

12-81

John N. Warfield

THE OPTIONS FIELD METHODOLOGY FOR DESIGN

John N. Warfield
December, 1981

THE OPTIONS FIELD METHODOLOGY FOR DESIGN

Background

The "Options Field" methodology for design was invented by the present author during a project carried out for the Office of Education. In this project it was found that there was a need for a method of design that exhibited a collection of characteristics that no known method of design offered.⁺ Specifically, it was intended that the method would have all of these characteristics:

- Offer a systematic way to portray a finished design
- Offer a systematic way to develop the background for doing a design
- Be suitable for a group of people to use when working collaboratively, with help from a skilled facilitator and computer programs designed to keep track of the status of the design at all intermediate points in its evolution
- Take into account interdependencies among design dimensions
- Specifically account for the "Law of Requisite Variety" set forth by Ashby as a necessity to be satisfied in design
- Present the design in outline form on one large display, capable of being updated as it is developed
- Provide for iteration as required to arrive at a completed design
- Be applicable to all kinds of systems, including product

⁺ This method was first discussed in an unpublished memorandum titled "A Methodology for Conceptual Design of Systems and its Application to Environmental Education". Since then the method has been illustrated in several publications. As applied in environmental education, it is discussed in the report DESIGNS FOR THE FUTURE OF ENVIRONMENTAL EDUCATION, U. S. Department of Education Publication No. E-81-39000.

designs, process designs, organizational designs, curriculum designs, and combinations of these

The Options Field method of design was created to take advantage of a method called Interpretive Structural Modeling (ISM), also invented by the present author, since ISM can be used to help a group perform several aspects of a design effort. The ISM process is a computer-assisted group process whereby a group is helped by a skilled facilitator (familiar with the ISM process) to create a structure for a set of elements, based upon a selected relation. The freedom to select a desired relation in each instance of application is what allows the ISM process to be used several times in the Options Field method, each time with a different type of relation. By this means the ISM method allows several of the wanted features of the OF method to be achieved.

Steps in the Options Field Method

The Options Field (OF) Method involves the following steps.

- STEP 1. Generate a list of options from which choices will be made during the design process. This list should be as inclusive as possible. Each option should be "simple", i.e., it should not involve two distinct possibilities. For example, options for a roof of a house might include "shingles", "slate", etc., but would not include "slate OR shingles", since this is a composite option rather than a simple option.
- STEP 2. Aggregate the options in "dimensions". A dimension is (a) a set of simple options, (b) an area in which there is agreement that a choice must be made in order to give a complete statement of the minimum essentials of the design. A dimension may be numerical (as in the case of the length and width of a rectangular room of a house) or qualitative. Examples will be given later.
- STEP 3. Determine which dimensions are dependent upon other dimensions. This is done using the ISM process.

The group compares dimensions by inspecting the options in each, to see if choice of some option in one dimension could restrict the choice of options in another dimension.

- STEP 4. Form clusters of dimensions. Two dimensions lie in the same cluster if and only if they are dependent.
- STEP 5. Rank order the clusters on the basis of the sequence in which options will be selected. This can be done using the ISM process with the clusters as the elements.
- STEP 6. For each cluster, rank order the member dimensions in terms of the sequence with which choices will be made within the cluster. This may be done with ISM if necessary.
- STEP 7. Put all the dimensions on the chart called the Options Field (examples will appear later), showing them in the rank order found in Steps 5 and 6, with the options for each dimension listed underneath the dimension, each option preceded by a bullet to facilitate drawing to follow.
- STEP 8. Select an option (simple or compound--if the latter it will be a combination of at least two simple options) from the first dimension in the rank ordering found earlier.
- STEP 9. Draw a line tying the selected option to the "Tie Line" (examples appear later).
- STEP 10. Rule out any options in other dimensions that have been pre-empted by the choice just made.
- STEP 11. Repeat Steps 8, 9, and 10, for each successive dimension until (a) the design is complete OR (b) some dimension become inaccessible because prior choices have ruled out all options in that dimension. If the latter occurs, the group must begin again and make choices that are not so restrictive. Otherwise the design is completed by choice of options under all dimensions, iterating if required, to produce an "Options Profile". The latter

portrays all of the dimensions (hence all of the clusters), the order in which choices were made, and all of the choices that were made. Also it shows which choices were considered but not made.

