Morphological Analysis Perspective (MAP) - An application of General Morphological Analysis (GMA) to software engineering project management

In the late 1940s, Fritz Zwicky proposed General Morphological Analysis (GMA) as a generalized form of morphological research. Fritz Zwicky was a Swiss astrophysicist and aerospace scientists who was based at the California Institute of Technology [1].

What is Morphology?
The term morphology originated from classical Greek (morphē) which means shape or form. The general definition of morphology is “the study of form or pattern”, i.e. the shape and arrangement of parts of an object. The “objects” in question can be physical (e.g. an organism or an ecology), social/organizational (e.g. a corporation or a social institution), or mental (e.g. linguistic forms or any system of ideas) [1].

General Morphological Analysis (GMA) is essentially a method for identifying and investigating the entire set of possible relationships contained in a given problem [1]. It requires the identification of all the parameters or dimensions of the problem to be investigated. As described by Fritz Zwicky [3], the morphological method is comprised of five steps. GMA enables the analysis of complex, multidimensional problems.

Cross-consistency assessment uses the concept that many pairs of values in the morphological field are mutually incompatible. Therefore any consideration of values containing mutually incompatible values would also be mutually inconsistent [1]. To conduct a cross-consistency assessment a matrix is created of all the parameter values in the morphological field and each value is compared, pair-wise, with one another. A judgment is made to determine if the pair can coexist, i.e. the pair represents a consistent relationship [1].

General Morphological Analysis has primarily been used for developing scenario and strategy laboratories and for structuring and analyzing policy spaces [1]. For example in his address to the Swedish Parliamentary IT Commission, Tom Richey discussed the Swedish Total Defense authorities’ use of morphological analysis to develop a strategy for the Swedish bomb shelter program after the Cold War [1]. A small heterogeneous group of specialists - no more than 5 to 7 people was formed. The individuals in the group represented different aspects of the issue; this included representation for financial, political, military, technical, security policy and ethical aspects of the issue. The primary parameters of the problem were defined along with their respective values (Figure 3).

What is the Morphological Analysis Perspective (MAP)?
The Morphological Analysis Perspective (MAP) is the iterative application of General Morphological Analysis to a software engineering project during the project definition and planning phase.

Why use the Morphological Analysis Perspective (MAP)?
First, corporate strategic objectives have become exceedingly complex. John C. Camillus describes corporate strategy issues as “wicked” problems [4]. In this context the definition of wicked is:

“A wicked problem has innumerable causes, is tough to describe, and doesn't have a right answer” [4].

The MAP provides a visual representation of the total problem and enables the development of a scope with input from all stakeholders including technical stakeholders.

Second, Software Engineering Project Managers, according to The Software Engineering Body of Knowledge Version 3.0, have to coordinate the activities within fifteen knowledge areas and seven related disciplines[2]. This makes software engineering project management a complex multidimensional management problem. The MAP provides a visual representation of the total problem and enables the development of an effective plan utilizing input from all dimensions.

Third, the goal of the software engineering project manager is to successfully complete the project. Success is a product of three abstract variables [5]:
1. A properly managed project
2. A competent manager
3. A mature software engineering environment

The assumption of this research is that the project manager is competent and the software engineering environment is mature. The focus, therefore, is on ensuring that the project is properly managed. 1. Lubekich and A. Parra defines a foundational component of a properly managed project as:

“A properly managed project has a clear, communicated, and managed set of goals and objectives...” [5]

The Morphological Analysis Perspective (MAP) creates visual map of the entire problem using the Morphological field and enables the creation of goals and objectives that are clear and easy to communicate.

Figure 1: Morphological Field

The first two steps are the analysis phase of the method. The problem is concisely defined and the parameters (or dimensions) of the problem are identified. Each dimension is assigned a range of relevant “values” or conditions [1]. The next three steps are the synthesis phase of the method. For each parameter the defined range of relevant values or conditions are documented using a morphological field (see Figure 1) and a morphological box - also known as a "Zwicky box" is constructed (see Figure 2). The morphological field and Zwicky box are a representation of the total problem set. The total problem set represents a well-defined problem which can now be reduced to a smaller set representing the solution space. The reduction of the total problem set is achieved using “cross-consistency assessment” [1].

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Figure 2: Zwicky Box

Figure 3: Morphological field

The morphological field represented (4x4x3x3x4) 2,304 possible configurations. The morphological analysis for this problem was completed using a computer application. The application facilitated entering the parameters along with their values and enabled the group to easily build the cross-consistency matrix and conduct pair-wise comparisons. This reduced the problem set of 2,304 possible scenarios down to a solution set with only 125 scenarios. The computer application also enabled the group to visualize possible solutions by using parameter values as a single input driver (Figure 4) or multiple input drivers (Figure 5).

Figure 4: Solution space (blue) with single driver input (red)

Figure 5: Solution space (blue) with multiple driver input (red)
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REFERENCES


