

**RELEVANCE TREE AND MORPHOLOGICAL ANALYSIS**

by

The Futures Group

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## I HISTORY

A "relevance tree" is an analytic technique that subdivides a broad topic into increasingly smaller subtopics. The output is a pictorial representation with a hierarchical structure that shows how a given topic can be subdivided into increasingly finer levels of detail.

"Morphological analysis" is a complementary technique, often used in conjunction with a relevance tree, that is used to identify new product opportunities. This technique involves mapping options to obtain an overall perspective of possible solutions.

Morphological analysis was first applied to the aerospace industry by F. Zwicky, a professor at the California Institute of Technology. Zwicky chose to analyze the structure of jet engine technology. His first task was to define the important parameters of jet engine technology, which include thrust mechanism, oxidizer, and fuel type. He continued, in turn, to break each of these technologies down into its component parts. Having exhausted the possibilities under each parameter heading, the alternative approaches were assembled in all possible permutations: for example, a ramjet that used atmospheric oxygen and a solid fuel. For some permutations, a jet engine system already existed; for others, no systems or products were available. Zwicky viewed the permutations representing "empty cells" as stimuli for creativity and for each asked, "Why not?" For example, "Why not a nuclear-powered ceramic fan-jet?"

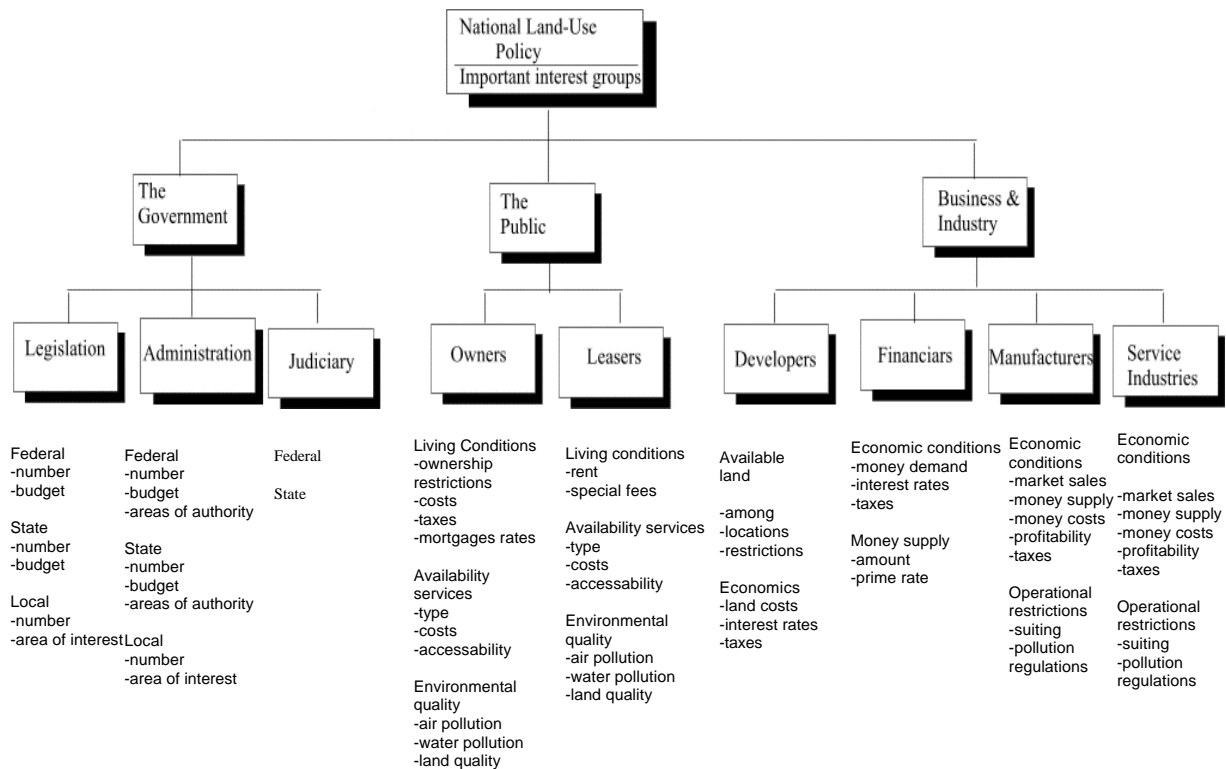
Although Zwicky coined the term morphological analysis, the technique predates him and can be traced back to Ramón Lull (1235-1315), according to Lucien Gerardin. Zwicky was the first to use the technique in modern-day applications. The primary use of morphological analysis has been in technological forecasting and new product ideation. However, the technique can also be used in constructing scenarios.