Examples of Past Applications

Now we will present a set of examples of past applications of the OF method of design.

A. Design of a Revised Judicial System, Including a Court Administrator.

Figure 1 shows a completed options profile for a revised judicial system. The system as designed here includes a court administrator to supplement the usual clerk/judge court system which has allowed courts to become overloaded. Note that the design is for civil and "law" cases, and for state or possibly federal district courts.

For more details on this design, consult Reference 1.

B. Design of a Technology Transfer Organization.

Figure 2 shows a completed options profile for a technology transfer organization. Note that this organization has nine dimensions, and that technological needs are considered first, then presumed innovation style, then presumed innovator skills, etc.

For more details, consult Reference 2.

C. Design of a Peace Research Forum.

Figure 3 shows an options field for a peace research forum. This forum was conceived to have twelve dimensions, with the first choices being made in the dimension: "Basic Outcomes Sought". Note that a composite option consisting of nine objectives was chosen under that dimension. Under the final dimension "Targets" are listed three choices for groups to reach through the forum: governments, industry leaders, and political leaders.

Figure 1. Options Profile for a Revised Judicial System

Type of Case	Name of Courthouse	Organizing Mode	Admin. Functions
• criminal	→ Fed. District Ct.	• clerks/judges	→ fiscal mgt.
→ civil	• Fed. App. Ct.	→ clerks/judges ct. admin.	→ systems analysis
→ law	• Fed. Supreme Ct.	→ open system	→ facilities mgt.
• equity	→ State District Ct.	→ closed system	→ report mgt.
• federal question	• State App. Ct.		→ liaison
• diversity juris (\$10,000)	• State Supreme Ct.		→ jury & witness mgt.
			→ personnel mgt.
			→ general mgt.
			→ public info. mgt.
			→ caseflow mgt.

Tie Line

A Conceptual Design for Technology Transfer Centers Based on Senate Bill S1250

• Technological Needs	• Presumed Innovation Style	• Presumed Innovator Skills	• Information Channels	• Innovator's Interaction Resources
<ul style="list-style-type: none"> Basic Research Applied Research Development Long Term Short Term Holistic Product-Oriented Process-Oriented 	<ul style="list-style-type: none"> Exploration of significant and fundamental facts Determination of facts Empirical work designed to choose among alternatives as applied to new interests "Invisible" Colleges Intraorganizational communication patterns Interorganizational communication patterns 	<ul style="list-style-type: none"> Can read prose Can write Can use technical language Can read translatable graphics Has adequate memory and recall skills 	<ul style="list-style-type: none"> Literature Vendors Customers Other sources external to the laboratory Laboratory Technical Staff Company Research Programs Analysis and experimentation Previous personal experience Group Discussion Other Divisions 	<ul style="list-style-type: none"> Laboratory Environment (New College Grads) Non-Laboratory Environment (Short Courses, Seminars, Conferences) Computer-Assisted Processes Print Modules Physical Modules
• Formal Literature Sources	• Informal Literature Sources	• Information Broker/Mediator	• Origin of Funding	Systems Tie Line
<ul style="list-style-type: none"> Textbooks Trade Journals Privately sponsored Engineering Journals Professional Engineering Journals Handbooks Other Journals Conference proceedings Scientific & Math. journals Abstracts 	<ul style="list-style-type: none"> Internal Reports Reports from other corporations Government reports University Reports Reports of unknown origin 	<ul style="list-style-type: none"> Universities Business Organization Government agencies Foreign country counterparts Lecturers Group discussion leaders Guide and interpreter Information process manager 	<ul style="list-style-type: none"> Local Tax Funds State Tax Funds Federal Tax Funds In-kind Transfers Private funds 	

Figure 2 Options Profile for a Technology Transfer Organization

A. Basic Outcomes Sought

- To organize world peace research efforts.
- To assemble and disseminate peace related efforts.
- To establish credibility of peace research efforts.
- To investigate processes of conflict development and resolution.
- To allow all countries to achieve a sense of security.
- To reduce the chances of armed conflict.
- To alleviate the worldwide entry problem.
- To promote greater accessibility to resources for all the world's population.
- To reduce worldwide disease and hunger.

