REGULATION, THE INVISIBLE PART OF THE GOAL ORIENTED REQUIREMENTS ENGINEERING ICEBERG

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Abstract: Goal-Oriented Requirements Engineering (GORE) is considered to be one of the main achievements that the requirements of the Requirements Engineering field has produced since its inception. Several GORE methods were designed in the last twenty years in both research and industry. Curiously, GORE methods seem to have emerged out of nowhere in the early 1990s, the concept of Goal appearing as a natural element in explaining human and organizational behaviour. We have found no theoretical or philosophical work that explicitly link GORE to an underlying organizational model. In this paper, we show that most GORE methods are implicitly based on the goal-seeking, decision making organizational model. We argue that there are other organizational models that may better explain human behaviour, albeit at the expense of more complex models. We present one such alternative model that explains individual and organizational survival through continuous regulation. We give our point of view of the changes needed in GORE methods to support this alternative view through the use of maintenance goals and beliefs.

1 INTRODUCTION

In the 25 years or so since the advent of requirements engineering (RE) research as an academic discipline, its flagship methods have been the Goal-Oriented Requirements Engineering (GORE). The GORE methods have been lauded as one of the main achievement of the RE community, especially in its first 15 years of existence (van Lamsweerde, 2001), (Mylopoulos, Kolp and Castro, 2006). GORE is still a very active field of research with dedicated workshops and conference tracks (e.g. the i* International workshop series, International Workshop on Requirements, Intentions and Goals in Conceptual Modeling).

In RE practice, GORE methods developed in research have had less influence but they are matched by goal-oriented methods that were created by RE practitioners, e.g. Goal-Oriented Use Cases (Cockburn, 2001), Essential Use Cases (Constantine, 1995). In this paper we designate all these methods as GORE, whether they have emerged from research or from practice.

The emergence of GORE methods has coincided with a less software centric view of requirements. RE has evolved out of software specification methods by capturing more and more of the environment of the envisioned software system (Nuseibeh and Easterbrook, 2000), i.e. the composite system (van Lamsweerde, 2001). The GORE movement has been based on the understanding that goals justify and explain requirements that are assigned to agents in the composite system (software system and its environment), and that they help detecting and resolving conflicts among different stakeholder viewpoints (Dardenne, van Lamsweerde and Fickas, 1993). In GORE methods and subsequently in RE, it has been assumed that the behaviour of the stakeholders in the environment of the software system is predominantly goal-oriented, see for example (Loucopoulos and Kavakli, 1995), (Nuseibeh and Easterbrook, 2000).

There has been little debate concerning the epistemological roots of GORE methods (for an exception, see our own work (Regev and Wegmann, 2005)). Very few RE researchers have challenged this assumption. The few papers that have discussed problems with GORE methods have sought to supplement them with more artefacts, such as subject matters (Zave and Jackson, 1997) and scenarios (Rolland, Souveyet and Ben Achour, 1998).

For Nuseibeh and Easterbrook (Nuseibeh and Easterbrook, 2000) there are several types of RE depending on the end product that is envisioned. They give the following examples: RE for information systems, RE for embedded control systems and RE for generic services e.g. networking and operating systems. In this classification our discussion applies mostly to RE for information systems. In this type of RE, the composite system is the organization that the envisioned computer-based system serves. Nuseibeh and Easterbrook further state that the context of most RE and software activities is in this field of information systems development. Hence our discussion is applicable to many RE projects. We hope that readers interested in other types of RE will benefit from this discussion as well.

We take Gause and Weinberg's view that RE is about discovering what is desired (Gause and Weinberg, 1989). In this paper, we show that what people desire has more to do with the way they regulate their affairs than with the goals they seem to pursue. We base our proposal mostly on Vickers concept of Appreciative System (Vickers, 1968), (Vickers, 1987), (Regev, Hayard and Wegmann, 2011) and show that goals are only the visible part of the way individuals and organizations regulate their relationships in order to survive. We also show that GORE methods have most of the necessary constructs to model this behaviour, e.g. maintenance goals and beliefs. We advocate a more systematic use of and widespread use of these concepts for better understanding regulation.

We begin by reviewing the GORE research (Section 2). We then introduce the regulation organizational model and show that it can be used as the underlying mechanism of which goal-oriented behaviour is but the visible part (Section 3). We identify some of the shortcomings of GORE methods and propose remedies based on the regulation-oriented view (Section 4). We review some related work in Section 5.

