
(FOURTH LEVEL)

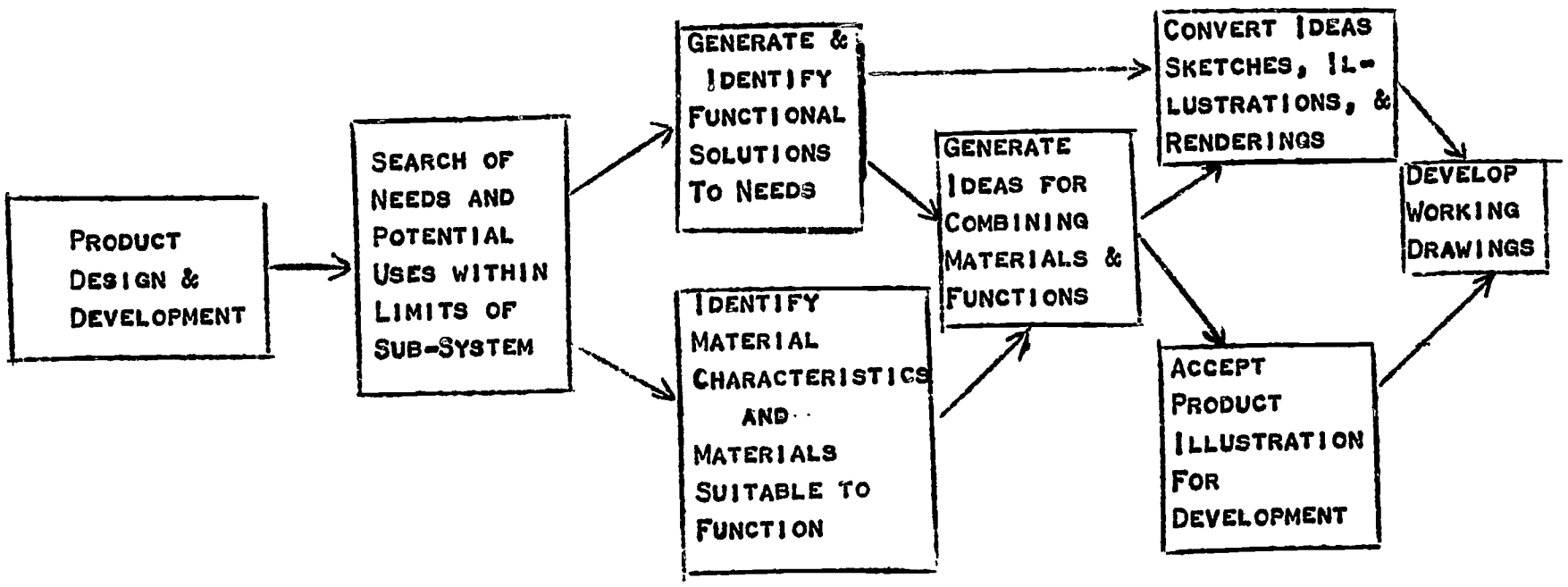

FIGURE 16

The model reveals functions or goal gradients important for the understanding of product design and development. They provide the framework for providing experiences and also for designing the resource laboratory area for gaining specialized knowledge and skills. The model at this level also becomes useful for identifying jobs and occupations and the experiences may be specialized to the extent of vocational or occupational preparation. Some of the jobs and occupations which become evident for Product Design and Development include designers, artists, draftsmen, and scientists.

The Product Research goal-gradient is closely related to Product Design and possibly can either grow out of Product Design or lead to it. The separate treatment in the design model of Figure 8 does allow the detail of content as shown by Figure 17.

SNAP MAP OF PRODUCT RESEARCH AND EXPERIMENTATION
(FOURTH LEVEL)

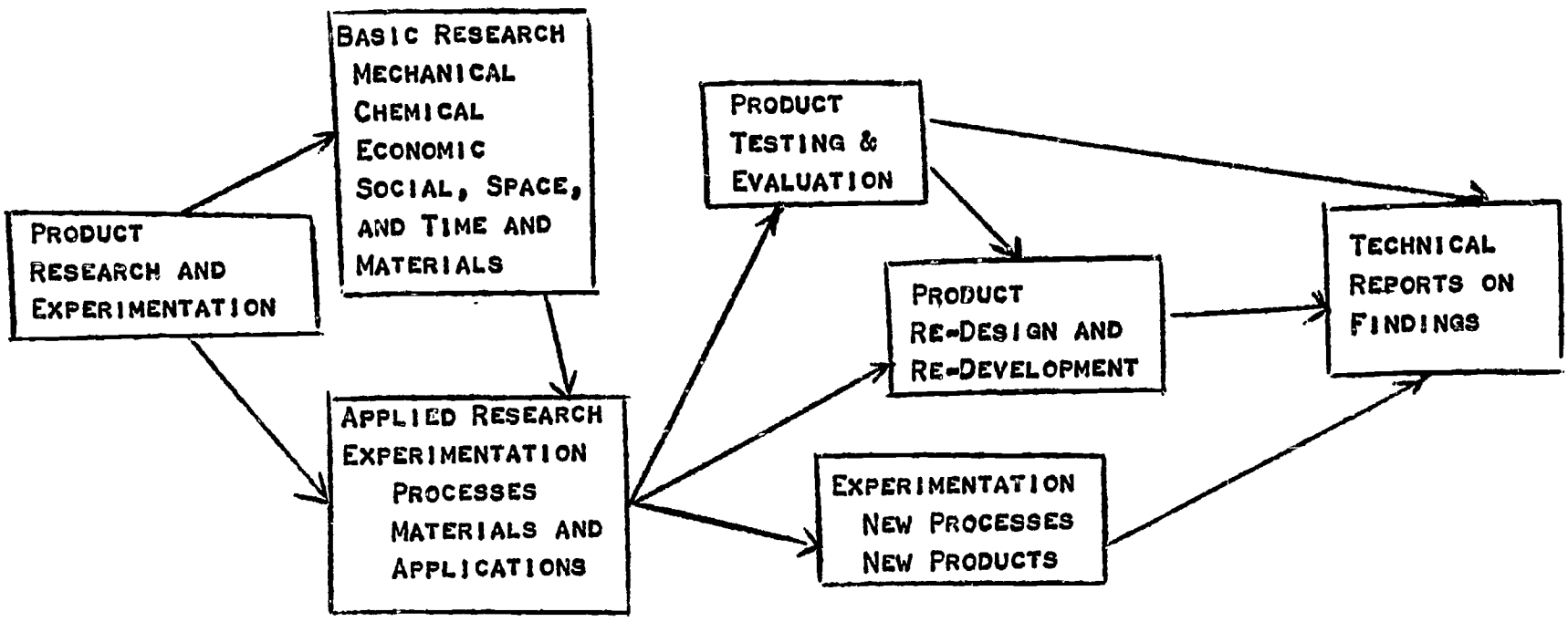

FIGURE 17

Some of the details of experience and knowledge important to the understanding of Product Research and Experimentation are revealed by the model of Figure 17. Basic research as a goal-gradient may not be carried out as such but the findings of basic research done throughout the nation can be drawn upon for use in Applied Research activities. Applied Research is an important goal-gradient and experience area for technical occupations and for general understanding of Product Research and Development. The resulting efforts of Applied Research lead to the identified goal-gradients of Product Testing and Evaluation, to Product Re-design and Re-development, and to Experimentation with potentially new processes and products. Research efforts terminate in Technical Reports on Findings which may lead to decisions for manufacturing.

The Design Model Development goal-gradient is illustrated by Figure 18:

SNAP MAP OF DESIGN MODEL DEVELOPMENT
(FOURTH LEVEL)

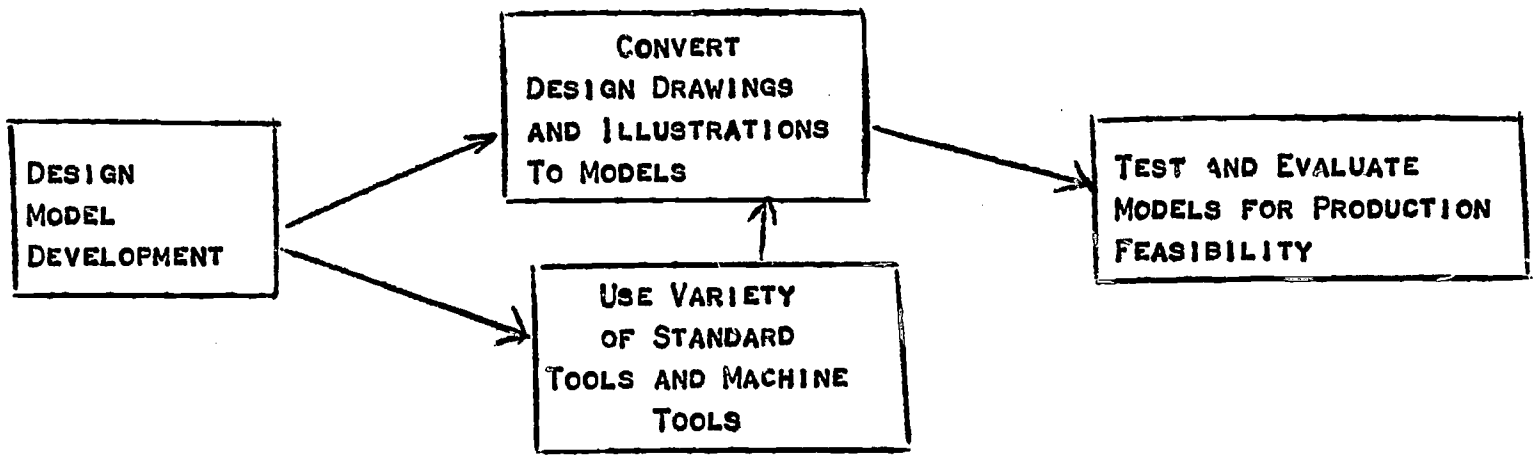

FIGURE 18

This model reveals the need for custom construction work with skill and knowledge of many materials, machines, and tools. Realism of appearance and true size or scaled size and shape are more important than the exact material required by the finished product.

The Production Model Development goal-gradient is presented in Figure 19:

SNAP MAP OF PRODUCTION MODEL DEVELOPMENT
(FOURTH LEVEL)

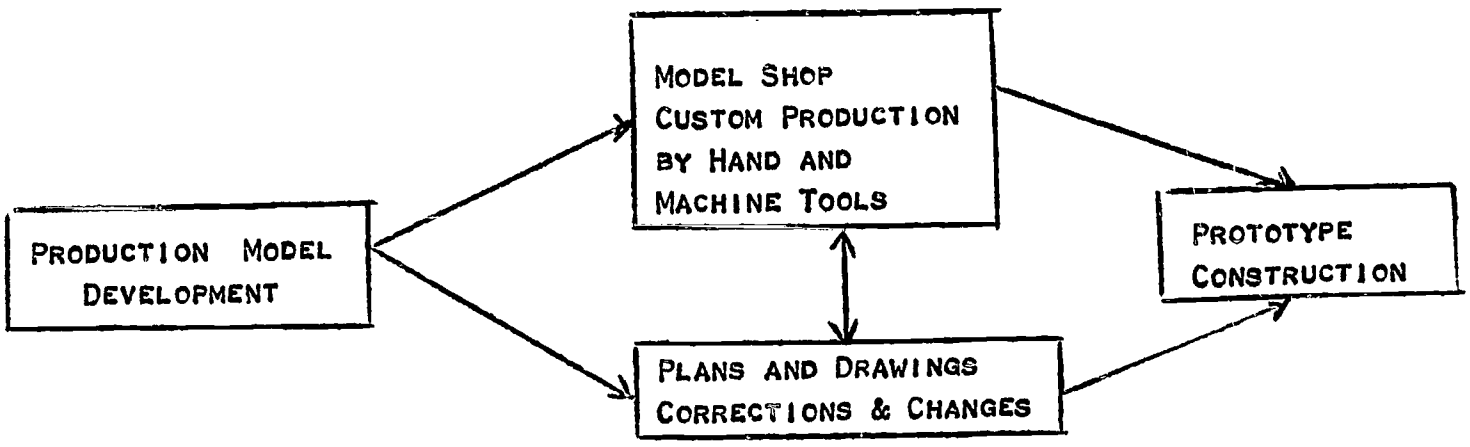

FIGURE 19

The production model development is closely related to design model development and the activities may be carried out in the same facilities. The prototype is more exacting and becomes the basis for tooling-up for production. Final engineering problems and changes are made at this point of development.