Tie Lie

B. Action Initiatives

- Identify and predict potential conflicts.
- Form federal peace department of the U. S. government.
- Distribute foreign economic aid.
- Establish an international peace institute.
- Evaluate past and present peace agencies.
- Establish a peace journal.
- Establish global security information system (Stevenson).
- Develop an economic model for a peaceful world.
- Develop a real-time voice translator.
- Investigate alternative energy sources.
- Map world resources.
- Organize a world peace day.

Action Initiatives Continued

- Develop appropriate technologies for the Third World.
- Develop the sea for human habitation, e.g. floating cities.
- Develop the sea for food production, i.e. aquaculture.
- Build rat proof grain storage in the Third World.
- Redirect world aggressions via sports.
- Develop game theory research applications to international relations.
- Improve urban development in the Third World.
- Re-orient engineering education.
- Develop alternative diets.
- Initiate/intensify arms control efforts.

C. Time Horizon for the Action Initiatives

- One Year
- Five Years
- Ten Years
- 20 Years
- 30 Years
- 50 Years

D. Obstacles to Overcome

- Current Investment in Defense Industry
- Fear of Unknown Consequences of Change
- Narcissistic Decision Making
- Nationalism
- Unsatisfactory Living Conditions Paving Way for Revolutionary Actions

E. Participating Agencies/Groups

- United Nations
- National Academy of Sciences
- Group of 77
- Peace Corps
- European Economic Community
- Department of Defense
- Department of State
- World Bank
- International Monetary Fund
- National Governments
- World Health Organization
- World Populations
- International Institute for Applied Systems Analysis
- Professional Engineering Societies.

F. Instrumentalities

- A vehicle for implementation of world peace efforts.
- A source of funding for world peace efforts.
- A methodology for peace efforts.
- A source of information relevant to peace efforts.
- A short term schedule of peace research activities.
- A long term schedule for peace ventures.
- Personnel to accomplish peace research.

G. Origins of Financing

- Federal Tax Funds
- Private Funds
- In-kind Gifts
- Local Tax Funds
- Foundations
- International Organization.

H. Planning Mode

- Holistic/Systemic
- Process-oriented
- Issue-oriented
- Participatory
- Futures-creative

I. Approach for Implementation

- Idea Generation
- Idea Structuring
- Modeling
- Meetings
- Seminars
- Public Forums

J. Targets

- Governments
- Revolutionaries
- Terrorists
- Inciters
- Individuals
- Intellectuals
- Industry Leaders
- Political Leaders

Figure 3. Options Profile for a Peace Research Forum

D. Design of a Product Engineering Center.

Figure 4 shows an options profile for a product engineering center. Note that this design is 10-dimensional. Goals and Objectives were considered to be the highest priority dimension. The terminology used in this design corresponds to that in Reference 3. The design was carried out by an engineering manager in a product engineering center.

E. Design of an Authority Allocation System.

For purposes of managing new product development in a corporation, an options profile was generated for allocating authority for various decisions. The options profile is shown in Figure 5.

F. Options Field for Reducing Municipal Expenditures.

Figure 6 shows an options field that might be applied to setting up a system for reducing municipal expenditures.

G. Design of a Press Safety System.

A press is a mechanically-powered machine that shears, punches, forms, or assembles metal or other material by means of cutting, shaping, or combination dies attached to slides. The press consists of a stationary bed or anvil and a slide or slides having a controlled reciprocating motion toward and away from the bed surface, the slide being guided in a definite path by the frame of the press. Press safety is aimed at preventing operators from being wounded or killed in accidents.

Figure 7 shows an options profile for a press safety system. Note that the system includes eight dimensions, and this particular system is designed for the situation where, in production, the operator loads a part into a die.