2 AN OVERVIEW OF GORE METHODS

GORE methods use the concept of Goal as the main construct for defining requirements. The first papers linking goals and requirements date to the beginning of the RE discipline, e.g. (Dubois, 1989), (Robinson, 1989), (Dardenne, Fickas and van Lamsweerde, 1991). The link with the concept of goal seems to have emerged naturally from research into software specification e.g. (Robinson, 1989) that relied on Artificial Intelligence (AI) artefacts, e.g. (Nilsson, 1971). Hence, most GORE methods use a vocabulary inherited from Artificial Intelligence, e.g. goals, agents, roles, objectives, constraints, and obstacles.

Many GORE methods have been defined over the years. The most prominent are: KAOS, GBRAM (Anton, 1996), i* (Yu, 1997), GRL (ITU-T, 2008), TROPOS (Mylopoulos, Kolp and Castro, 2001), ESPRIT CREWS (Rolland et al., 1998), and Goal-oriented Use Case (Cockburn, 2001).

Numerous goal types have been defined in these methods. Following is a very partial list of goal types: Achievement, maintenance, softgoal, feedback, satisfaction, etc.

Very quickly goals have become a central concept in RE. Zave and Jackson, for example, offer the following definition, "Requirements Engineering is about the satisfaction of goals" (Zave and Jackson, 1997). The call for papers of the Requirements Engineering conference series also strongly links requirements and goals, e.g. Requirements Engineering Conference 2004 (RE04):

> Requirements Engineering (RE) is the branch of systems engineering concerned with the goals, desired properties and constraints of complex systems, ranging from embedded software systems and software-based products to large enterprise and socio-technical systems that involve software systems, organisations and people.

The focus on goals is understandable, not only because of the AI roots of GORE methods, but also because it relates with the goal-seeking organizational model prevalent in the neighbouring discipline of Information System (Checkland and Holwell, 1998). Many GORE methods take for granted this goal-seeking model. Modelling the organization, through Enterprise modelling, for example, is assumed to include goals, e.g. (Loucopoulos and Kavakli, 1995): "Enterprise modelling is about describing, in some formal way, a social system with its agents, work roles, goals, responsibilities and the like." (Nuseibeh and Easterbrook, 2000): "Enterprise modelling and analysis deals with understanding an organisation's structure; the business rules that affect its operation; the goals, tasks and responsibilities of its constituent members; and the data that it needs, generates and manipulates."

It is thus assumed that high-level enterprise goals can be gradually refined into requirements that can be assigned to the envisioned system (Dardenne et al., 1993), (Nuseibeh and Easterbrook, 2000). This refinement is most often done with the help of and/or goal trees inherited from (Nilsson, 1971).

Several RE researchers have reported problems with this assumption, e.g. (Anton, 1996), (Zave and Jackson, 1997), (Rolland et al., 1998), stating that goal discovery and goal refinement are not straightforward tasks, that enterprise goals are not necessarily a good starting point for goal refinement and that goal abstraction may lead to unrealistic or unwanted alternatives. The proposed remedies were to bound goal abstraction and refinement with the subject matter of the organization (Zave and Jackson, 1997), to use interview transcripts and organizational documents for goal discovery (Anton, 1996) and to use scenarios and goals reasoning together so that they inform one another (Rolland et al., 1998).

There have been surprisingly few attempts to link GORE to other organizational viewpoints, the only exception known to us is our own previous work (Regev and Wegmann, 2005). This is surprising because in their suggested roadmap for RE, Nuseibeh and Easterbrook (2000) suggest that, "RE is a multi-disciplinary, human-centred process." They further state that (Nuseibeh and Easterbrook, 2000),

> RE needs to be sensitive to how people perceive and understand the world around them, how they interact, and how the sociology of the workplace affects their actions. RE draws on the cognitive and social sciences to provide both theoretical grounding and practical techniques for eliciting and modelling requirements

Nuseibeh and Easterbrook (2000) list the following disciplines as part of RE: Cognitive psychology, anthropology, sociology and linguistics. They proceed to prescribe that (Nuseibeh and Easterbrook, 2000):

> There is an important philosophical element in RE. RE is concerned with interpreting and understanding stakeholder terminology, concepts, viewpoints and goals. Hence, RE must concern itself with an understanding of beliefs of stakeholders (epistemology), the question of what is observable in the world (phenomenology), and the question of what can be agreed on as objectively true (ontology). Such issues become important whenever one wishes to talk about validating requirements, especially where stakeholders may have divergent goals and incompatible belief systems.