The Production Planning and Processing goal-gradient model is shown in Figure 20:

SNAP MAP OF PRODUCTION PLANNING AND PROCESSING
(FOURTH LEVEL)

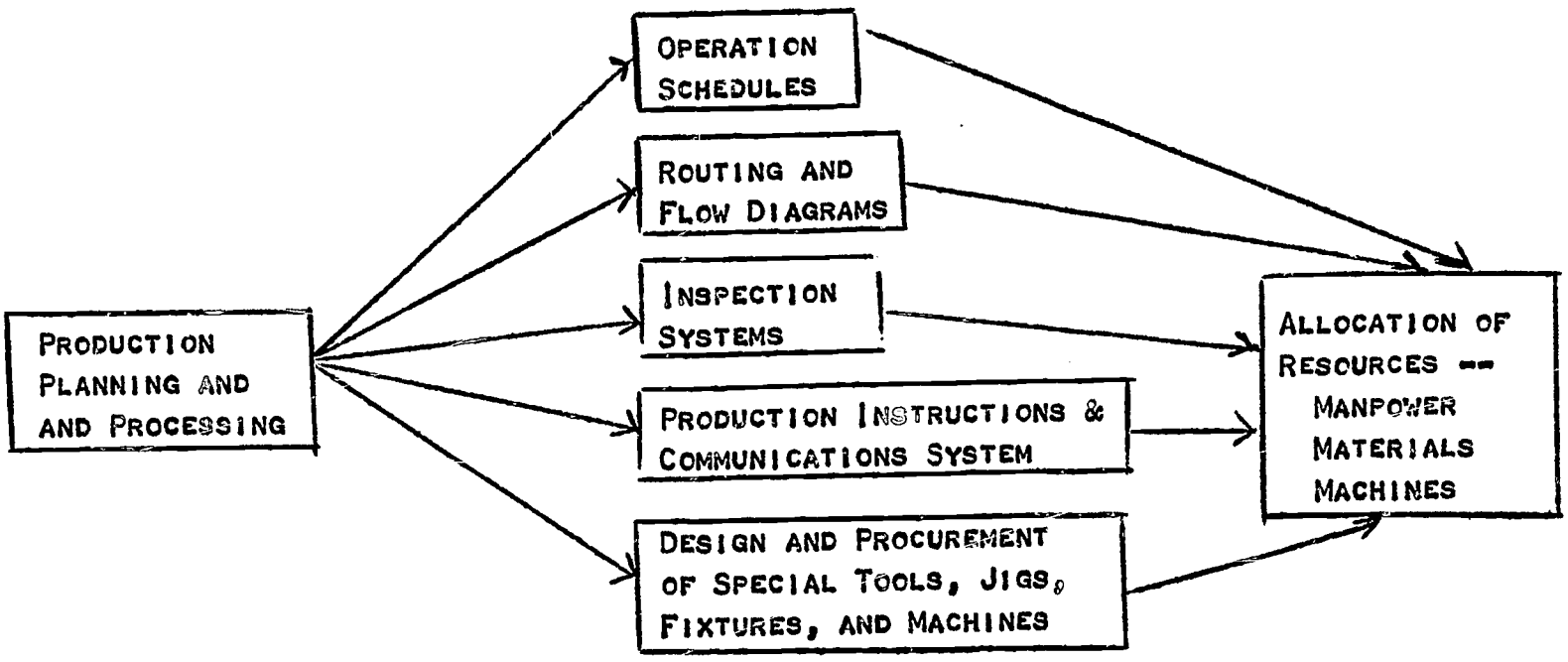

Figure 20

Production planning and processing includes basically six areas which summarize as allocation of resources for manufacturing. Essentially the models presented in Figure 21 through 34 are also elements of Production Planning and Processings. All models presented should be considered as dynamic and developmental, subject to change and probably never complete or final.

The Process Engineering model is shown in Figure 21.

SNAP MAP OF PROCESS ENGINEERING
(FOURTH LEVEL)

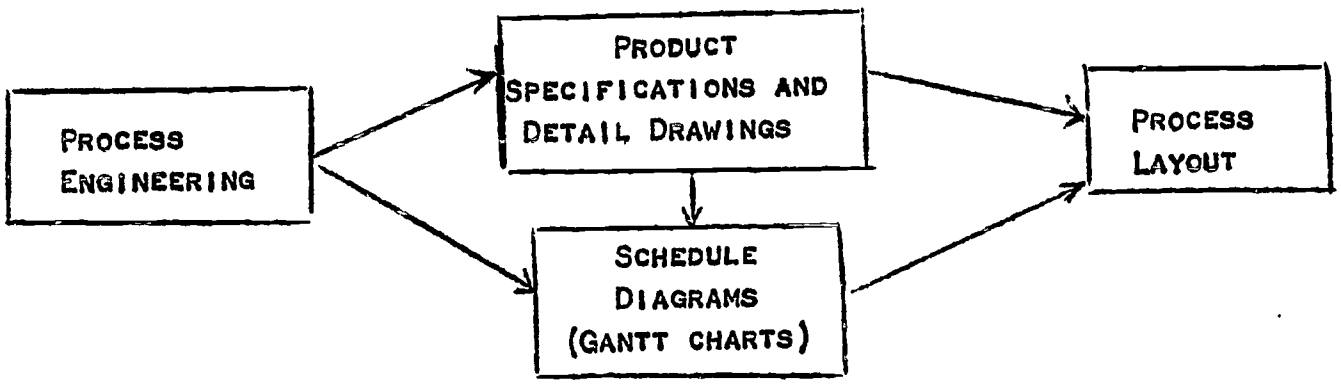

FIGURE 21

Processing Engineering converts the detailed specifications of products into forecast schedules and a "road-map" for processing action.

The Plant and Equipment Layout goal-gradient is illustrated by Figure 22:

SNAP MAP OF PLANT AND EQUIPMENT LAYOUT
(FOURTH LEVEL)

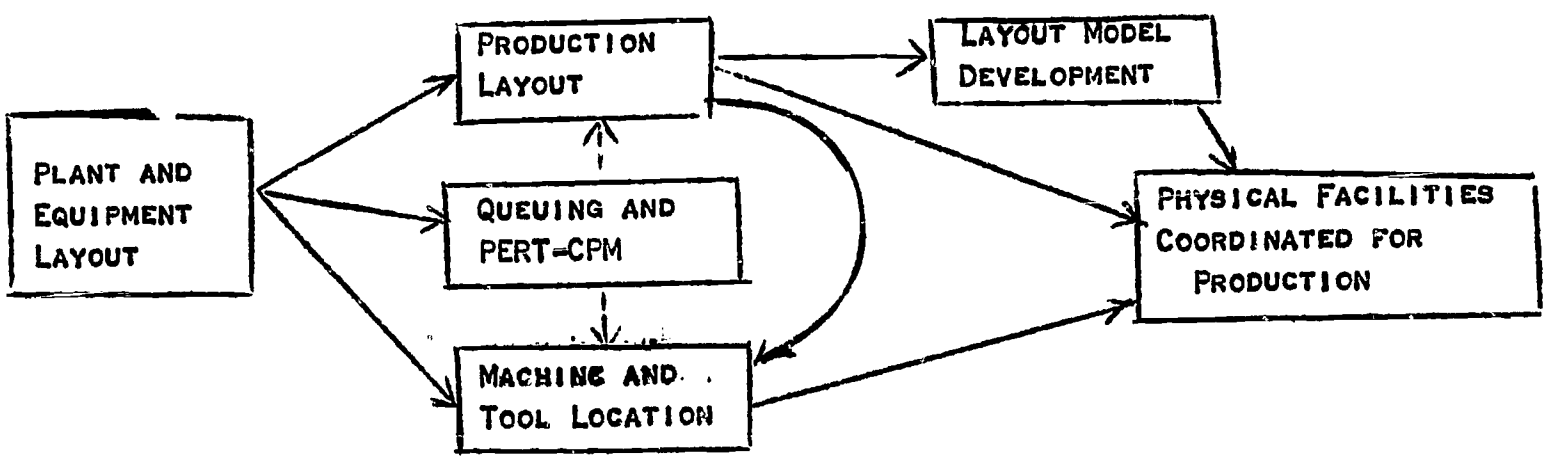

FIGURE 22

Plant and Equipment Layout problems can be solved by schematics or by physical layout models. Balancing the flow of parts and components to maintain optimum production becomes a very complicated problem. It is greatly simplified by the abstract model.

The Material Handling goal-gradient system or SNAP MAP is presented in Figure 23:

SNAP MAP OF MATERIAL HANDLING
(FOURTH LEVEL)

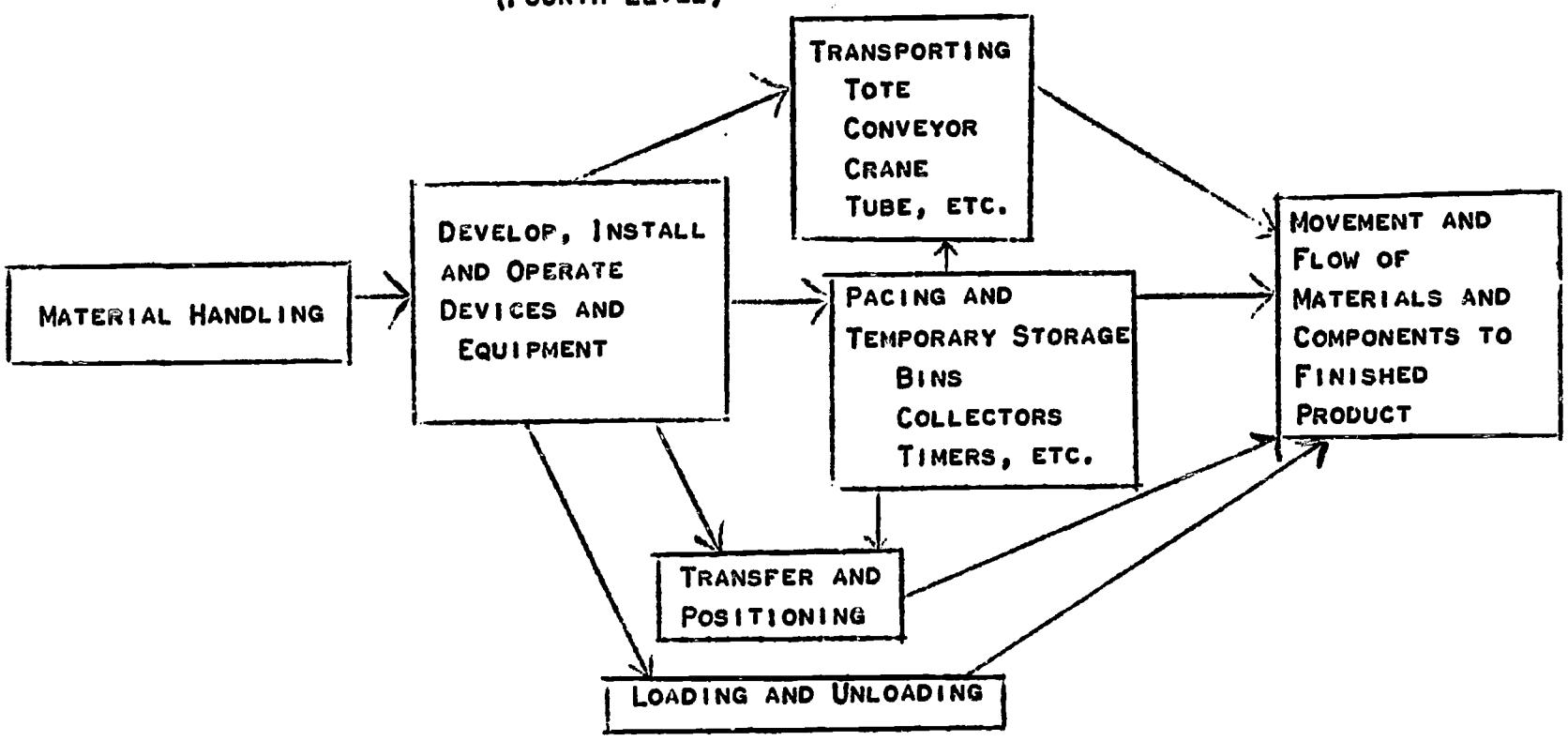

FIGURE 23

To improve the material handling in the production plant is to increase the extent of automation. The devices and specialized equipment which transports, paces, transfers, positions, loads, and unloads is designed to replace the repetitive tasks which formerly were performed by muscle power. Hydraulics, pneumatics, and electronics are un-named in the goal-gradients of the model but actually constitute the backbone of material handling.

The Work Measurement SNAP MAP is presented in Figure 24:

SNAP MAP OF WORK MEASUREMENT
(FOURTH LEVEL)

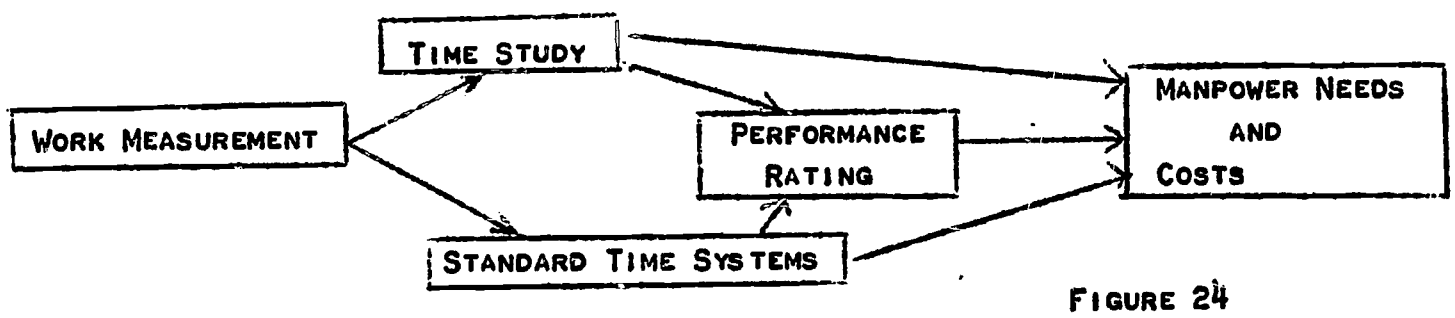

FIGURE 24

Work Measurements are made to determine costs of labor and manpower needs. The two basic approaches to work measurement are pre-determined standard time systems or direct time study. Performance ratings are made to set work expectations and to build incentives.