H. Design of a Manufacturing Engineering Organization.

Figure 8 shows an options profile for the design of a manufacturing engineering department. Note that this department is presumed by the designers to have seven dimensions. This particular department is partitioned into product groups (see dimension 1) with a compound-option reward system.

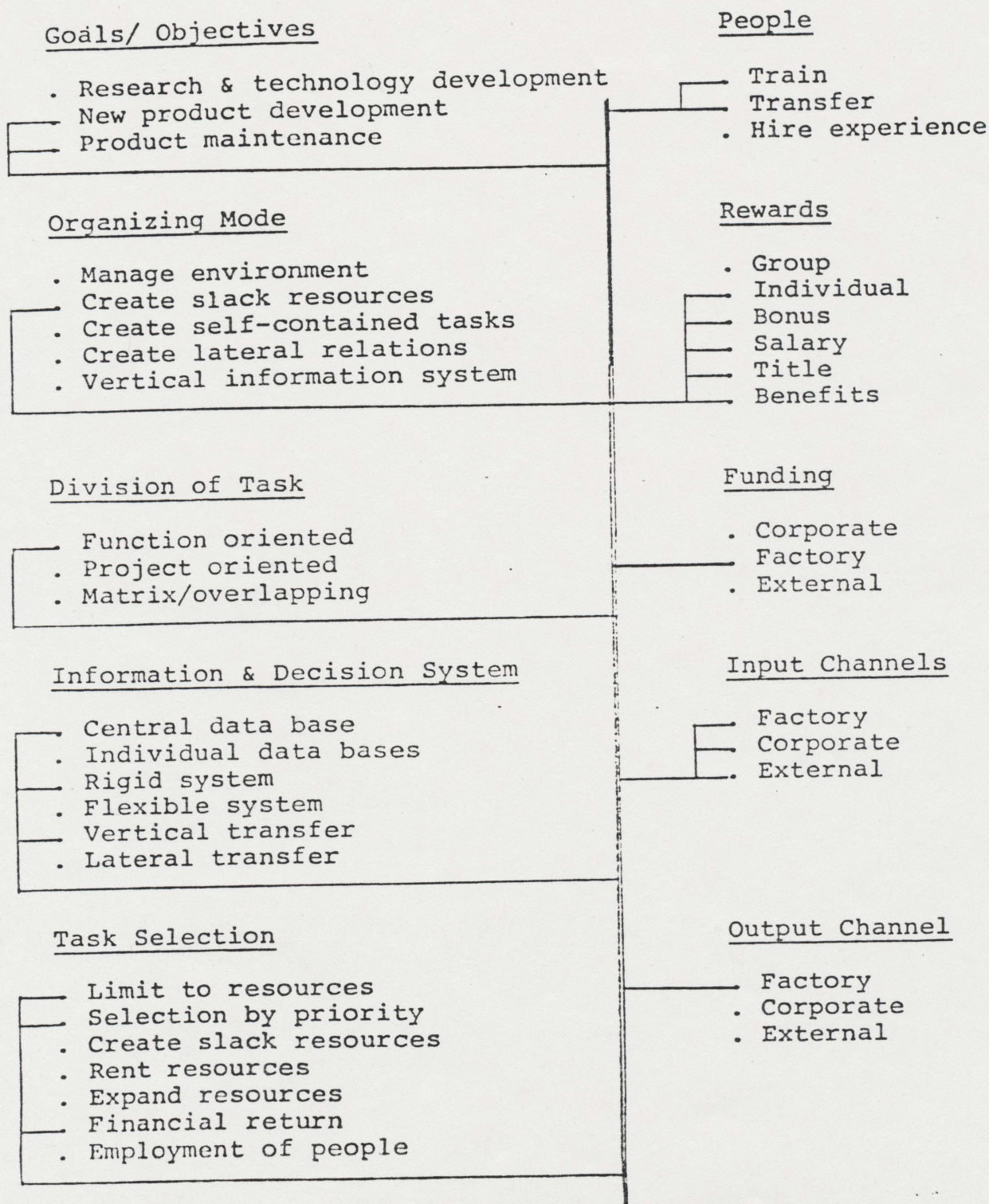


Figure 4 Options Profile for Product Engineering Center

AUTHORITYALLOCATION

Product Design Approval	<u>P.M.</u>	<u>F.M.</u>	C.E.O.
Project Budget	<u>P.M.</u>	F.M.	<u>C.E.O.</u>
Subtask Schedule	<u>P.M.</u>	<u>F.M.</u> *	C.E.O.
Manpower Assignment	<u>P.M.</u>	<u>F.M.</u>	C.E.O.
Functional Budget	<u>P.M.</u>	<u>F.M.</u>	<u>C.E.O.</u>
Project Objectives	<u>P.M.</u>	F.M.	<u>C.E.O.</u>
Functional Methodology	<u>P.M.</u>	<u>F.M.</u>	C.E.O.
Promotion/Pay	<u>P.M.</u>	<u>F.M.</u>	C.E.O.
Functional Resource Pool	P.M.	<u>F.M.</u>	<u>C.E.O.</u>
Manpower Location	<u>P.M.</u>	<u>F.M.</u>	C.E.O.

—— Primary Authority Line

- - - - To Be Consulted

* In this case only, dashed line implies limited approving authority, see text.

P. M. refers to the Project Manager

F. M. refers to the Functional Manager

C. E. O. refers to the Chief Executive Officer

Figure 45. Options Profile for Authority Allocation in New Product Development

Fi

1. Municipal Team	2. Public Inputs	3. Outside Inputs	4. Outside Pressures	5. Heritage ¹⁴