While prescribing the need to incorporate different epistemological, phenomenological and ontological systems, Nuseibeh and Easterbrook perpetuate the already prevalent organizational model in RE, namely goal achievement by repeating the main assumption of GORE methods about goal achievement.

By focusing on goal achievement, GORE methods have set aside all these aspects of epistemology and phenomenology and have applied a unique ontology supposed to be universal. In the recent years, KAOS and more so i* have become the main GORE methods with dozens of research papers devoted to them. Most of these are papers that use these methods in specific areas or that propose extensions to them. i* has been incorporated into the URN ITU-T standard (ITU-T, 2008) with seemingly hardly a questioning of its assumptions. Recently, a well received study of the i* graphical notation was published (Moody, Heymans and Matulevičius, 2009), noting that major improvement is needed in order to make i* user friendly. The study however remained at the graphical level and did not investigate the epistemological or ontological aspects of i*.

Sutcliffe and Maiden (1993) proposed a notable kind of goal in a paper that seems to have received little attention by GORE researchers. They proposed 6 classes of goals. One of the classes is called "feedback goals." They describe these goals as maintaining a desired state with a related tolerance range, spawning corrective actions when the state is considered to be outside the tolerance range (Sutcliffe and Maiden, 1993). Curiously, this class of goals has not been picked up by subsequent GORE research. We have ourselves added feedback into GORE research about 10 years later (Regev and Wegmann, 2004), (Regev and Wegmann, 2005) without noticing the significance of Sutcliffe and Maiden's feedback goal class at the time.

In the following section we propose an epistemological view for GORE methods that may help to alleviate some of their shortcomings. This view is an extension of our previous work (Regev and Wegmann, 2005). To clarify our discussion, we use Zave and Jackson's example of the development of a turnstile for a zoo (Zave and Jackson, 1997) as a running example. We reproduce their problem description here verbatim for the clarity of the discussion (Zave and Jackson 1997):

> Requirements engineering is about the satisfaction of goals [..]. But goals by themselves do not make a good starting point for requirements engineering. To see why, consider a project to develop a computer-controlled turnstile guarding the entrance to a zoo [..].

If the engineers are told that the goal of the system is to deny entrance to people who have not paid the admission charge, they may decide that the goal has been stated too narrowly. Is not the real goal to ensure the profitability of the zoo? Should they consider other ways of improving profits, such as cutting costs? What if there is more money to be made by closing the zoo and selling the land? And what is the goal of profit? If the goal of profit is the happiness of the zoo owner, would religion or devotion to family be more effective? Obviously there is something wrong here. Almost every goal is a subgoal with some higher purpose. Both engineering and religion are concerned with goal satisfaction; what distinguishes them is their subject matter.

The engineers should be told, in addition to the goal, that the subject matter is the zoo entrance. This information should take the form of designations of phenomena observable at the zoo entrance, such as visitors, coins, and the action of entering the zoo. These designations circumscribe the area in which alternative goal satisfaction strategies can be considered, at the same time that they provide the basis for formal representation of requirements.

3 SURVIVAL AND REGULATION AS THE SOURCE OF GOALS

As we have seen, GORE methods seek to define the highest-level goals that are adequate for defining requirements for an envisioned system. Despite their important advancement, this is one aspect that the mainstream GORE methods (e.g. i*, KAOS) have not defined yet. So-called high-level goals are often described as strategic goals in GORE papers (see High-level goals entry in the previous section). It is therefore important to understand what is a strategic goal. If we define the strategic level as being geared toward the survival of the organization we have to define what survival means: We have shown elsewhere, e.g. (Regev and Wegmann, 2005), (Regev and Wegmann, 2009), that survival can be understood in terms of the maintenance of relatively stable states, often called norms, that an observer can use to identify an organization. The zoo, for example, maintains a large set of norms for its animals, employees, visitors, owners, animal rights activists etc. For the animals, it maintains a stable place in which to live, get fed and cared for, and maybe reproduce. For the visitors the zoo maintains a stable place where they can view animals while being certain that they are well cared for. The location of the zoo, its name, its layout, the animals it houses are all aspects that change very little over time. It is quite probable that the zoo you visited as a child still exists and you can visit it with your children or grandchildren. It is also quite probable that most of the animals and employees who were at the zoo when you were a child are no longer there. But the zoo is still there. Hence the zoo maintains its identity despite changes in all of its components (e.g. employees, suppliers, management, animals, visitors).