## II DESCRIPTION

**Relevance-tree analysis** has proven to be a powerful intellectual stimulus to ensure that a given problem or issue is prepared in comprehensive detail and that the important relationships among the items considered are shown in both current and potential situations.

A relevance tree looks much like an organizational chart and presents information in a hierarchical structure. The hierarchy begins at a high level of abstraction and descends with greater degrees of detail in succeeding levels of the tree. The entries at a particular level, when taken together, are intended to describe completely the item to which they are connected in the level above. Ideally, each entry at a particular level is orthogonal; that is, it should not overlap with any other entry, thus being mutually exclusive of other entries. Finally, the items at a given level should be addressed from the

"same point of view." These conditions are often difficult to achieve in practice. If pursued properly, the structure can ultimately lead to a clearer understanding of the topic under analysis. For example, in the case shown here, the entries in the tree are descriptive of the socioeconomic characteristics of important interests involved in land use. Thus, the major branches in the tree might include the government, the public, business, and industry — as all are involved in some way with, and impacted by, federal land-use regulations. For the public, this branch might be described in terms of owners and leasers; owners, in turn, might be described in terms of living conditions, available services, and the environmental quality of their residence. At greater levels of detail, living conditions might be further defined by restrictions on ownership relating to residence size, type, location; conditions imposed on ownership of second homes; purchase costs; taxes, mortgage rates, etc. — all quantitative variables.



In the case of business and industry, their interests might be represented by land developers, financiers, manufacturers, and service industries. Manufacturers might be described in terms of their economic conditions related to sales of various products, money supply, the cost of money, profitability, and various tax regulations — also quantifiable variables. Operational restrictions for manufacturers might be further defined by various sitting criteria and pollution regulations. The same economic conditions might also describe the most important industrial sectors, such as agriculture, chemicals, energy, food processing, metals, minerals, transportation, and so on.

The aim in relevance-tree analysis is to carry the level of detail to where the items or issues involved are sufficiently clear, preferably in quantified terms, so that their nature can be reviewed in terms of current conditions and potential options. In the land-use case, an assessment of demands and attitudes about consequences of alternative future federal land-use policies is more likely. Alternative assessments result because preparation of a relevance tree often leads to insights about future conditions and important interests that are not current factors in decision making.

**Morphological analysis** is a proven ideation method that leads to "organized invention." The technique allows for two key elements:

- a systematic analysis of the current and future structure of an industry area (or domain) as well as key gaps in that structure.
- a strong stimulus for the invention of new alternatives that fill these gaps and meet any imposed requirements.

### III HOW TO DO IT

Morphological analysis involves mapping a discipline to obtain a wide perspective of existing solutions and future possibilities. Zwicky outlined five basic steps in the development of the morphological method:

1. Formulation and definition of a problem;
2. Identification and characterization of all parameters toward a solution;
3. Construction of a multidimensional matrix (morphological box) whose combinations will contain all possible solutions;
4. Evaluation of the outcome based on feasibility and achievement of desired goals; and
5. In-depth analysis of best possibilities considering available resources.

