GQM+Strategies®: Experiences from Industrial Case Studies and Visualization Needs

Henning Barthel, Jens Heidrich, Jürgen Münch, Adam Trendowicz
Fraunhofer Institute for Experimental Software Engineering
Fraunhofer-Platz 1, 67663 Kaiserslautern, Germany, +49-631-6800-0
{henning.barthel, jens.heidrich, juergen.muench, adam.trendowicz}@iese.fraunhofer.de

Abstract

Explicitly linking software-related activities to an organization's higher-level goals has been shown to be critical for several purposes such as aligning activities to strategies or linking budgets to strategic objectives. GQM+Strategies® provides mechanisms for explicitly linking goals and strategies in an organization based on goal-oriented measurement. Developing strategic measurement systems with GQM+Strategies® requires that higher-level decision makers are involved and that, as a consequence, their information needs are addressed. Experience has shown that it is important to use adequate representations for decision makers when involving them in the definition of strategic measurement systems. This article sketches practical experience from three industrial pilot studies that applied the method, derives requirements for representing strategic measurement systems to decision makers in an adequate format, and proposes visualization mechanisms that can contribute to the fulfillment of the stated requirements. In the conclusion, next steps and future research questions are sketched.

1. Introduction

Explicitly linking software activities to an organization's higher-level goals is becoming increasingly important for a multitude of reasons. Studies show, for instance, that funding decisions in IT investments are increasingly made on higher levels of company hierarchies than before, thus rather by managers than by technicians [4]. Based on the authors' experience, being able to show the contributions of software-related activities and demonstrate their value for the strategic objectives of an organization significantly helps in obtaining sufficient resources for critical activities (such as QA). In addition, this defends software and IT departments from irrational budget cuts and personnel reductions in case of critical economic situations.

GQM+Strategies® is an approach for clarifying and harmonizing goals and strategies across all levels of an organization, communicating business goals throughout the whole company, aligning goals with strategies, monitoring the deployment strategy, and obtaining feedback about the success or failure of strategies and business goals [3]. One central result of the approach is a model of a strategic measurement system, the so-called GQM+Strategies® grid. It specifies goals and strategies across all levels of an organization, including the measurement program needed to monitor and control them.

Experience gained by the authors when developing such grids with organizations has shown that it is crucial to include not only engineers but also managers in the development of such grids. The authors have learned that adequate representations for grids addressing the specific viewpoints and information needs of decision makers are essential for their involvement. Especially during the elicitation of a company's goals and strategies and during the process of making goals measurable, the authors recognized the need for visual aids to structure the provided information and for discussing and reviewing the results with decision makers.

Section 2 of this article sketches practical experience from three industrial pilot studies that applied the method, Section 3 derives requirements for decision makers based on the case studies, Section 4 discusses visualization mechanisms for applying GQM+Strategies® in practice, Section 5 presents related work in the field, and Section 6 summarizes the article and briefly discusses future work.

2. Experiences from Case Studies

The GQM+Strategies® approach was applied in different industrial settings. The following section pre-

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sents experiences and lessons learned from three selected case studies from different domains.

(1) Case study #1 was conducted in the context of a European telecommunication company. They used the approach to drive strategic improvement programs and to support the paradigm shift towards purpose-driven metrics.

When the approach was applied, it became clear that easy-to-use templates have to be developed for documenting a GQM+Strategies® grid and that the connection to existing standards needs to be clarified. When deploying the method and the resulting grid to the company, it is important to address operational/strategic planning including, for instance, the sequence and scheduling of different strategies. Moreover, the relationships between the different goals on different organizational levels need to be clarified in terms of conflicting or supporting goals

(2) Case study #2 was conducted in the context of a European automotive supplier. Their intention was to support CMMI Measurement and Analysis (MMI), which was enforced by top-level management. They used the approach for harmonizing strategies and goals across different units and defining corresponding management objectives. The company developed integrated tool support for GQM+Strategies®, on top of an existing GQM infrastructure. This includes mechanisms for storing and analyzing the evolution of all information and for activating goals and strategies (e.g., deploying them to different organizational units of the company).