Maintaining norms is a powerful motivator for action. The zoo's management might want to maintain its image as a modern facility and therefore maintain the fit with the state of the art in visitor management and feel that it's entrance system is not up to date and needs to be replaced. It may believe that manual entrance control is not efficient enough and that by cutting costs on entrance control, it could use the money thus saved to better maintain its animals' health.

To maintain its norms relatively stable doesn't mean that the norms don't change at all. Organizations that survive over the long run make changes to their norms but in a very controlled way. This means that changes must be controlled for the organization to maintain its identity for its stakeholders. Consider what may happen if the zoo changed its location or name twice a year or more often. Would it be still recognized by its visitor? Would its employees continue to work there? What if it changed its mission from a zoo to a theme park, to a museum etc.? But of course the zoo also changes its norms, it may add new kinds of animals, playgrounds, activities, partnerships with other likeminded organizations. By saying that its norms should not change too much, we are actually placing bounds on how much change is acceptable. Remember the tolerance range defined by Sutcliffe and Maiden for feedback goals (1993).

What enables an organization to maintain and change its norms are the relationships it has with individuals and organizations, both inside and outside the organization. This is a consequence of the open system model of organizations (Regev and Wegmann, 2005), (Regev and Wegmann, 2009). These relationships must themselves be maintained within very specific bounds (norms) for the organization to be able to leverage them for maintaining other norms. Thus, the zoo needs a continuous flow of visitors to maintain its funding and it places very strict bounds on what the visitors can and cannot do. For starters, visitors must in most cases pay their admission. They may pay a bit less if they are part of specific classes of people (seniors, children group members). Some visitors may not pay at all if the zoo has a real reason to want them to visit the zoo (e.g. VIPs, teachers accompanying a school class, very young children). Hence, there is a tolerance range for the admission price but it is not a wildly changing aspect. There are other bounds on what visitors are allowed to do in the zoo so that their presence will be beneficial for the zoo and not detrimental, e.g. it is probably forbidden to feed the animals outside of very controlled food dispensed by the zoo to specific animals, it is forbidden to mistreat animals etc. Visitors who do not conform to these bounds may be denied further admission to the zoo, despite the zoo's willingness to have as many visitors as possible. Applying different price schemes and denying entrance are likely to be translated into goals for the turnstile. Understanding the norms and where they come from helps analysts to understand the goals expressed by the stakeholders and discover non-expressed goals as well.

The study of the way norms are maintained stable is called regulation (or control). A feedback regulator (or controller), e.g. a thermostat, an automatic pilot, maintains a given state stable, e.g. temperature, course, by sensing the current state comparing it with the given state, and applying some action if the difference is above the tolerance level. Vickers (Vickers, 1968), (Vickers, 1987) proposed the concept of the appreciative system, by extending this model of a feedback regulation to human and organizational regulation. Vickers's appreciative system has three components (Vickers, 1968), (Vickers, 1987), (Regev, Wegmann and Hayard, 2011): Reality judgments, Value judgments and Action judgments. With reality judgments, some aspect of reality is singled out to be the study of attention. In value judgments, this reality judgment is matched to a category within which it is then compared to the norm (what ought to be). In Action judgment, some action might be taken to bring the reality judgment closer to the norm. The three judgments function as a complete system so that change to one of them requires change to the others. Hence, the way we view and judge the world affect our actions and our actions affect our view and judgments (Vickers, 1968), (Vickers, 1987).

As we have seen before, the value judgment is done with some tolerance around the norm. In a simple automaton the information to be sensed, the norm and tolerances to be compared with and the kind of actions to be taken are all given by its designer. In an appreciative system, they are all subject to continuous change; nothing is set once and for all by a designer. Hence, an appreciative system creates its own dynamics, which an automaton does not.