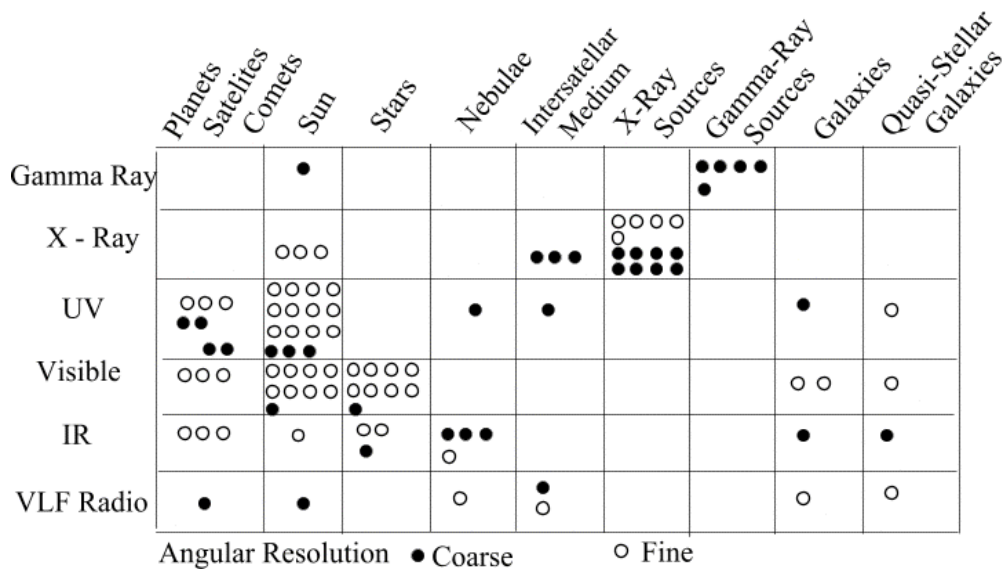
Steps 2 and 3 form the heart of morphological analysis since Steps 1, 4, and 5 are often involved in other forms of analysis. Step 2, identification of parameters, involves studying the problem and present solutions to develop a framework. This step can involve developing a relevance tree to help define a given topic. Once parameters are identified, a morphological box can be constructed that lists parameters along one dimension. The second dimension is determined by the nature of the problem.

**MORPHOLOGICAL BOX**

<b>Values</b>						
<b>Parameters</b>						
Parameter A						
Parameter B						
Parameter C						
Parameter D						

For example, the McDonnell Douglas corporation under contract to the National Aeronautics and Space Administration employed morphological analysis in an astronomy planning study. The technique was used to explore three dimensions: astronomical bodies; portions of the electromagnetic spectrum; and particular parameters of interest, such as angular resolution. The following matrix was developed with each cell representing a potential series of measurements.

**EXAMPLE OF A MORPHOLOGICAL BOX**



Source: Theodore Gordon and M. J. Raffensperger, "The Relevance Tree Method for Planning Basic Research," *A Guide to Practical Technological Forecasting*, New Jersey: Prentice-Hall, 1973.

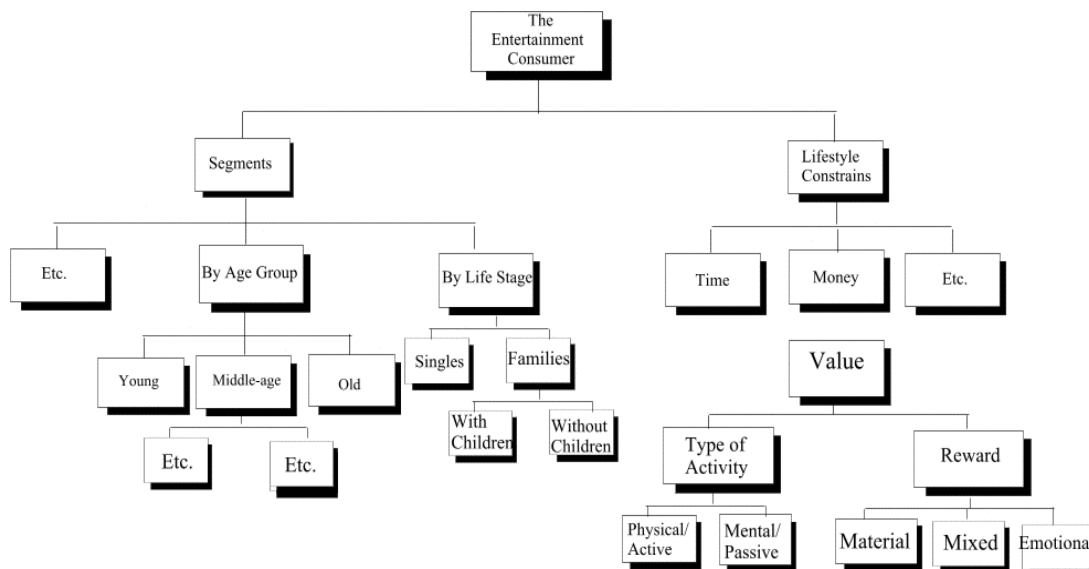
The purpose of morphology is to organize information in a relevant and useful way in order to help solve a problem or stimulate new ways of thinking. No "right" or "wrong" way exists for constructing a morphology. Good knowledge about a problem or issue, however, is essential to developing the most effective morphological framework.