Creating transparency helped them to overcome mistrust and to define goals at the interfaces with collaborating organizations/units. It also became clear that resource needs can be justified in terms of the goals they are contributing to, and the consequences of budget cuts in terms of goal attainment could be illustrated. The company distinguished between different types of goal inheritance between different organizational levels, such as goals inherited identically from one level to another or goals inherited with different target values only, or goals refined by different subgoals.

(3) Case study #3 was conducted in the context of an Asian company from the insurance domain. Their main motivation for applying the method was to align their strategies and goals for a new business domain and to quantitatively measure whether they would be able to achieve the goals. Moreover, they intended to clarify the goals and strategies of different organizational units involved and to define an IT strategy for the new domain.

The method helped the company to identify gaps in the alignment of their goals, strategies, and measurement data, and to fill these gaps. For getting accepted in such an industrial setting, the GQM+Strategies® grid needs to be documented in an easy-to-understand, easy-to-maintain, and easy-to-exchange manner. Tool support was needed for dealing effectively with more complex grid structures.

3. Requirements for Decision Makers

In the following, the basic needs of decision makers, which underline the GQM+Strategies® approach [2], are derived on the basis of our experience from practical applications and resulting benefits are discussed. The approach is based on the popular GQM approach [1] and supports a company in structuring its goals and strategies across different organizational levels. *Organizational goals* (such as "improving customer satisfaction") are defined and *strategies* are formulated that deal with the goals (such as "testing reliability in"). The strategies defined on one organizational level (e.g., the business level) need to be mapped to the goals of the lower levels (e.g., the software level). *GQM models* are defined for each organizational goal to measure the success/failure of attaining the goal. Attached to the goals and strategies at each level of the model is information about relevant *context factors* and *assumptions* that support interpreting and rolling up the resulting measurement data at each level so that a clear plan of action can be defined if a goal/strategy fails. The whole structure is called a GQM+Strategies® grid.

In analogy to [11], some basic requirements for using such grids as a basis for decision-making can be derived: (R1) Natural representation: The defined grid needs to represent the organizational structure, goals, strategies, and measurement initiatives in a natural way so that decisions can be made transparently.

(R2) Measurability: Using the grid as an active instrument for monitoring organizational goals and strategies requires goals to be quantified and their attainment to be measured so that deviations from target settings are easy to detect and countermeasures can be introduced effectively.

(R3) Customizability: The defined grid needs to be custom-tailored to the specific organizational needs, especially reflecting the underlying assumptions for choosing specific goals and strategies. Moreover, the grid needs to be detailed to the operational level of the company, so that the defined strategies can actually be implemented.

(R4) Formality: The grid needs an appropriate degree of formality so that it can consistently be communicated within the organization and misunderstandings