<ul style="list-style-type: none"> • Mayor • Mayor & Council • Department Heads • Planning Commission • Planning Committee • Government Employees 	<ul style="list-style-type: none"> • Council Meetings • Budget Hearings • Neighborhood Meetings • Availability of Public Officials • Letters to Government • Letters to the Editor • Public Surveys • Court Suit 	<ul style="list-style-type: none"> • Consultants • Vendors 	<ul style="list-style-type: none"> • State Government • Federal Government • Regional Government Units • Contracts 	<ul style="list-style-type: none"> • Past • Present • Future
6. Time Frame	7. Integration of Government Units	8. Input Methodologies	9. Labor	10. Data Handling
<ul style="list-style-type: none"> • Week • Month • Year • 5 Years • 10 Years • 25 Years • 50 Years 	<ul style="list-style-type: none"> • Independent Units • Special Districts • County Government 	<ul style="list-style-type: none"> • Lecture • Random • Public Survey • Nominal Group Technique • Interpretive Structural Modeling • Delphi with Government Participants • Delphi with Public Participants 	<ul style="list-style-type: none"> • Skilled Trades • Junior College • Semi-skilled • Volunteers • Temporary • Degreed • Unionized 	<ul style="list-style-type: none"> • Handwritten • Typed • Computer Printout • Magnetic Tape • Microfilm