The Methods Study SNAP MAP is presented in Figure 25:

SNAP MAP OF METHODS STUDY
(FOURTH LEVEL)

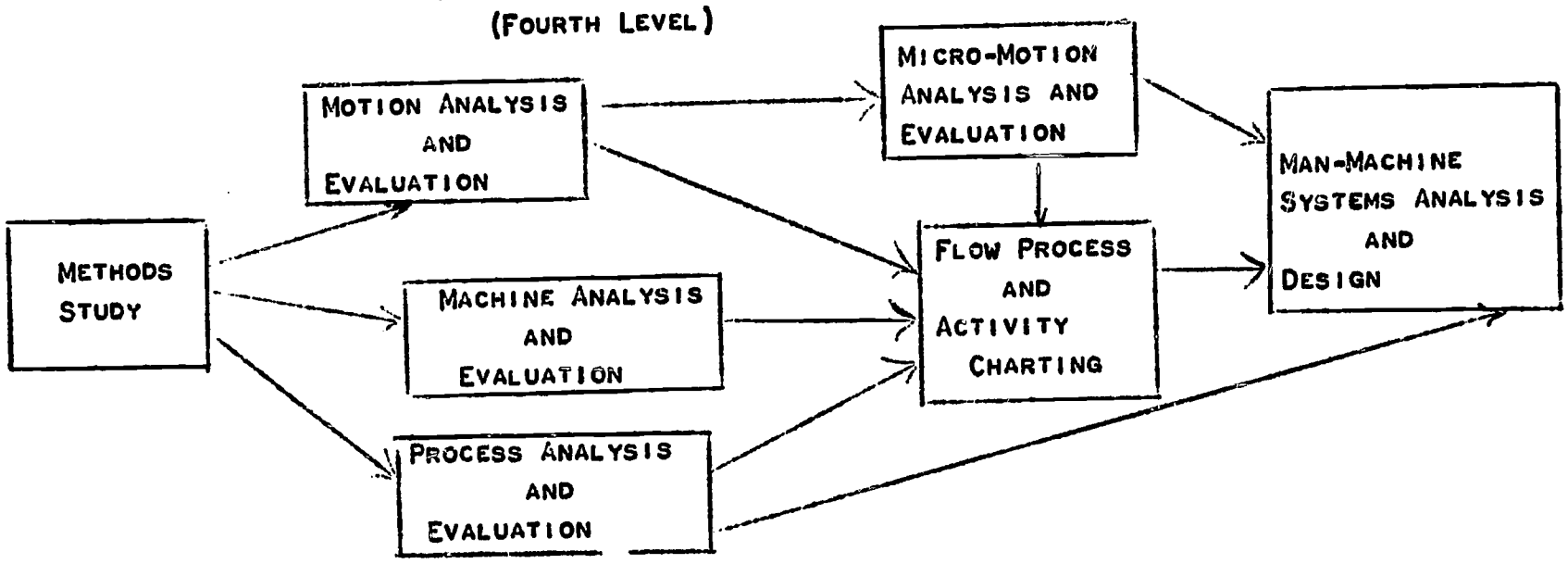

FIGURE 25

Methods Study is the basis for improvements in manufacturing and seeks to reveal all aspects and details of existing methods and procedures. Detailed notions of man and operations of machines are plotted and charted as data for improvement problems.

The Methods Improvement and Automation model is the natural follow-up of the Methods Study and it is illustrated in model form by Figure 26:

SNAP MAP OF METHODS IMPROVEMENT AND AUTOMATION
(FOURTH LEVEL)

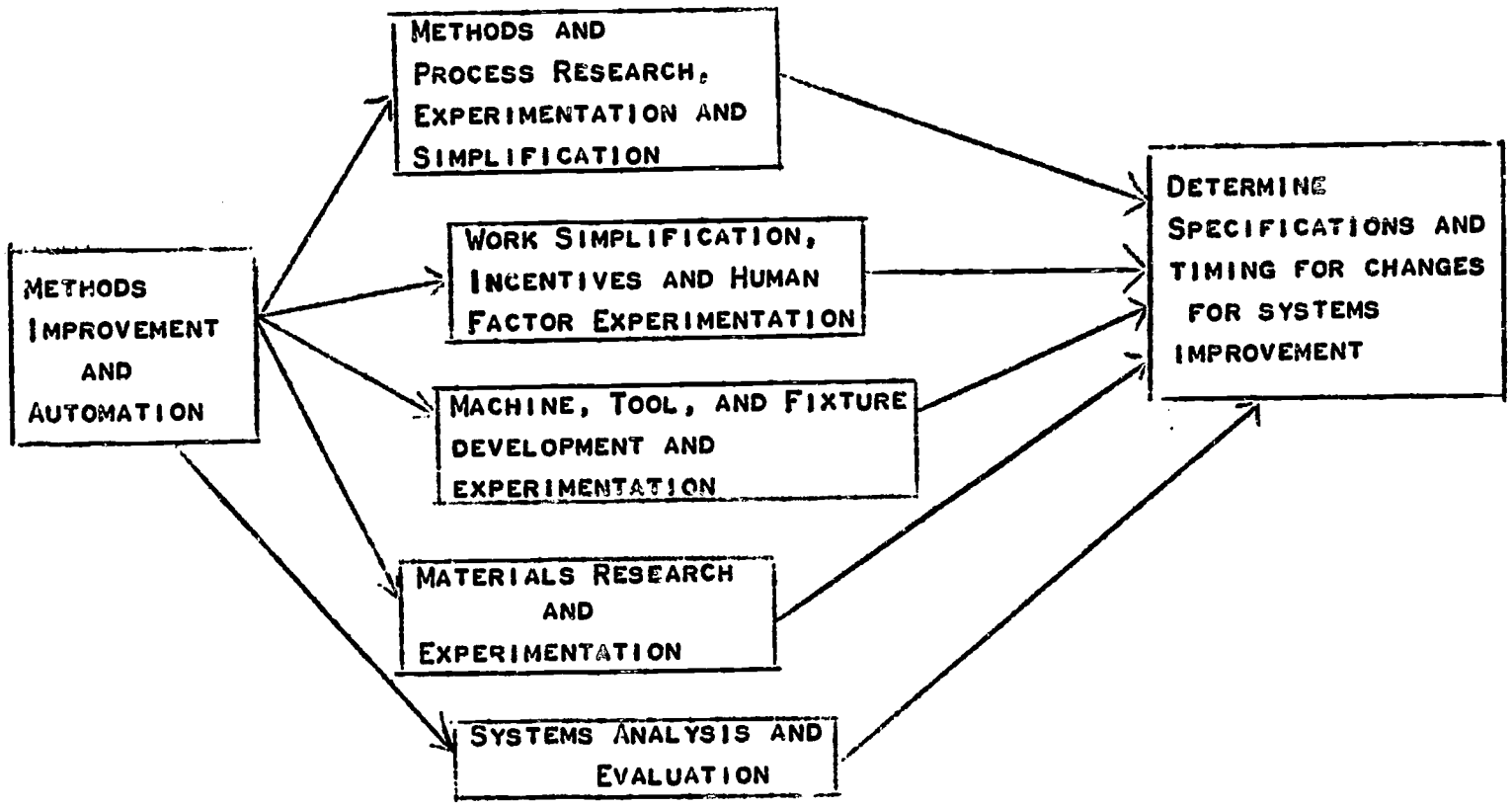

FIGURE 26

Methods Improvement efforts allow the management team to know how to do better than they are doing. Decisions for change may be delayed by other factors. As in material handling, the overall methods improvement action leads to automation and therefore greater application of hydraulics, pneumatics and electronics. Following through from decisions to change, leads to the "Tool-up" goal - gradient which is modeled in Figure 27.

SNAP MAP OF TOOL-UP
(FOURTH LEVEL)

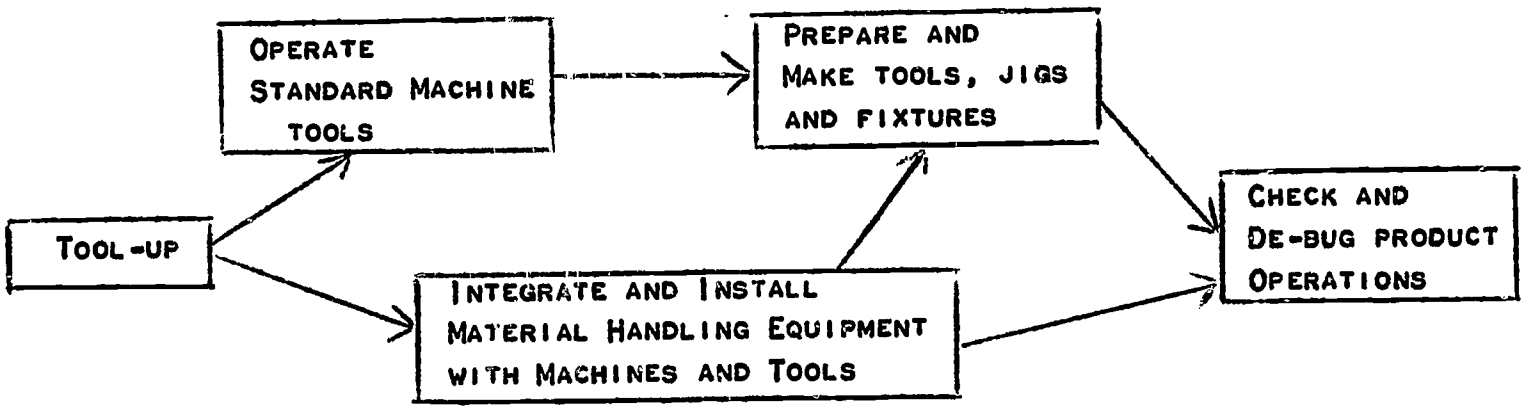

FIGURE 27

The Tool-up model illustrates the need for high levels of skill and knowledge to prepare production facilities to carry out decisions from process engineering and from methods improvement. Placed under continuous operational responsibility, the many goal-gradients as sub-systems of Production Planning and Processing become dynamic toward improvement and change. The improvements and changes culminate in the Tool-up responsibility and the total motion is toward automation.

All systems operating to achieve production and improvement changes must be serviced and maintained and the model of this service function is presented by Figure 28:

SNAP MAP OF MAINTENANCE & SERVICE
(FOURTH LEVEL)

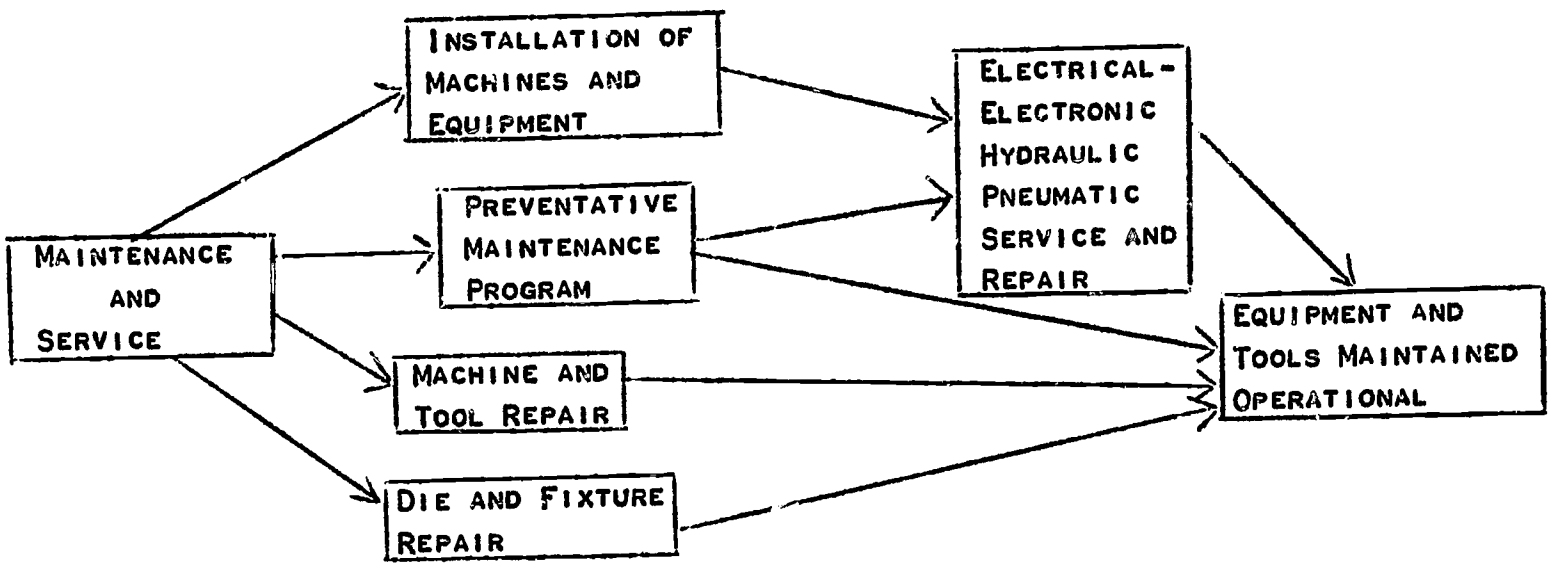

FIGURE 28

The Maintenance and Service responsibility includes the three essential areas; installation, prevention, and repair. The service is an adjunct to the organization for manufacturing and is usually separately organized. Considerable skill and knowledge are required in this area of responsibility.