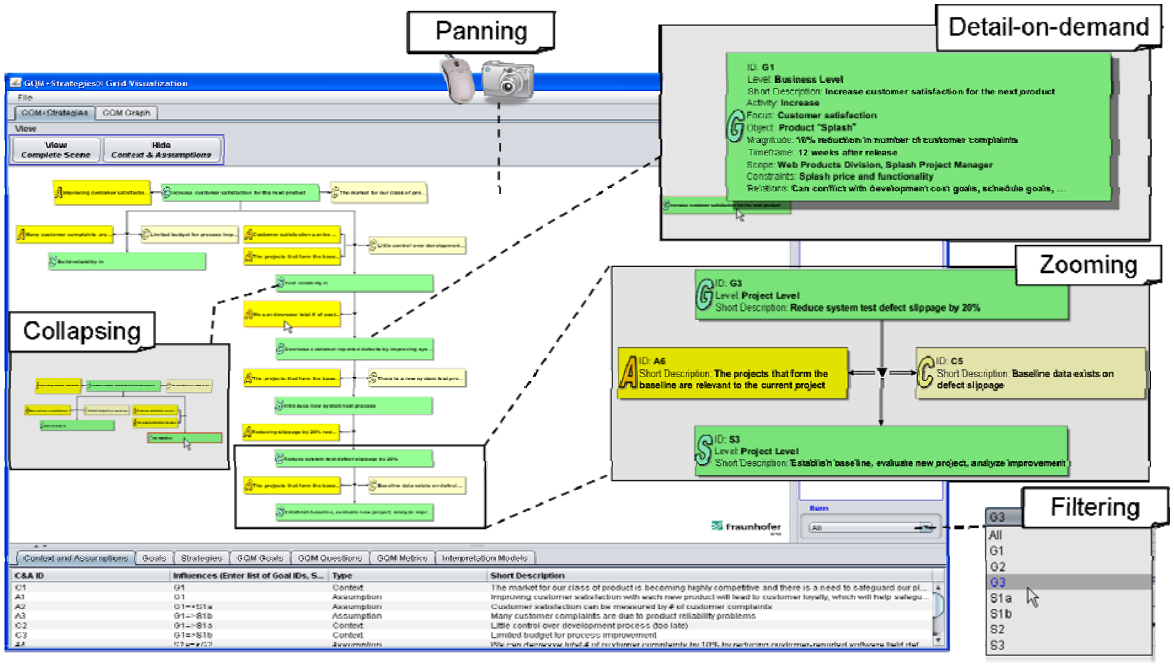

Figure 1: Sample Visualization of a GQM⁺Strategies® Grid

can be avoided.

(R5) Understandability: The grid needs to be communicated within the organization. Therefore, the representation of the grid needs to be easy to understand by all decision makers so that a clear plan of action can be derived.

(R6) Integration: For carrying out the strategies of the grid and for monitoring and controlling the goals, the grid needs to be integrated into organizational and development processes (e.g., integration with the existing measurement procedure and infrastructure).

(R7) Flexibility: To actually be usable, the grid must represent an up-to-date picture of the organization. Changes in the market (and consequently changes of business goals) need to be reflected in the grid. This requires a flexible, easy-to-maintain infrastructure.

(R8) Traceability: The GQM⁺Strategies® grid defines links between different goals, strategies, and GQM models on different levels of the organization. For each of those elements, the decision maker must be able to effectively access the rationale (context and assumptions) for defining the element and the effects/relationships it has to other elements of the grid so that decisions can be made on a sound basis.

From these requirements, some essential benefits arise for decision makers: (B1) Communication facilities: An appropriately presented grid (R1, R4, R5) supports different people in the organization in understanding each other and in coordinating decisions across different levels of the organization. (B2) Packaging facilities: A formalized and tailorable grid (R4, R3) allows for packing and reusing the grid (for different parts of the organization). (B3) Analysis and reasoning facilities: A grid that is measureable with explicitly specified relationships (R2, R4, R8) is the basis for sound analysis and reasoning. (B4) Guidance and control facilities: An appropriately represented, measurable, well understood and traceable grid (R1, R2, R5, R8) is required for guiding decisions and controlling goals and strategies. (B5) Transparent decision-making facilities: A customizable grid, which is integrated into all relevant processes and reflects an up-to-date picture of the organization (R3, R6, R7), allows for transparent decision-making.

4. Visualizing GQM⁺Strategies® Grids

The requirements and resulting benefits listed in Section 2 were taken as a basis for defining an appropriate representation of a GQM⁺Strategies® grid for decision-making. Examples from practice show that such grids can be huge for a whole organization (containing dozens of goals, strategies, context and assumptions, and GQM models). Scalability is one issue when dealing with such grids. The tree-like structure defined by a grid is very intuitive, yet cognitively difficult to grasp for large and complex grids. Therefore,

proper visualization and navigation support is essential for meeting the basic requirements. In this section, we will focus on one specific visual representation that was created for grids and corresponding tool support. Addressing the requirements in a more comprehensive way would need to take into account other aspects (such as processes for how to create, use, and maintain the grid), which is beyond the scope of this paper.

Because it is crucial for effective decision-making to understand the effects of any changes in the context of a grid's entire set of goals and strategies, appropriate visualization techniques are necessary for providing an overview of the overall grid and offering dedicated abstraction, interaction, and drill-down capabilities.