A morphological framework could incorporate a relevance tree and define the parameters of the entertainment industry through either of two morphological diagrams:

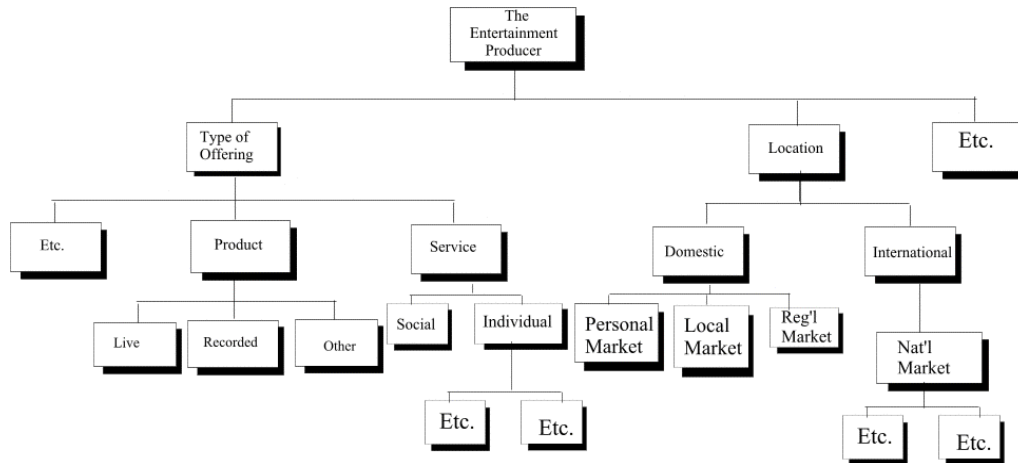
- **Consumer Morphology.** A "demand-side" morphology would identify the key parameters and subparameters of entertainment with regard to consumer issues, concerns, and needs.
- **Producer Morphology.** A "supply-side" morphology would identify the key parameters and subparameters of entertainment with regard to how various options are made available to consumers.

Current entertainment options would be arrayed in this framework, and trend analysis would describe the forces that shape the future of the industry and help identify new targets of opportunity.

### The Entertainment Consumer



### The Entertainment Producer



Parameters at an appropriate level of detail would form a morphological matrix. Dimensions from the consumer morphology would follow the horizontal axis; dimensions from the producer morphology would follow the vertical axis. A preliminary example of this type of matrix is shown below.

Consumer	SINGLES (ALL AGES)						FAMILIES WITH CHILDREN		
	Physical Activity			Mental Activity			Physical Activity		
	Material Reward	Emotional Reward	Mixed Reward	Material Reward	Emotional Reward	Mixed Reward	Material Reward	Emotional Reward	Mixed Reward
Producer									
Live product	Casino table games			Plays					
"Recorded" product	Slot machines			Movie-theaters					
Mixed product		Dance clubs			Disney Park				
Individual "service"									
Social "service"		Dance clubs							

Michel Godet posits that morphological analysis is also appropriate for scenario construction. The Hudson Institute combined morphological analysis with scenarios to create a variety of nuclear threats and potential worlds. Godet describes scenarios as configurations of components, such as

demographic, economics, etc., with a certain number of possible states for each of these components. In essence, a morphological space can define a range of possible scenarios.

#### IV STRENGTHS AND WEAKNESSES

A number of strengths give power to these techniques, including:

*Provision of new insights.* Material is often presented in a manner that creates a greater understanding of a concept. Relevance trees can break down topics in new and insightful ways. Morphological analysis provides key insights on new research directions.

- Richness of data. Morphological analysis can provide a multitude of combinations and permutations not yet explored.
- Systematic analysis. These techniques allow for a systematic analysis of the current and future structure of an industry (or system) and identification of key gaps.