Figure 6. Options Field for Reducing Municipal Expenditures

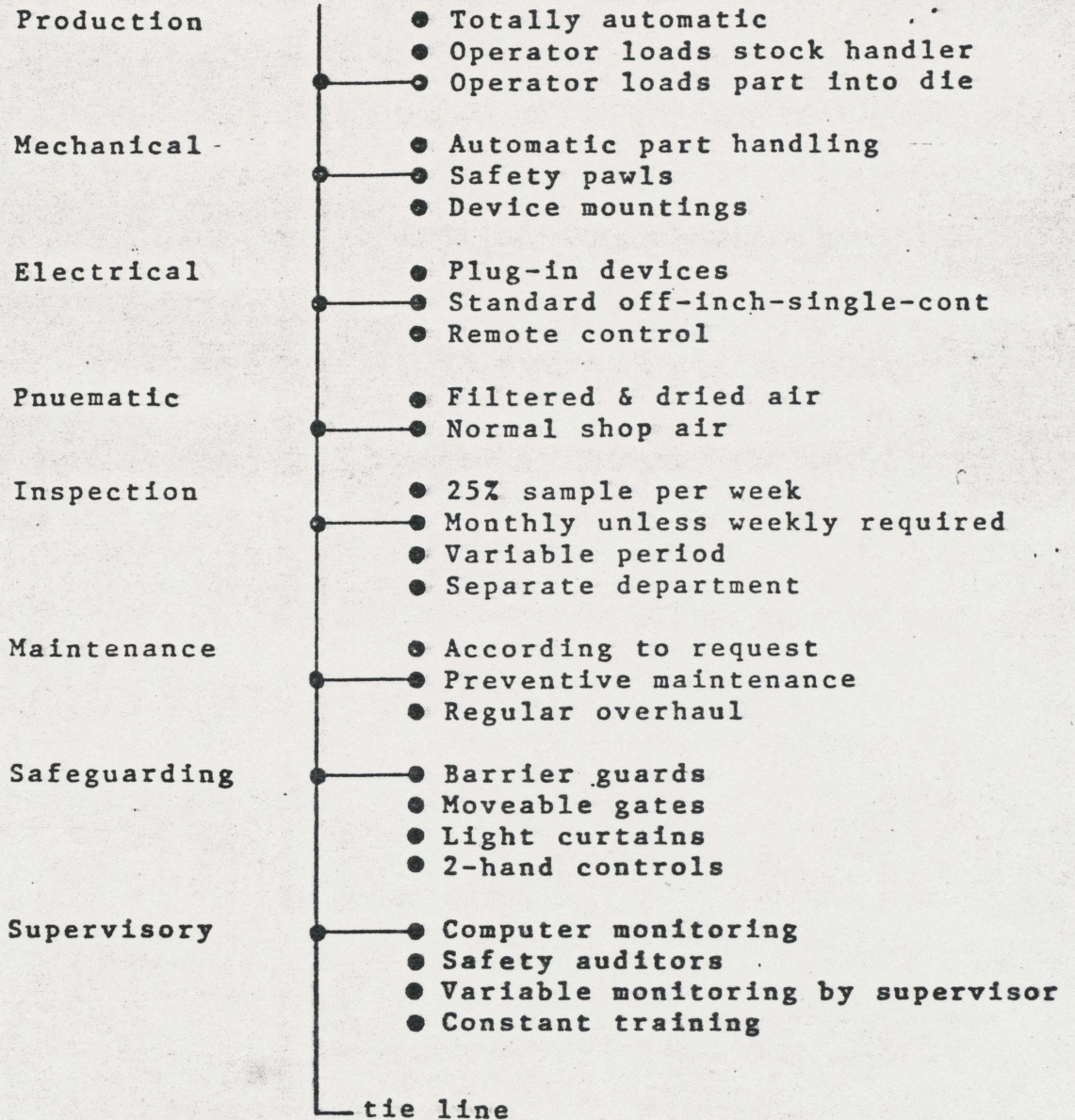
DIMENSIONSOPTIONS

Figure 7. Options Profile for a Press Safety System

OPTIONS PROFILE FOR THE DESIGN OF A MANUFACTURING ENGINEERING DEPARTMENT

ORGANIZATIONAL STRUCTURE	INDIVIDUAL ACTOR SKILLS	ORGANIZING MODE	REWARD SYSTEM	
<ul style="list-style-type: none"> * Functional Division of labor * Product Divisionalization * Span of Control * Distribution of Power 	<ul style="list-style-type: none"> * can read and write * comprehend technical information * effective communicator * adequate technical background 	<ul style="list-style-type: none"> * Slack Resources * Self-contained tasks * Vertical Integration * Lateral Relations 	<ul style="list-style-type: none"> * Bonus Plan * Profit Sharing * Personal Recognition * Promotion * Seniority Benefits * Continued Employment 	
	<p>INFORMATION PROCESSING AND STORAGE</p> <ul style="list-style-type: none"> * use of computers * manual files * consistent coding * data base * update & distribution frequency * On-line systems 	<p>FORMAL INFORMATION SOURCES</p> <ul style="list-style-type: none"> * trade journals * text books * handbooks * professional journals * consultants * Conferences * vendor catalogs 	<p>INFORMAL INFORMATION SOURCES</p> <ul style="list-style-type: none"> * internal experts * vendor experience * other industries * University research * consumer feedback * competitors 	SYSTEMS TIE LINE

Figure 8. Options Profile for the Design of a Manufacturing Engineering Department

The Design "Quad"

You may notice that the examples did not specifically point out the clusters of dimensions. But basically, we are dealing with a four-level structure which we call the design "quad".