The Manufacturing goal-gradient is illustrated by Figure 29:

SNAP MAP OF MANUFACTURING
(FOURTH LEVEL)

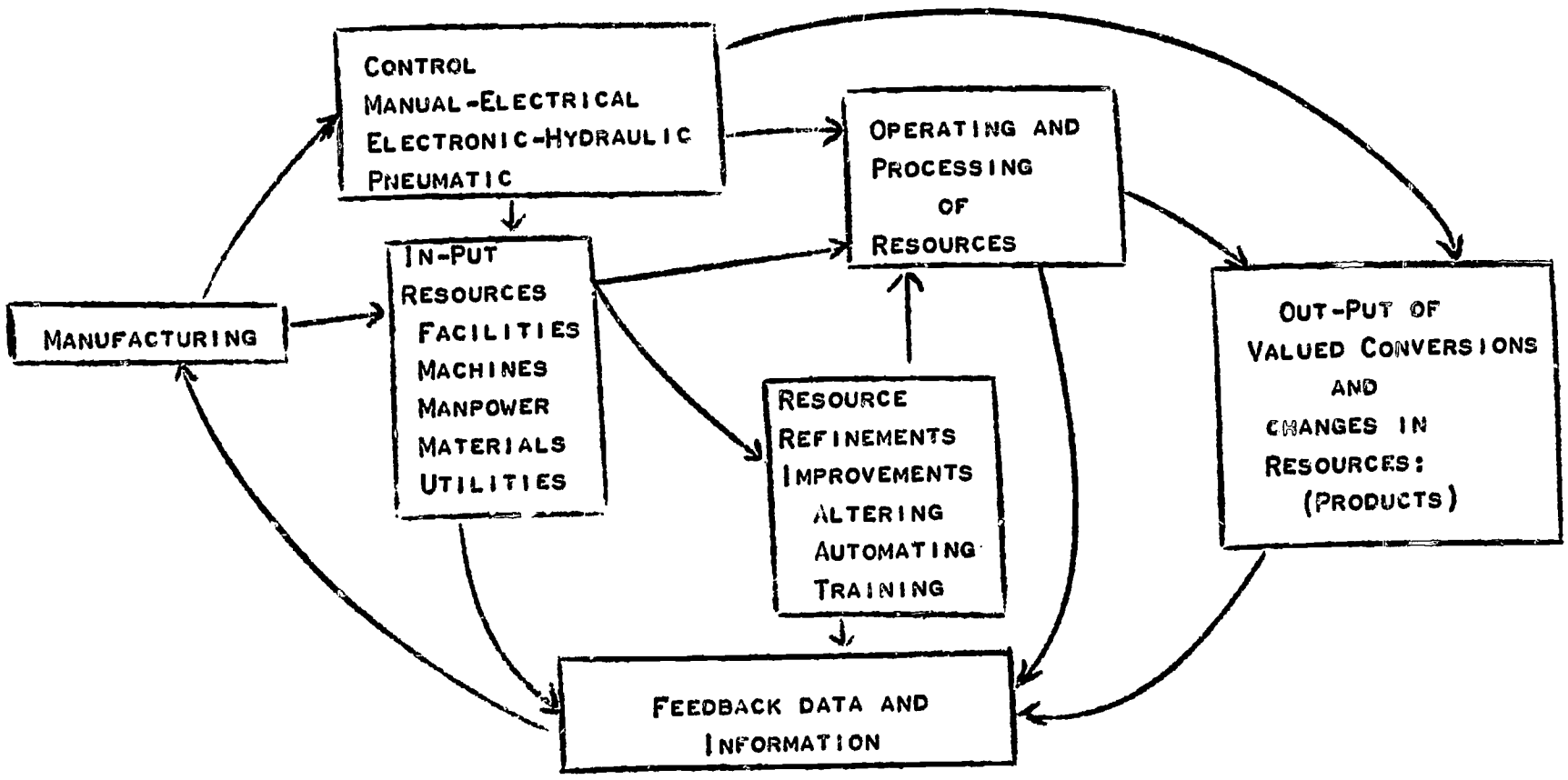

FIGURE 29

Manufacturing is modeled in Figure 29 to reveal general goal-gradients including In-Put, Operating, Control, Out-Put, and Feedback but the sub-system models included in Figures 30 through 34 are also essential details of manufacturing. The Parts Forming and Processing sub-system is modeled in Figure 30.

SNAP MAP OF PARTS FORMING AND PROCESSING
(FOURTH LEVEL)

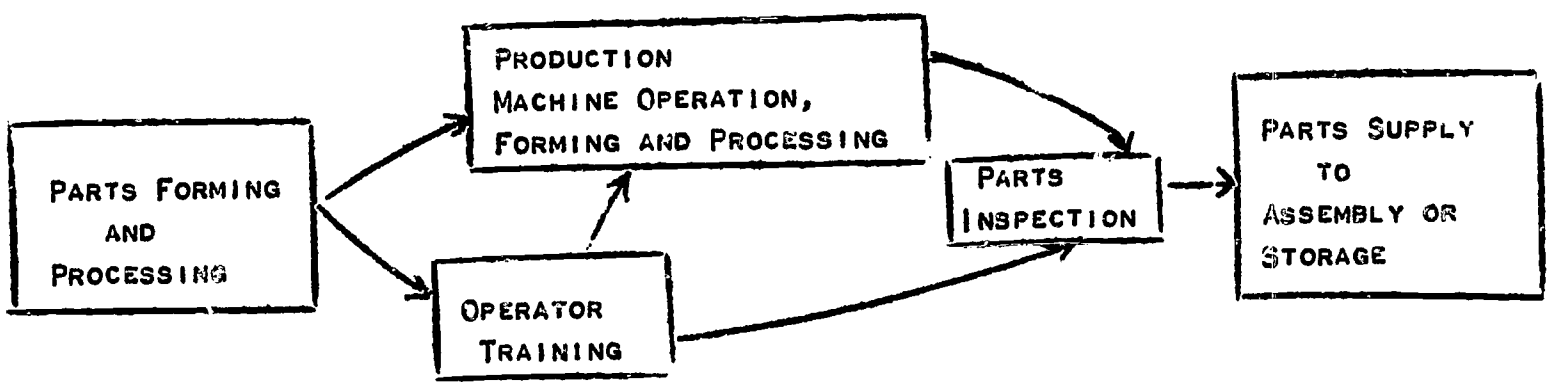

FIGURE 30

The Parts Forming and Processing sub-system is at the heart of manufacturing and understanding of manufacturing. Specialized machines create need for operator training to perform specific tasks and produced parts must be inspected to determine levels of acceptance and rejection for the finished product. The inspection process is based upon standards determined by the Quality Control sub-system which is modeled in Figure 31:

SNAP MAP OF QUALITY CONTROL
(FOURTH LEVEL)

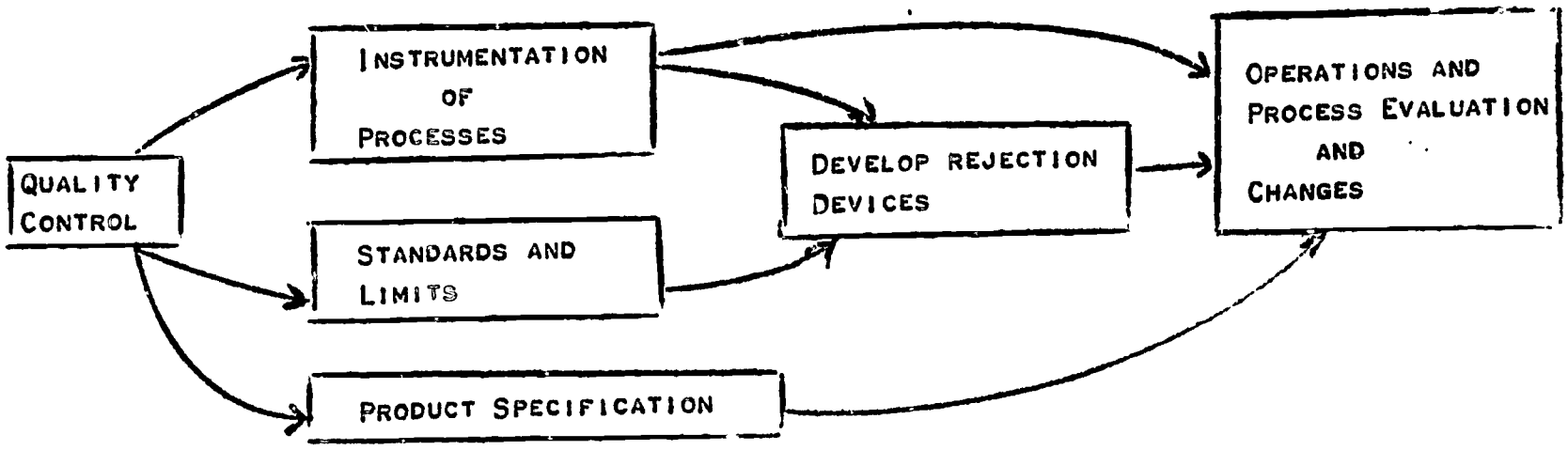

FIGURE 31

Quality Control as a Sub-system is usually independent from production and charged with maintaining quality standards. Optimum in size and specific dimensions and in ingredients and characteristics are set as desirable standards. Deviations from the optimums are set as minimum and maximum limits for acceptability. Instrumentation is then designed to hold manufactured parts within the acceptable limits. Data from parts and component production are collected and analyzed to determine quality in relation to standards and to exercise control for continuation or change. Rejects resulting from the quality control function are sent to the Salvage Sub-system which is modeled in Figure 32:

SNAP MAP OF SALVAGE
(FOURTH LEVEL)

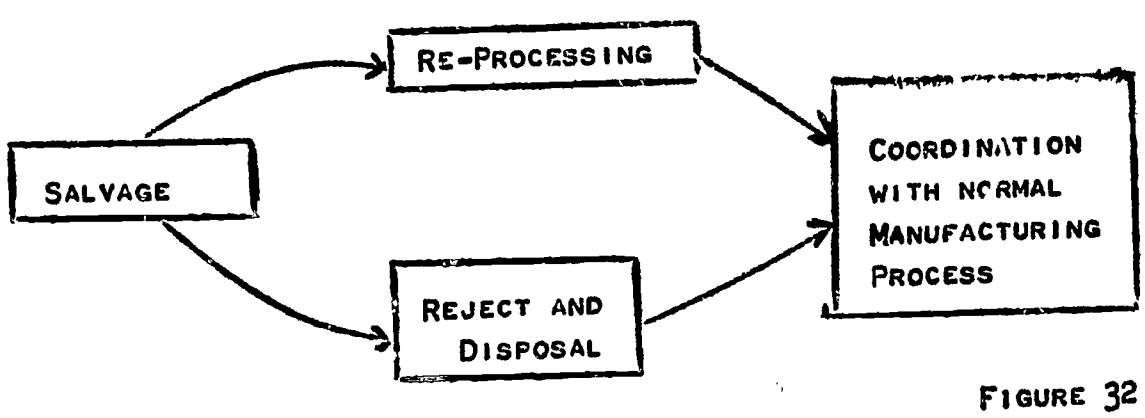

FIGURE 32

Salvaged parts or components may be re-processed to bring dimension within limits or quality up to standard or they may be rejected completely and disposed of as scrap. The salvage operation must be coordinated with the normal process of manufacture to protect the cost of manufacture.

The Parts Assembly SNAP Model is presented in Figure 33:

SNAP MAP OF PARTS ASSEMBLY
(FOURTH LEVEL)

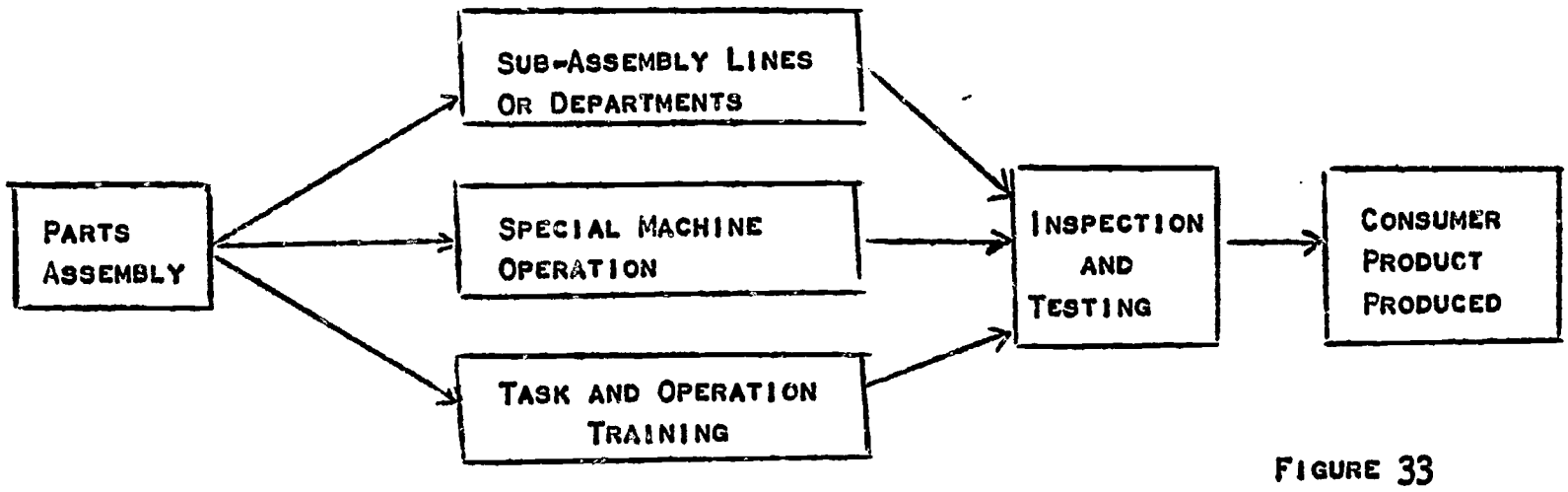

FIGURE 33

The Parts Assembly sub-system is probably the most visible aspect of our modern manufacturing operation. The drudgery and repetition of assembly work is well publicized. Specific tasks and operations are still common and they require short term specific training. Automation is entering the assembly line however, and many special machines are performing assembly operations. Assemblies and sub-assemblies from lines or departments must pass through inspection to qualify as acceptable consumer products. In most manufacturing plants, the operation is not even completed when the consumer product is finished because it must be packaged and prepared for shipment. This final stage subsystem is modeled in Figure 34:

SNAP MAP OF PACKAGING
(FOURTH LEVEL)

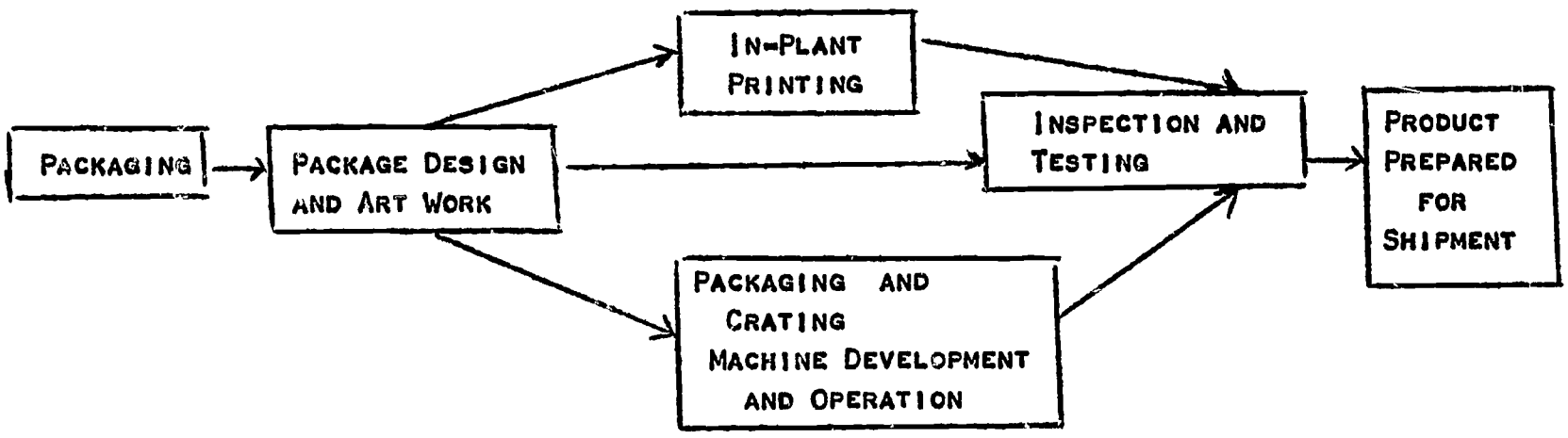

FIGURE 34

The Packaging sub-system may be farmed out to packaging specialists or it may be an in-plant operation. It does involve essentially "product development" except that the product is auxillary rather than primary. Painting and art work on the package are important operations and packing may be achieved manually or by special machine. Machine packaging or further automation has become quite common. The package and contents must pass inspection and testing once again before shipment for consumer use.