Potential drawbacks include:

- *An overabundance of possibilities.* Morphological analysis may yield too many possibilities. Human judgments are still needed to direct the outcome.
- *Human error.* The development of both relevance trees and morphological boxes requires critical judgments. If the underlying thought processes are not insightful, the outcomes of these methods will be weak.

#### V FRONTIERS

The large number of combinations derived by morphological analysis is often a hindrance to its use. In an effort to minimize this problem, Michel Godet introduced a methodological approach to scenarios, which involves a number of steps:

- Identification of economic, technical, and strategic criteria to assess and select the best solutions;

- Identification of crucial components and their classification by criteria of weighted differences; and
- Introduction of constraints of exclusion or preference.

This approach has been integrated into a micro-software package (MOPPHOL).

The Futures Group (TFG) has developed a computer analysis program that facilitates the process and organizes the output in priority. In a recent study for a major chemical company, TFG used a general permutation program, customized for food care, to analyze food storage and food preparation technologies in priority. Two permutation programs were run: a food storage program, and a food preparation program. These programs permuted all possible combinations of elements from the three subsystems to form a large set of potential products.

For each subsystem element, two numbers were entered to describe how well each element met the two criteria:

- Breakthrough potential; and
- Relationship to client company.

The criteria were weighted in terms of their importance to the client. For example, if a product has a high breakthrough potential, that criterion may be given a higher weight than relationship to client company. The computer program combined all possible permutations of all subsystem elements and derived a score for each product composed of those elements. The products were then rank-ordered according to their score so that the products coming closest to meeting all the criteria were listed first.

The following journals cover new developments in morphological analysis:

**Futures**

**Publisher:** Butterworth-Heinemann  
Linacre House, Jordan Hill  
Oxford, OX2 8DP UK  
Phone +44 865 310166  
Fax: +44 865 310898

**Futures Research**

*[Zukunftsforschung]*

**Publisher:** Swiss Society for Futures  
Research  
SZF, Haldenweg 10 A, Muri, Ch-3074,  
Switzerland  
Phone: 031-952-66-55  
Fax: 031-952-68-00

**Futures Research Quarterly**

**Publisher:** World Future Society  
7910 Woodmont Avenue, Suite 450  
Bethesda, MD 20814 USA  
Phone: (301) 656-8274 Fax: (301) 951-  
0394

**Futurescope**

**Publisher:** Decision Resources, Inc.  
17 New England Executive Park  
Burlington, MA 01803 USA  
Phone: (617) 270-1200 Fax: (617) 273-  
3048

**The Futurist**

**Publisher:** World Future Society  
7910 Woodmont Avenue, Suite 450  
Bethesda, MD 20814 USA  
Phone: (301) 656-8274  
Fax: (301) 951-0394

**Long-Range Planning**

**Publisher:** Pergamon Press  
Headington Hill Hall  
Oxford OX3 OBW UK  
Phone: (0865) 79141 Fax: (0865) 60285

**Social Indicators Network News (SINET)**

**Publisher:** P.O. Box 24064  
Emory University Station  
Atlanta, GA 30322 USA  
Phone: (404) 373-4756 Fax: (404) 727-  
7532

**Technological Forecasting and Social  
Change**

**Publisher:** Elsevier Science Publishing Co.,  
Inc.  
655 Avenue of the Americas  
New York, NY 10010 USA  
Phone: (212) 633-3941 Fax: (212) 633-  
3990

**Technology Forecasts and Technology  
Surveys**

**Publisher:** Technology Forecasts  
205 S. Beverly Drive, Suite 208  
Beverly Hills, CA 90212 USA  
Phone: (213) 273-3486

## **VI      SAMPLE OF APPLICATIONS**

Applications of relevance tree and morphological analysis abound.

- Zwicky, developer of morphological analysis, claims over 30 industrial applications.
- The Hudson Institute combined morphological analysis with scenarios to create a variety of nuclear threats and future possible worlds.
- Look-Out Studies Group used the technique for Thomson-CSF in a study of communication by mass media.
- TFG incorporated relevance trees and morphological analysis in numerous studies, including new product ideation for consumer products firms and role definition for the unmanned vehicles in current and future U.S. Coast Guard missions.

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