We used the *InSEViz* framework, developed at Fraunhofer IESE, for effectively visualizing 2D structures for implementing the visual grid representation. Figure 1 shows a sample visualization using the framework. For visualizing the relationships between different objectives at various organizational levels, node-link diagrams representing connections as edges between vertices are used. The goals and strategies as well as the context factors and assumptions attached to them are visualized using graphical node elements such as text, geometric shapes and images, shadows, and color fills. The same approach is used for visualizing the GQM models. All nodes as well as geometrical edges representing the links between them are automatically layouted by the framework, reflecting the overall structure of the grid. This supports the user in better understanding (R1, R5) the relationships between goals and strategies across all levels of the organization, which improves the traceability (R8) and maintainability (R7) of the GQM+Strategies® grid.

However, a large number of nodes and links increase the overall visual, and thus the cognitive, complexity of a grid. In order to reduce this complexity, a filtering approach that implements concept- and role-oriented views is used. For instance, according to his role, a user can switch between different views showing the business goals and strategies or just the corresponding GQM graph. The view-based approach supports potential grid users with analysis and reasoning tasks (R2, R4, R8), as it is improved further by the following interaction and filtering operators:

- Panning and zooming: A virtual camera within the geometric space of the visualization treats the data display as a camera, enabling the user to interactively pan and zoom within the scene to explore the grid. Moving and zooming the camera accordingly changes the viewpoint seen by the user.
- Collapsing: The user can collapse single elements or edges to hide all the subsequent details and relations on lower levels.
- Detail-on-demand: Dependent on the zoom level, different levels of details are displayed to the user. When the user moves the mouse over this node, the full set of information is provided.
- Filtering: The framework uses several mechanisms to filter out irrelevant data depending on the user's role. For instance, higher levels of the organization may be filtered out for users on lower levels.

These pre-built interaction and filtering operators are independently customizable by the user for each view. Other operators may be integrated into the framework, supporting specialized context and role-oriented analysis and reasoning tasks (R3). Currently, the visualization is created based on a relational DB model (created from an Excel sheet). In the future, it is planned to allow grid customizations directly within the tool using specialized operators to, for instance, add new goals or strategies.

5. Related Work

Several approaches to software measurement have been developed using different mechanisms for guiding the choice of data to be collected and analyzed. The GQM approach [1] provides a method for defining goals, refining them into questions and finally data to be collected, and then analyzing and interpreting them. Several instruments and tools are available for visualizing the GQM model (e.g., as an abstraction sheet or a GQM tree). Balanced Scorecard (BSC) [8] links strategic objectives and measures. The typical visualization consists of four perspectives: financial, customer, internal business processes, and learning and growth. Strategy maps are used to link strategies associated with those perspectives. Practical Software Measurement (PSM) [10] offers detailed guidance on software measurement. Tree-like structures are used to link issues, measurement categories, and measures. CoBIT® [7] and ITIL [9] are approaches from the IT governance/service domain and offer connections between sets of goals and attributes of the IT infrastructure. CoBIT® uses a fixed linkage structure between outcome measures and performance indicators on the business, IT, process, and activity levels. Although these approaches recognize the need to link organizational goals and measures, they do not support building up a comprehensive grid of goals and strategies at different levels of the organization that are linked explicitly [2], nor do they address proper visualization mechanisms and related issues for decision making.

In [6], a survey on graph visualization and navigation techniques is illustrated and [11] describes a gen-

eralized view of the problem of graph, network, and hierarchy visualization. Visualizing hierarchical graphs as node-link diagrams is used to address the layout problems. The visualization and interaction techniques realized within our prototype framework make use of design patterns presented in [5].

6. Conclusion

This article presented experiences from industrial case studies, discussed requirements, and illustrated an initial approach for visualizing decision makers' information needs using the GQM+Strategies® approach. The requirements were based on initial case studies with companies applying GQM+Strategies®. A first systematic evaluation of the visualization mechanisms using our prototype platform is ongoing in the context of one software division of a German supplier company. There, the focus is on scalability of the approach dealing with hundreds of goals and strategies. Future work will be conducted regarding how to create and maintain a GQM+Strategies® grid. Furthermore, we are planning to investigate mechanisms for how to feed information from the data analysis and interpretation process back to the grid. This could be used to visualize the impact of empirical evidence on business goals and strategies.

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