The fourth-level models were presented to reveal considerable content important for understanding Manufacturing as one of the important aspects of industry. Great details of content may be produced by continuation of the modeling process at the fifth level and possibly even on to the sixth. The three other major areas identified with the Industrial Arts may likewise be modeled as was done with the manufacturing example.

It should be of particular interest for the industrial educator that content identified by the modeling technique fits together as the "body" of content over the network structure and requires no other inventorying or classification. However, this does not deny the value of the inventory and classification of content for use in changing or improving the models.

The Teaching - Learning Theory Undergirding the Orchestrated Systems Approach

The theory of teaching and learning which undergirds the "Orchestrated Systems Approach" is based upon development of individual self motivation and self discipline for investigation, discovery of new knowledge, and practice under anticipation for development of new and useful skills. The theory involves a plan for gaining adequate experience samples from orchestrated systems as a basis for seeking to match interests and talents before moving toward or polarizing around skill proficiencies. Individual differences are truly recognized and in fact, differences are required over a full range from the unknowing beginner to the highly skilled and knowledgeable craftsman or technician. Also involved in the theory is the creation of a "whole" which the student must synthesize and relate into an understanding of the "whole".

Analogy of a Ball Game

The theory as expressed may be simplified and communicated more effectively by drawing an analogy with a baseball game as follows:

Anyone who has gone early to a baseball game has observed the elements of the game being practiced before the game starts. Observations may be made of a pitcher pitching, a catcher catching, a hitter hitting, a fielder fielding, etc. to the very last element of the total game; but when the umpire calls, "Play ball!", something else is added to the sum of all the elements. Attempts to describe the baseball game in-play will result in the same list of elements identified before the game started. What has been the added ingredient after the game started? It must be the "orchestration" of all the elements that makes the difference. The "orchestrated" game-in-play certainly is more meaningful and interesting to spectators and players than were the practice activities and is actually the source and force behind involvement. It produces self motivation and self discipline particularly on the part of the players. Most approaches to education and training provide for the "pre-game" practice activities, but the "game" is never played. The opportunity for practice in anticipation of game-play is lost.

The commonly practiced factored-out content and "building blocks" approach may also be illustrated by an analogy for contrast with the orchestrated approach. For gaining an

understanding of industry from the "building-block" approach the analogy may be drawn from the story of The Six Blind Men Who Went To See The Elephant. According to the story, the first of the blind men stepped forward and felt of the elephant's leg. He declared that the elephant is like a tree. The second one stepped forward, felt of the tail and declared the elephant to be like a snake. They continued with their separate examinations and attempted to pool and share the separate experiences in order to know and understand the elephant but the separate descriptions added together could not describe the elephant. Can we develop an understanding of industry by providing experiences with factored out, isolated parts? We run the risk of the same problem encountered by the six blind men.

A comparison of various approaches to achieve understanding of industry and to develop those competencies needed for living in our industrial society may be better understood when illustrated abstractly by visual schematics as shown in Figure 35:

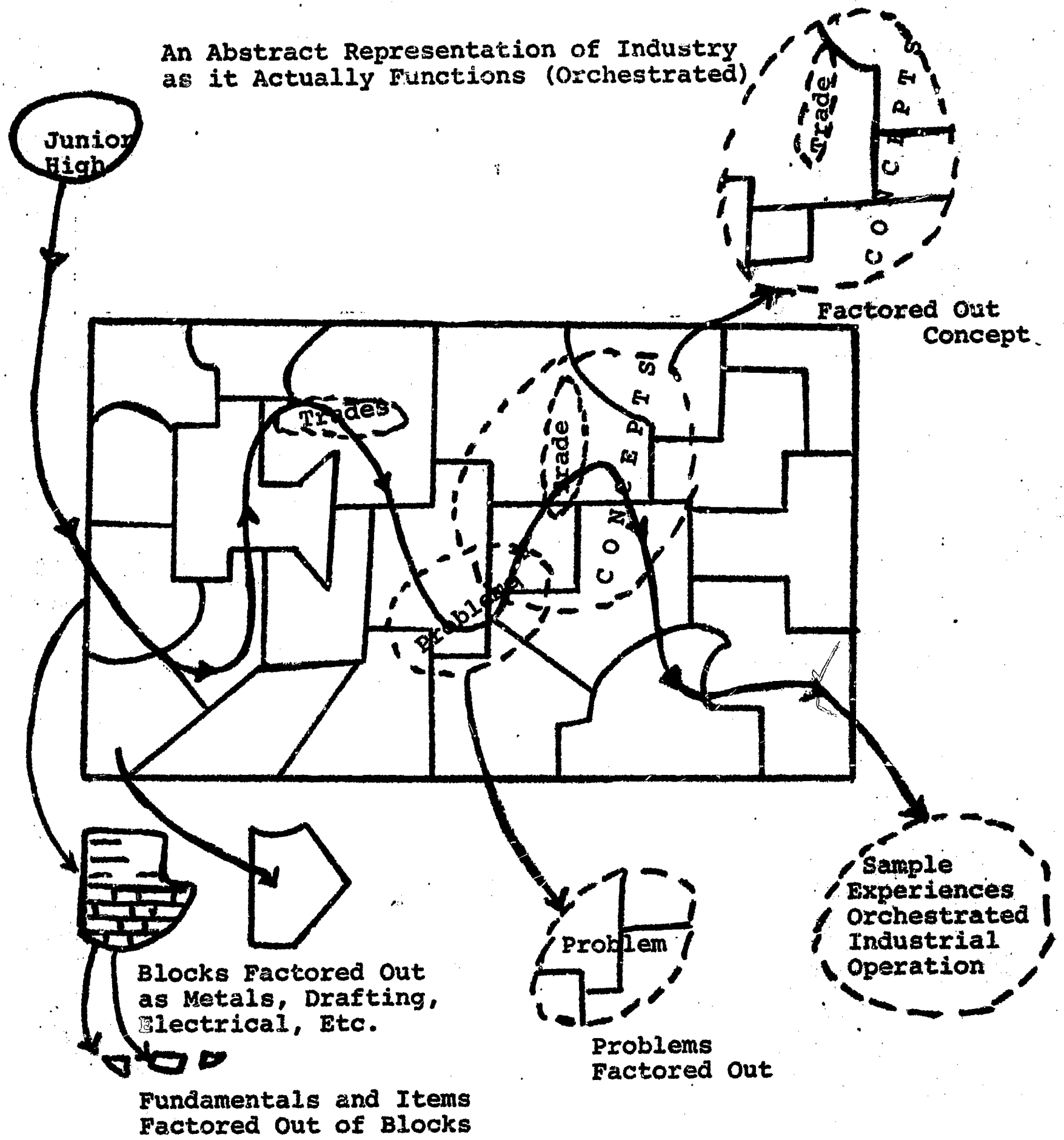
An Abstract Representation of Industry
as it Actually Functions (Orchestrated)
Junior High
Trade
CONCEPTS
Factored Out
Concept
Trades
Trade
CONCEPTS
Problem
Blocks Factored Out
as Metals, Drafting,
Electrical, Etc.
Fundamentals and Items
Factored Out of Blocks
Problem
Problems
Factored Out
Sample
Experiences
Orchestrated
Industrial
Operation

Figure 35

The jig-saw puzzle drawing was used to represent industry abstractly with all elements functioning in "orchestrated" operation. Most systems of instruction employ methods of factoring out certain areas of content for instruction. The most common classification of factored out content includes two categories of materials including metals and woods, then shifts to processes to include drawing and graphic arts, and finally shifts to two additional areas to include electricity-electronics and power and auto mechanics. These classifications or blocks of factored out content are generally further analyzed into smaller blocks of content and into basic fundamentals. Students are expected to learn the fundamentals and content of each block and to synthesize from that learning, the total understanding of industry. Time runs out before the student can get an adequate sample of experience and content from all the areas to be able to arrive at the understanding of industry.

The problem-solving approach to the study of industry is quite broadly associated but when analyzed graphically, it is revealed as another system for factoring out content but the system may cut across the boundary lines of materials and processes. Another system may also cut across the sharp lines of the blocked out content but again uses factored out content. Vocational training utilizes this system and it is frequently carried over into the industrial arts program for the purpose of understanding industry.

The conceptual approach may include a broad cut of content which includes materials, processes, problems, and jobs, but also employs factored out content.

The "Orchestrated Systems Approach" in contrast to the various systems which utilize factored out content would leave the operational system in contact and lead the student to take experience samples in the operational system. The sample experience is illustrated by the heavy line and arrows in Figure 35.

The theory of the Orchestrated Systems Approach also includes the concept of seeking improvement and changes, and in fact, expanding the technology by the same processes used by industry. The functions of research and development should bring the educational system to the "cutting edge" of change and the educational system therefore, should be expected to contribute to the changing technology. This seems to be our only hope of closing the broad gap between modern industry and education. To start on the same system of development and change that industry employs does not demand too much from education. The idea may be illustrated by the diagram of Figure 36:

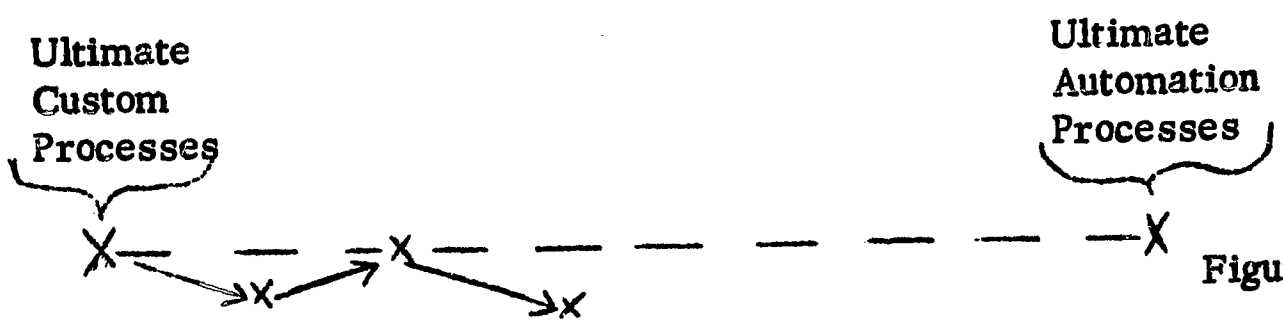

Figure 36

The two identified points of Figure 36 represent two opposite poles or two extreme opposites on a continuum. Considering this continuum, industrial educators may start with the ultimate custom processes and begin to move through changes and improvements toward the opposite pole. The system must be continued and the change functions continued if we are to achieve the same process of change employed by industry. We cannot continue to

start-from-scratch each semester and with each new class as our traditional shops and laboratories operate. We must adopt a system typical of industry and get into motion toward the goal of automation. We may never achieve ultimate automation but we can move away from ultimate custom processes in the direction of automated processes and thereby get on the cutting edge of change. Industrial educators can make their efforts cumulative toward the automation goal by building onto past experiences and by continually exerting effort for improved methods.

Expanding and changing technical content and the dearth of learning time combine to require a learning environment that accentuates "learning how to learn". By the very nature of the Orchestrated Systems Approach, the strategy shows promise for developing a problem-solving capability and the consequent versatility and flexibility that will help contend with the rapid change and increase in industrial knowledge.