This structure takes the form shown in Figure 9.

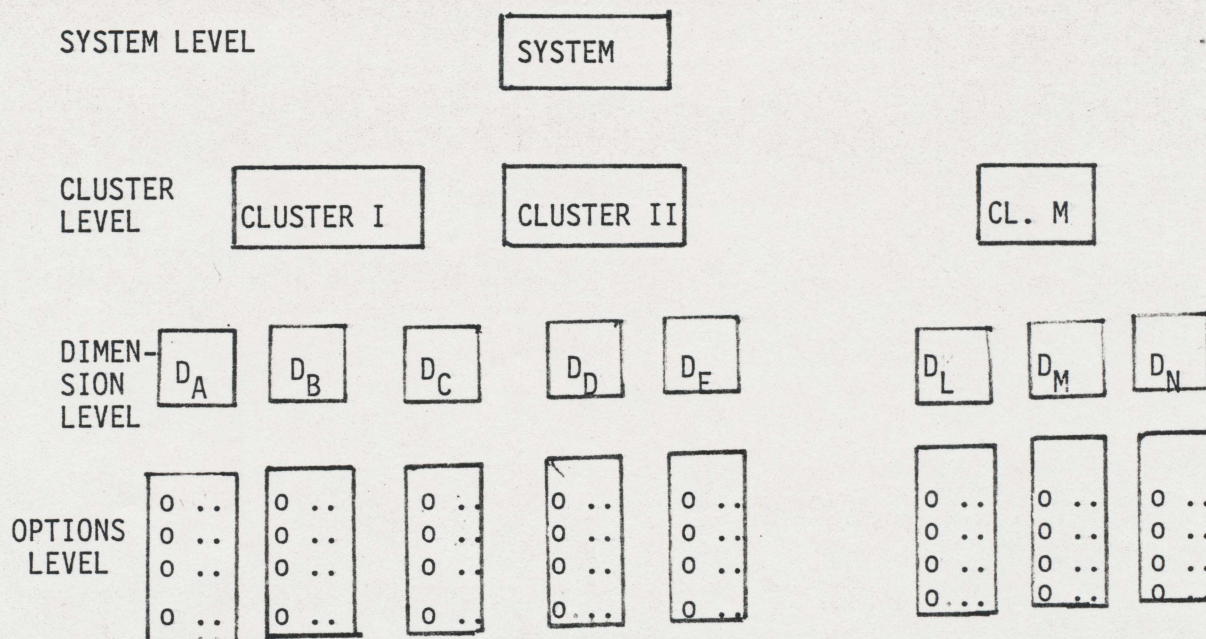


Figure 9. The design "Quad"

Notice that when an options profile is prepared, some of the options may require further elaboration. Any selected option can become a new "system" to be considered, and a new quad can be formed to deal with that option in a more specific way. In this way, a complete design may be formulated as a system of quads, the one we have described being the topmost quad in the system.

The Law of Requisite Variety

As embodied in the OF method of design, the Law of Requisite Variety states that if a system is known to have n dimensions, then the designer must specify the system in n dimensions, and not leave out any dimensions. Otherwise the design will lack the requisite variety and cannot be expected to perform according to the goals set forth for it.

References

1. J. Giampapa, "Design Innovation in the Judicial System: The Role of the Court Administrator", Proceedings of the Southeastern System Symposium, IEEE, New York, 1980, pp. 326-336.
2. D. Keever, "Design of Technology Transfer Organizations for Improving Productivity in the United States", Proceedings of the Southeastern System Symposium, IEEE, New York, 1980, pp. 337-348.
3. Jay Galbraith, Organization Design, Addison-Wesley, Reading, MA, 1977.