Instructional Strategies

The major strategy for instruction involves the creation of an environment which includes the "game-in-play" as well as "bull pen" learning and practice areas. A graphic illustration of the plan is presented by Figure 37:

GRAPHIC ILLUSTRATION

HARD GOODS MANUFACTURE --- ORCHESTRATED TRAINING SYSTEM

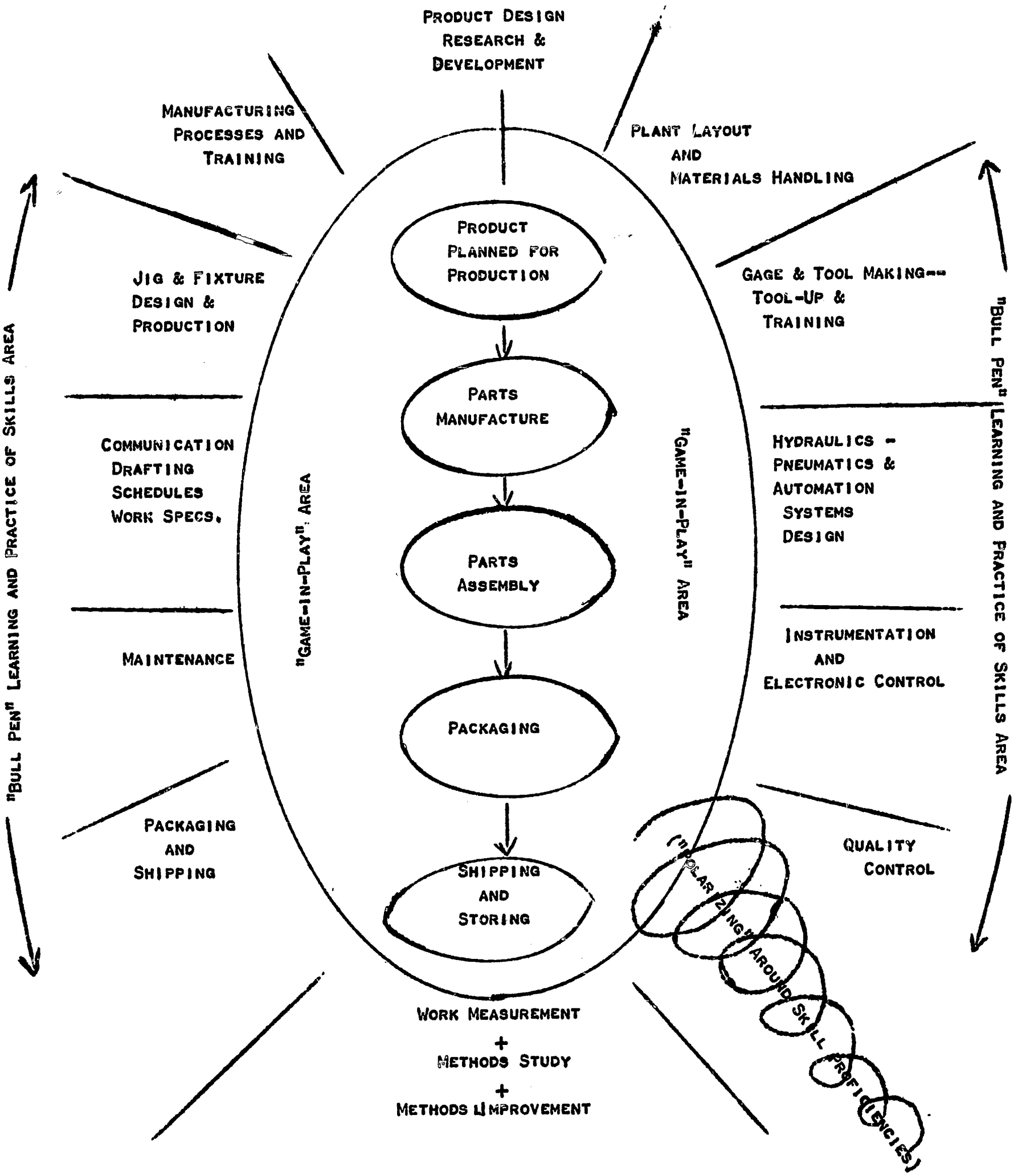

FIGURE 37

The "game-in-play" area in the sample illustration of Figure 37 includes an orchestrated manufacturing system for the production of a hard goods product. Learning and practice booths or areas are located around the "game-in-play" area to provide opportunity for development of specific skills and knowledge needed in the "game".

The beginning student of industry should experience the "orchestrated" whole as his first experience. He should have opportunity to try out at various responsibilities under a type of apprenticeship learning in the production system until he is motivated by interest and newly discovered talents to begin polarization around specific proficiencies. His learning and development should originate with the "whole" of industry then move to give attention to the "parts" or specifics. The individual's experience and learning will then be held in proper context and he will seek new knowledge and skill development in anticipation of performing in the "game".

The "game-in-play" area was conceived as an industrial enterprise laboratory which employs the same competitive and investigative techniques as industry. The enterprise laboratory will then provide the experiences for understanding technological change by participating in the very processes of seeking and making changes. The change and investigative process should move the enterprise from custom methods toward automation methods as an ever changing, always improving process of cumulative effort.

All systems or approaches to education must reckon with scope and sequence, with grade levels, and with ability levels. The Orchestrated Systems Approach cannot escape these considerations. The system is too young for an accumulation of experimental data as a basis for solution to these problems so the plans must be theoretical and subject to tests and research. The industrial enterprise laboratory of the Orchestrated Systems Approach brings into play a great range of specialized job and role responsibilities which create opportunity for individualized instruction and competency development. Operation of the system should discourage segregation of classes on the basis of beginners, intermediate, and advanced, and should encourage a broad spectrum of learning and experience including trade and technical job preparation as well as general understandings of industry.

For ideal operation of the Orchestrated Systems in the areas of manufacturing, construction, product servicing, and industrial communications, grade levels and ability levels would be recognized through provisions for individual differences and students would enter the system on the basis of "first entry", "second entry", "third entry", etc. to the extent of time available. "First entry" students, regardless of grade level, should enter into a rotating apprenticeship-type experience to become fully acquainted with the whole orchestrated system. "Second entry" should be for helper responsibilities, serving as junior member of a team from which he receives some of his instruction. "Third entries" should be a continuation of specialization with instructional responsibilities. (In this regard research has revealed that students who instruct others also learn most for themselves.) More advanced levels may continue specialization, and instruction, with added responsibilities for improvement changes in the operating system.

In realistic recognition of the junior high and secondary school organizations it would seem necessary to provide systems of the four basic areas at the junior high level with required exposure to all areas. At the secondary level, provision should be made for more sophisticated systems which offer opportunity for survey and discovery of interests and talents or for specialization of skill and knowledge competencies. Experimentation will

remain important for finalizing operational plans.

The determination of an adequate sample of experience and learning from industry to develop the general educational level of competencies needed by individuals in our industrial society is a most difficult problem to solve. Some criteria for selection of samples and identification of the orchestrated systems is important. The plan used for this Orchestrated Systems Approach is illustrated by Figure 38:

SNAP MAP OF PRODUCT ORIGIN-TO-CONSUMPTION

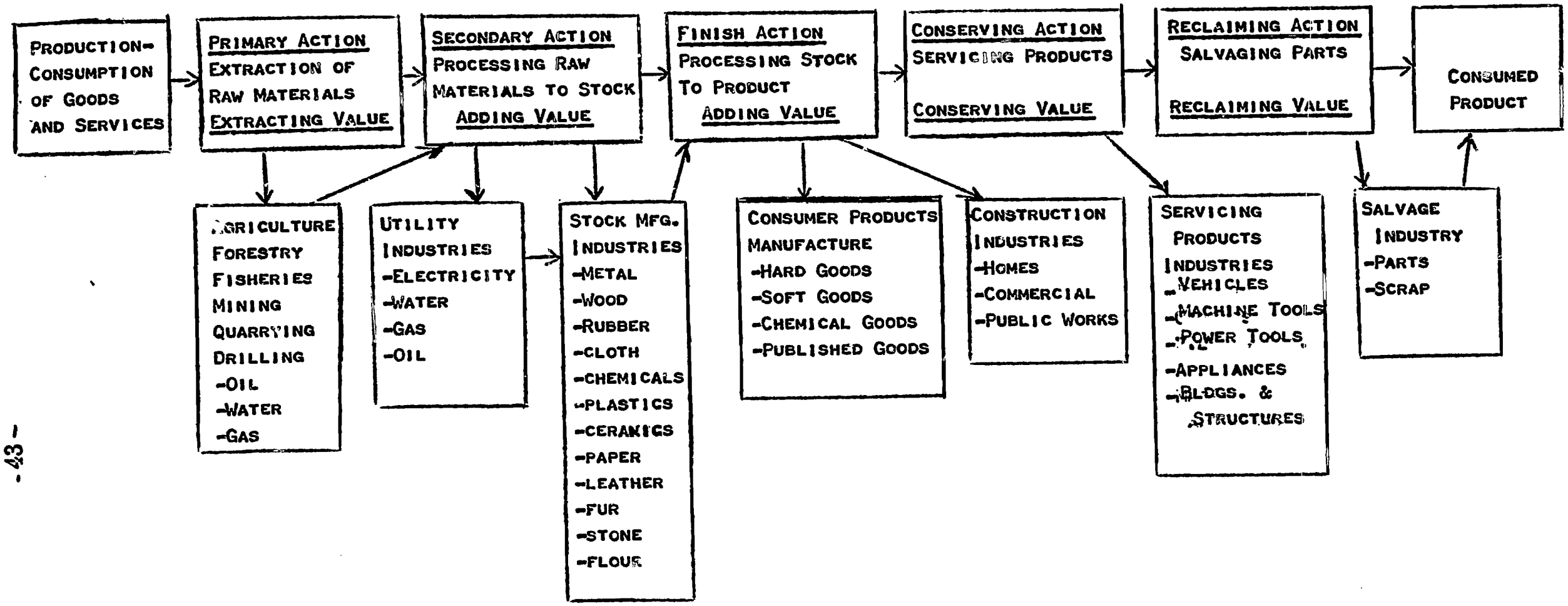

FIGURE 38

Figure 38 exposes the full range of activity from raw material to product consumption and provides a basis for judgment and decisions regarding industrial education content. Under the Orchestrated Systems Approach, industrial arts education was delimited to include the "Finish Action" of producing consumer products from stock materials, the "Conserving Action" of servicing consumer products, the "Re-claiming action" of salvaging parts and materials, and the "Industrial-technical Communication" which serves the above areas. The range of possibilities for orchestrated systems within these delimited categories are great and further means for delimitation are important. It was conceived that the classification of consumer products shown in Figure 38 gave adequate delimitation for practical use as did the classification under "Construction", "Servicing" and "Salvage". Other alternative classifications could be made for each of the categories.

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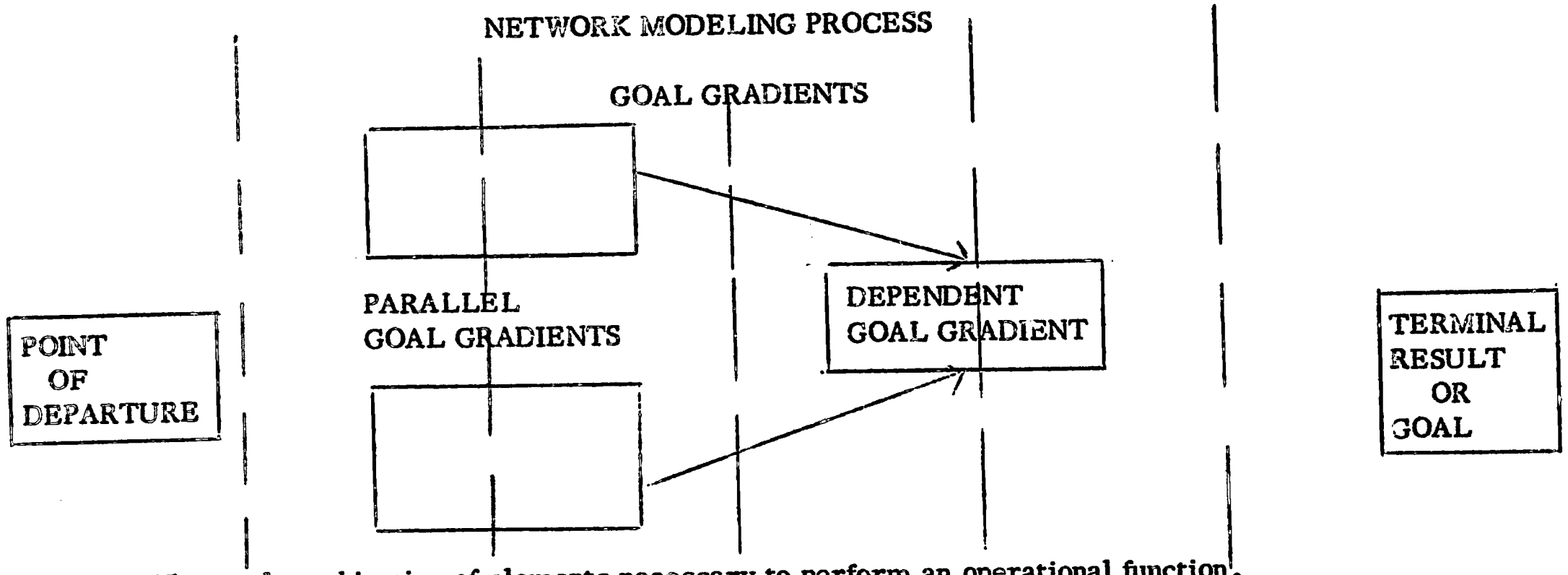
The Orchestrated Systems Approach utilized systems network modeling as a tool for identification of content and as a basis for delimitation of the responsibility of industrial arts. A teaching-learning theory and a strategy for instruction was developed for operation of the system. Solutions to many detailed problems of operation must depend upon future experimentation and research.



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"The most arresting fact about --- Systems modeling --- is that it is a new way of thinking ---. It provides rational ordering of alternatives --- in terms of feasibility and economy and the achievement of stated goals."

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The Parts Assembly SNAP Model is presented in Figure 33:

SNAP MAP OF PARTS ASSEMBLY
(FOURTH LEVEL)

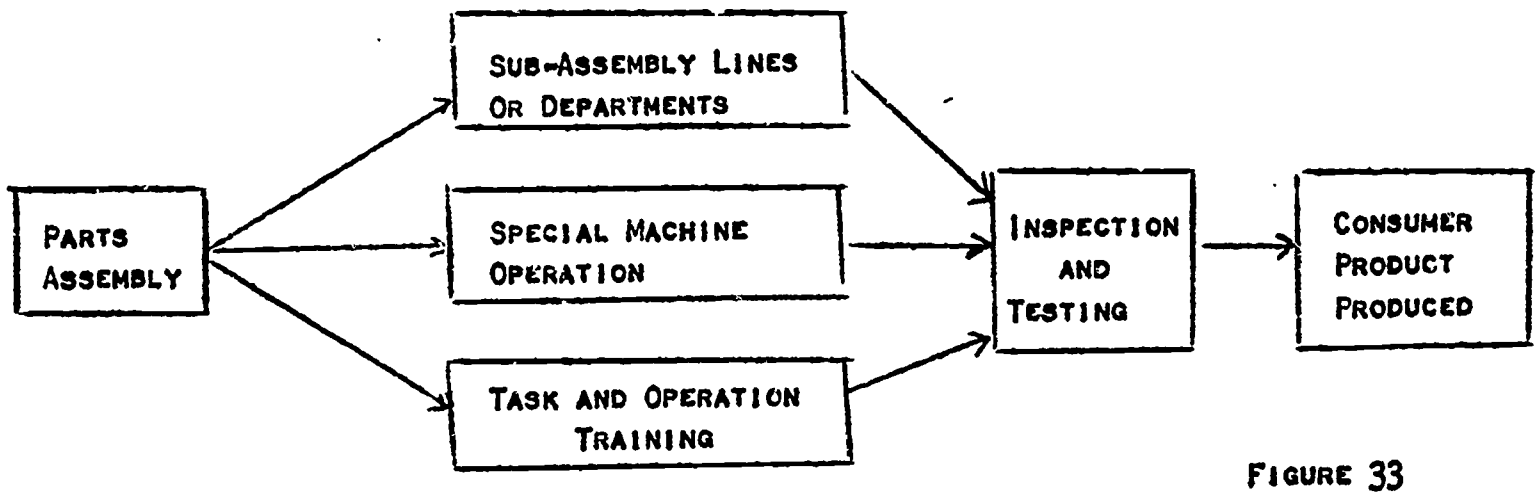


FIGURE 33

The Parts Assembly sub-system is probably the most visible aspect of our modern manufacturing operation. The drudgery and repetition of assembly work is well publicized. Specific tasks and operations are still common and they require short term specific training. Automation is entering the assembly line however, and many special machines are performing assembly operations. Assemblies and sub-assemblies from lines or departments must pass through inspection to qualify as acceptable consumer products. In most manufacturing plants, the operation is not even completed when the consumer product is finished because it must be packaged and prepared for shipment. This final stage sub-system is modeled in Figure 34:

SNAP MAP OF PACKAGING
(FOURTH LEVEL)

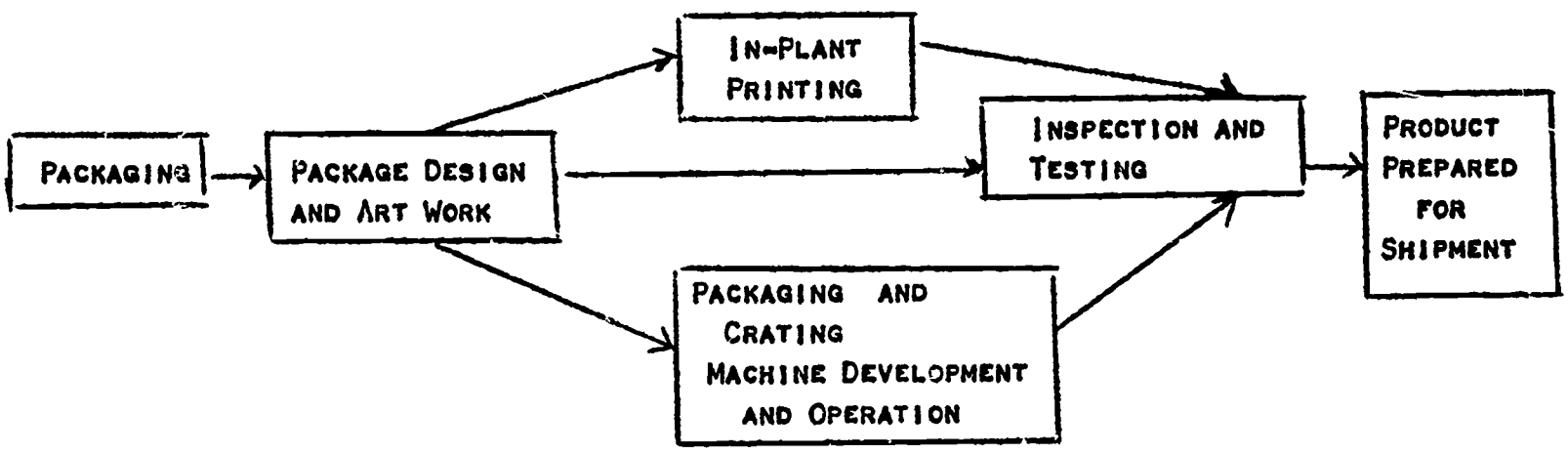


FIGURE 34

The Packaging sub-system may be farmed out to packaging specialists or it may be an in-plant operation. It does involve essentially "product development" except that the product is auxillary rather than primary. Painting and art work on the package are important operations and packing may be achieved manually or by special machine. Machine packaging or further automation has become quite common. The package and contents must pass inspection and testing once again before shipment for consumer use.

The fourth-level models were presented to reveal considerable content important for understanding Manufacturing as one of the important aspects of industry. Great details of content may be produced by continuation of the modeling process at the fifth level and possibly even on to the sixth. The three other major areas identified with the Industrial Arts may likewise be modeled as was done with the manufacturing example.

It should be of particular interest for the industrial educator that content identified by the modeling technique fits together as the "body" of content over the network structure and requires no other inventorying or classification. However, this does not deny the value of the inventory and classification of content for use in changing or improving the models.

The Teaching - Learning Theory Undergirding the Orchestrated Systems Approach

The theory of teaching and learning which undergirds the "Orchestrated Systems Approach" is based upon development of individual self motivation and self discipline for investigation, discovery of new knowledge, and practice under anticipation for development of new and useful skills. The theory involves a plan for gaining adequate experience samples from orchestrated systems as a basis for seeking to match interests and talents before moving toward or polarizing around skill proficiencies. Individual differences are truly recognized and in fact, differences are required over a full range from the unknowing beginner to the highly skilled and knowledgeable craftsman or technician. Also involved in the theory is the creation of a "whole" which the student must synthesize and relate into an understanding of the "whole".

Analogy of a Ball Game

The theory as expressed may be simplified and communicated more effectively by drawing an analogy with a baseball game as follows:

Anyone who has gone early to a baseball game has observed the elements of the game being practiced before the game starts. Observations may be made of a pitcher pitching, a catcher catching, a hitter hitting, a fielder fielding, etc. to the very last element of the total game; but when the umpire calls, "Play ball!", something else is added to the sum of all the elements. Attempts to describe the baseball game in-play will result in the same list of elements identified before the game started. What has been the added ingredient after the game started? It must be the "orchestration" of all the elements that makes the difference. The "orchestrated" game-in-play certainly is more meaningful and interesting to spectators and players than were the practice activities and is actually the source and force behind involvement. It produces self motivation and self discipline particularly on the part of the players. Most approaches to education and training provide for the "pre-game" practice activities, but the "game" is never played. The opportunity for practice in anticipation of game-play is lost.

The commonly practiced factored-out content and "building blocks" approach may also be illustrated by an analogy for contrast with the orchestrated approach. For gaining an

understanding of industry from the "building-block" approach the analogy may be drawn from the story of The Six Blind Men Who Went To See The Elephant. According to the story, the first of the blind men stepped forward and felt of the elephant's leg. He declared that the elephant is like a tree. The second one stepped forward, felt of the tail and declared the elephant to be like a snake. They continued with their separate examinations and attempted to pool and share the separate experiences in order to know and understand the elephant but the separate descriptions added together could not describe the elephant. Can we develop an understanding of industry by providing experiences with factored out, isolated parts? We run the risk of the same problem encountered by the six blind men.

A comparison of various approaches to achieve understanding of industry and to develop those competencies needed for living in our industrial society may be better understood when illustrated abstractly by visual schematics as shown in Figure 35:

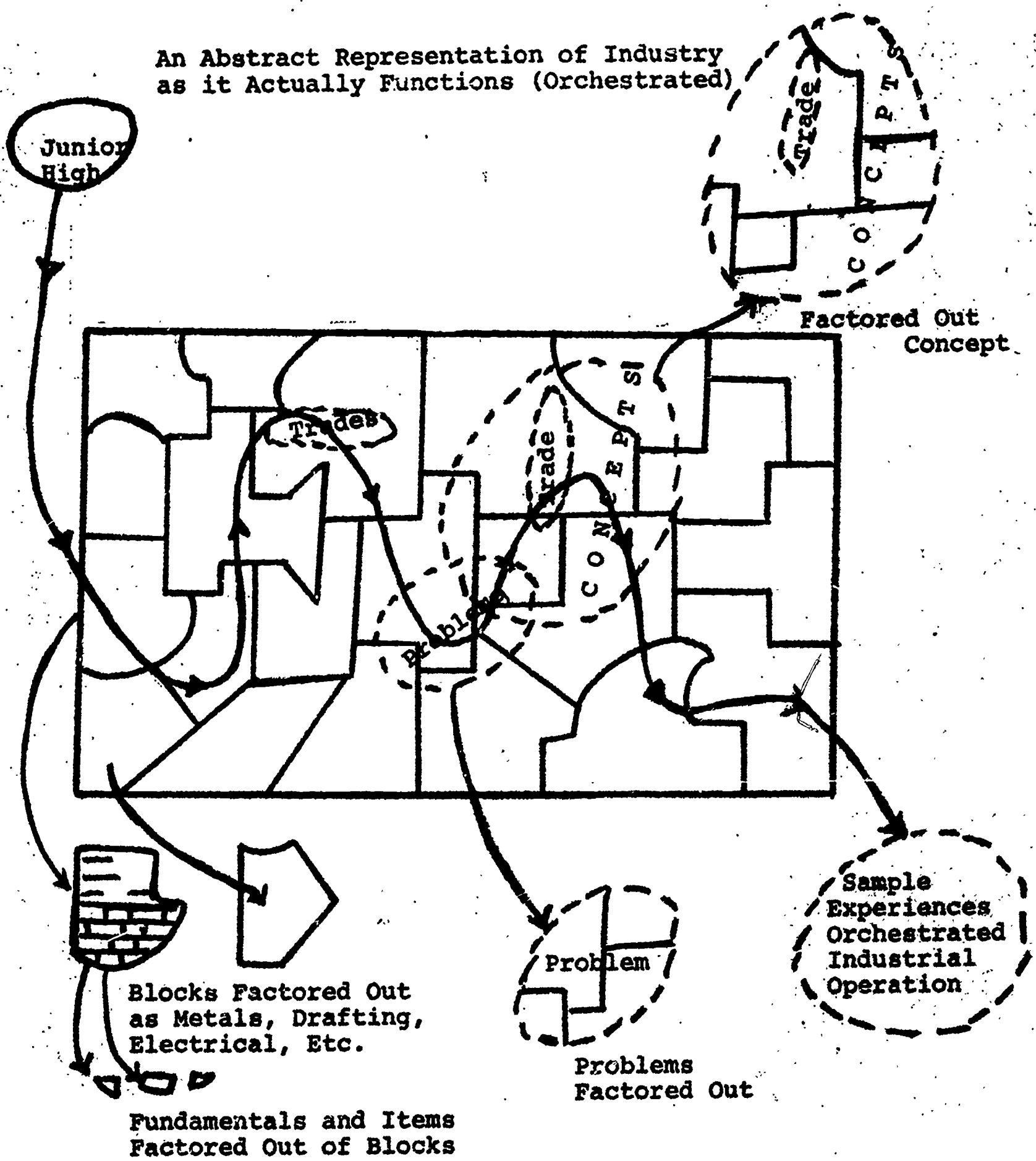

An Abstract Representation of Industry
as it Actually Functions (Orchestrated)
Junior High
Trade
CONCEPTS
Factored Out
Concept
Trades
Trade
CONCEPTS
Problem
Blocks Factored Out
as Metals, Drafting,
Electrical, Etc.
Fundamentals and Items
Factored Out of Blocks
Problem
Problems
Factored Out
Sample
Experiences
Orchestrated
Industrial
Operation

Figure 35

The jig-saw puzzle drawing was used to represent industry abstractly with all elements functioning in "orchestrated" operation. Most systems of instruction employ methods of factoring out certain areas of content for instruction. The most common classification of factored out content includes two categories of materials including metals and woods, then shifts to processes to include drawing and graphic arts, and finally shifts to two additional areas to include electricity-electronics and power and auto mechanics. These classifications or blocks of factored out content are generally further analyzed into smaller blocks of content and into basic fundamentals. Students are expected to learn the fundamentals and content of each block and to synthesize from that learning, the total understanding of industry. Time runs out before the student can get an adequate sample of experience and content from all the areas to be able to arrive at the understanding of industry.

The problem-solving approach to the study of industry is quite broadly associated but when analyzed graphically, it is revealed as another system for factoring out content but the system may cut across the boundary lines of materials and processes. Another system may also cut across the sharp lines of the blocked out content but again uses factored out content. Vocational training utilizes this system and it is frequently carried over into the industrial arts program for the purpose of understanding industry.

The conceptual approach may include a broad cut of content which includes materials, processes, problems, and jobs, but also employs factored out content.

The "Orchestrated Systems Approach" in contrast to the various systems which utilize factored out content would leave the operational system in contact and lead the student to take experience samples in the operational system. The sample experience is illustrated by the heavy line and arrows in Figure 35.

The theory of the Orchestrated Systems Approach also includes the concept of seeking improvement and changes, and in fact, expanding the technology by the same processes used by industry. The functions of research and development should bring the educational system to the "cutting edge" of change and the educational system therefore, should be expected to contribute to the changing technology. This seems to be our only hope of closing the broad gap between modern industry and education. To start on the same system of development and change that industry employs does not demand too much from education. The idea may be illustrated by the diagram of Figure 36:

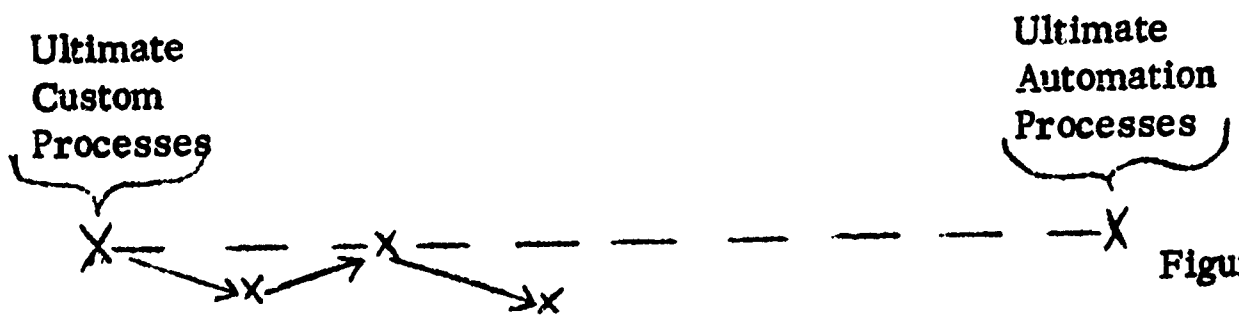


Figure 36

The two identified points of Figure 36 represent two opposite poles or two extreme opposites on a continuum. Considering this continuum, industrial educators may start with the ultimate custom processes and begin to move through changes and improvements toward the opposite pole. The system must be continued and the change functions continued if we are to achieve the same process of change employed by industry. We cannot continue to

start-from-scratch each semester and with each new class as our traditional shops and laboratories operate. We must adopt a system typical of industry and get into motion toward the goal of automation. We may never achieve ultimate automation but we can move away from ultimate custom processes in the direction of automated processes and thereby get on the cutting edge of change. Industrial educators can make their efforts cumulative toward the automation goal by building onto past experiences and by continually exerting effort for improved methods.

Expanding and changing technical content and the dearth of learning time combine to require a learning environment that accentuates "learning how to learn". By the very nature of the Orchestrated Systems Approach, the strategy shows promise for developing a problem-solving capability and the consequent versatility and flexibility that will help contend with the rapid change and increase in industrial knowledge.

Instructional Strategies

The major strategy for instruction involves the creation of an environment which includes the "game-in-play" as well as "bull pen" learning and practice areas. A graphic illustration of the plan is presented by Figure 37:

GRAPHIC ILLUSTRATION

HARD GOODS MANUFACTURE ---- ORCHESTRATED TRAINING SYSTEM

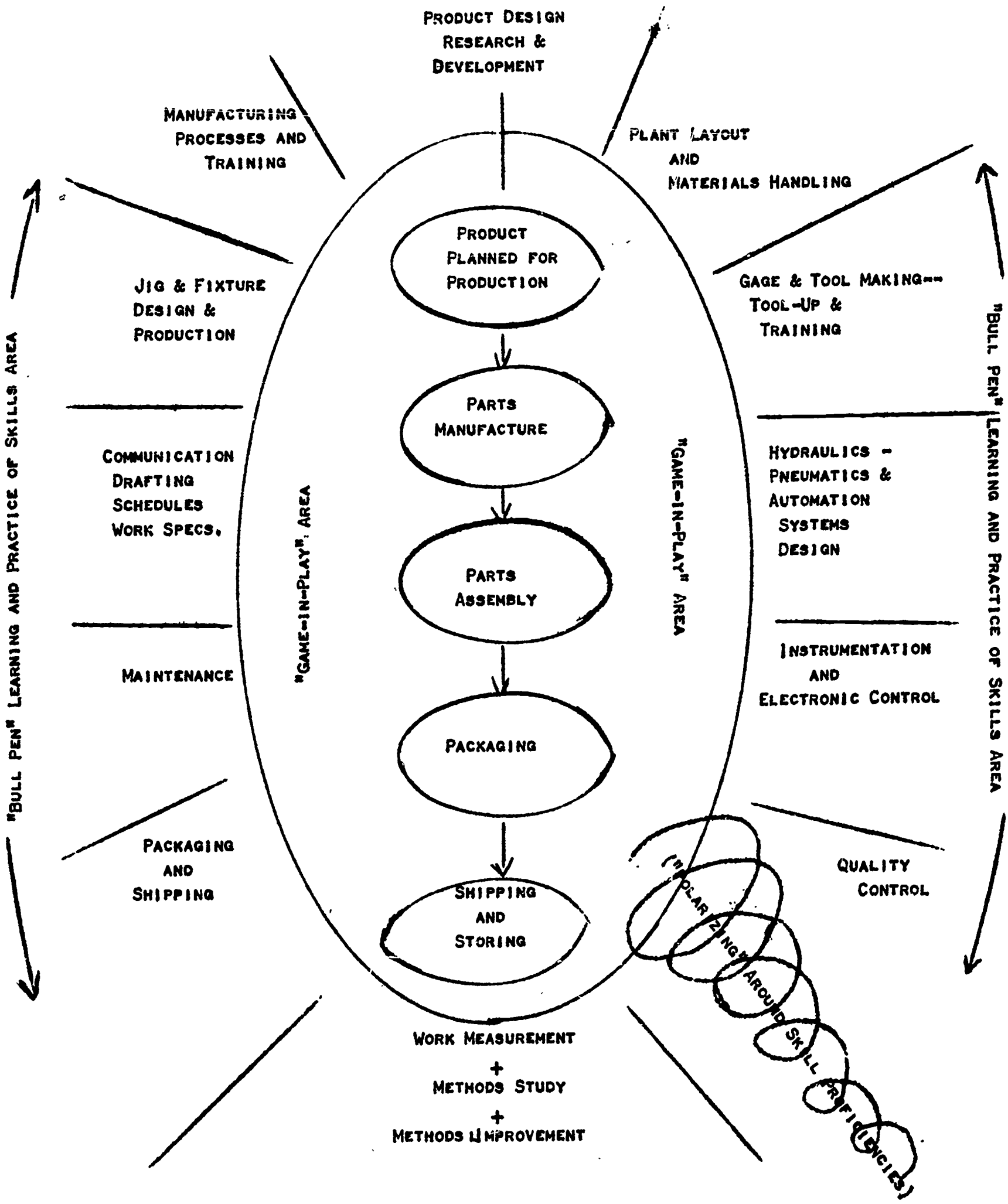


FIGURE 37

The "game-in-play" area in the sample illustration of Figure 37 includes an orchestrated manufacturing system for the production of a hard goods product. Learning and practice booths or areas are located around the "game-in-play" area to provide opportunity for development of specific skills and knowledge needed in the "game".

The beginning student of industry should experience the "orchestrated" whole as his first experience. He should have opportunity to try out at various responsibilities under a type of apprenticeship learning in the production system until he is motivated by interest and newly discovered talents to begin polarization around specific proficiencies. His learning and development should originate with the "whole" of industry then move to give attention to the "parts" or specifics. The individual's experience and learning will then be held in proper context and he will seek new knowledge and skill development in anticipation of performing in the "game".

The "game-in-play" area was conceived as an industrial enterprise laboratory which employs the same competitive and investigative techniques as industry. The enterprise laboratory will then provide the experiences for understanding technological change by participating in the very processes of seeking and making changes. The change and investigative process should move the enterprise from custom methods toward automation methods as an ever changing, always improving process of cumulative effort.

All systems or approaches to education must reckon with scope and sequence, with grade levels, and with ability levels. The Orchestrated Systems Approach cannot escape these considerations. The system is too young for an accumulation of experimental data as a basis for solution to these problems so the plans must be theoretical and subject to tests and research. The industrial enterprise laboratory of the Orchestrated Systems Approach brings into play a great range of specialized job and role responsibilities which create opportunity for individualized instruction and competency development. Operation of the system should discourage segregation of classes on the basis of beginners, intermediate, and advanced, and should encourage a broad spectrum of learning and experience including trade and technical job preparation as well as general understandings of industry.

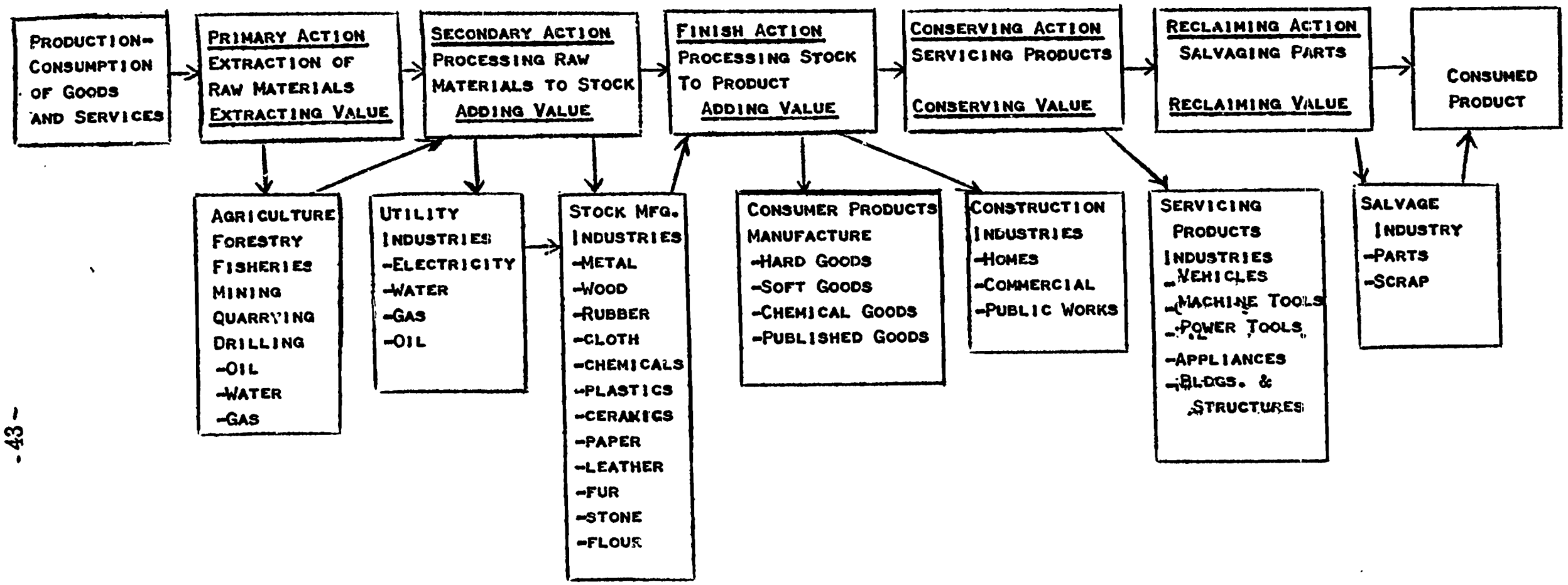
For ideal operation of the Orchestrated Systems in the areas of manufacturing, construction, product servicing, and industrial communications, grade levels and ability levels would be recognized through provisions for individual differences and students would enter the system on the basis of "first entry", "second entry", "third entry", etc. to the extent of time available. "First entry" students, regardless of grade level, should enter into a rotating apprenticeship-type experience to become fully acquainted with the whole orchestrated system. "Second entry" should be for helper responsibilities, serving as junior member of a team from which he receives some of his instruction. "Third entries" should be a continuation of specialization with instructional responsibilities. (In this regard research has revealed that students who instruct others also learn most for themselves.) More advanced levels may continue specialization, and instruction, with added responsibilities for improvement changes in the operating system.

In realistic recognition of the junior high and secondary school organizations it would seem necessary to provide systems of the four basic areas at the junior high level with required exposure to all areas. At the secondary level, provision should be made for more sophisticated systems which offer opportunity for survey and discovery of interests and talents or for specialization of skill and knowledge competencies. Experimentation will

remain important for finalizing operational plans.

The determination of an adequate sample of experience and learning from industry to develop the general educational level of competencies needed by individuals in our industrial society is a most difficult problem to solve. Some criteria for selection of samples and identification of the orchestrated systems is important. The plan used for this Orchestrated Systems Approach is illustrated by Figure 38:

SNAP MAP OF PRODUCT ORIGIN-TO-CONSUMPTION



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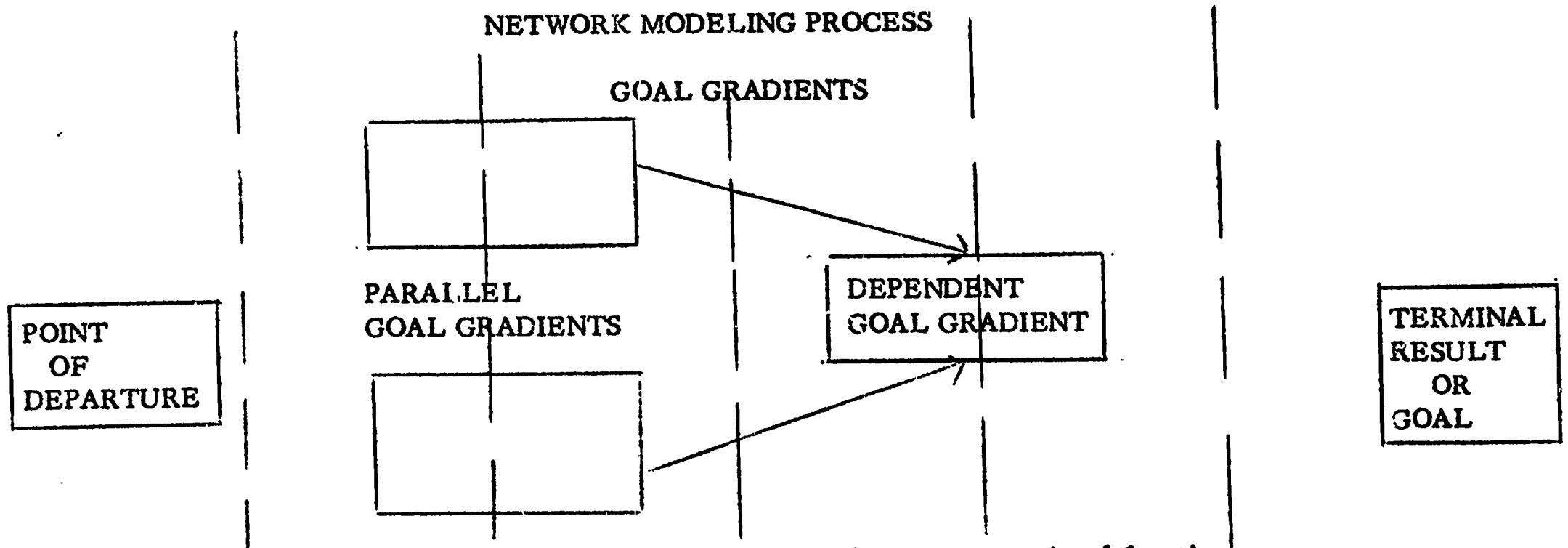

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