Whereas the appreciative system creates its own judgments, it is nevertheless a rather stable construct, i.e. it creates its own norms. Vickers calls these norms readiness. Hence an organization has a readiness (a tendency) to see things in certain ways, to value them in certain ways and to act in certain ways. All these are rather stable in time. It is often the role of the analyst to try and shake these readinesses.

Linking the appreciative system and GORE aspects, we can see that maintenance goals can be an approximation of norms, beliefs can be an approximation of reality and value judgments, and achievement goals can be an approximation of action judgments.

From this point of view, GORE methods have concentrated on the third stage, action judgments (achievement goals), and neglected the other two, norms (maintenance goals), and reality and value judgments (beliefs). This is easily understandable if we consider that actions judgments are much more visible than reality and value judgments.

Because the three judgments of the appreciative system are interlocked, goals cannot be changed without changing the beliefs that justify them.

4 IMPROVING GORE METHODS

Based on the regulation view we proposed in the previous section, we identified a number of shortcomings common to most GORE methods. We explain them and provide pointers for addressing them.

Maintenance is higher-level than achievement

Although many types of goals have been defined in GORE methods, the most popular goal type has been and remains the achievement goals; a goal that is to be achieved once and for all. The next most popular goal type is the softgoal. Both KAOS and GBRAM have introduced the concept of maintenance goal, a goal that "is satisfied as long as its target condition remains true" (Anton and Potts, 1998). Maintenance goals have not received much attention and remains largely unused. This is particularly unfortunate because maintenance goals have been identified as "high-level goals with which achievement goals should comply" (Anton and Potts, 1998).

As we have shown, the concept of maintenance goal is very useful to model norms. Consider some of the norms maintained by the zoo. A zoo just as any other organization is an organism that seeks some permanency and which takes actions to maintain this permanency. Thus, the zoo needs a continuous in-flow and out-flow of visitors, animals, feed, medicine, employees etc. without these flows the zoo may not survive. The zoo is likely to take many actions to restore any one of these flows to the norm it depends on if the flow comes to be below a given tolerance level. These actions can be modelled as maintenance, sofgoals, feedback and achievement goals.

If maintenance goals are augmented with tolerance levels (imported from feedback goals) they can be used to model norms.

The concept of high-level goal

While both why and how questions are encouraged by GORE methods, the how is much more prevalent in GORE publications. Most often, a so-called high-level goal is postulated to be strategic for the organization under analysis and is refined into subgoals.

For example, van Lamsweerde gives the following examples for "high-level, strategic concern": "serve more passengers" for a train transportation system" and "provide ubiquitous cash service for an ATM network system." (van Lamsweerde, 2001). It is not clear why these should be considered as high-level, strategic goals and how they can be satisfied. If the train transportation system serves a few more passengers, is this goal achieved? What will the system do next once this goal is achieved? What if this goal is never achieved? What would the ATM network system do once the ubiquitous cash service is provided? What are the criteria of achievement for a ubiquitous cash service? Looking closely at these goals, it becomes clear that they cannot be achieved once and for all but should be seen as maintenance goals, which are never fully satisfied. From the regulation viewpoint they therefore represent norms that may be considered essential for the survival of the system.

Identifying the norms that are considered essential for survival helps solve the unacceptable goal alternatives identified by Zave and Jackson. Identifying these strategic norms places the appropriate bounds on what is acceptable and not acceptable. For the zoo, these norms are the result of the relationships it maintains, between animals, visitors, employees, veterinarians, investors, buildings, donors, etc. Hence, rather than limiting the field of investigation to the objects and actions observable at the zoo entrance, the turnstile can be seen as an essential artefact in this regulation of relationships, even those that are not immediately observable at the zoo entrance, which will expand the field of investigation without crossing into subjects such as selling the zoo or religious devotion.

For example, asking what norms does the turnstile maintain may lead to answers such as that it regulates the in-flow of people, filtering between people who have the right to enter the zoo and those that don't. Knowing more about the norms maintained by the rest of the zoo, we can infer more about current and possible future norms. It is clear that the turnstile cannot maintain the expected norm if the zoo is not protected from rogue entrance elsewhere. The zoo must maintain this protection (probably in the form of a fence). Knowing that people can enter and leave the zoo only through the turnstile, we can see that the turnstile can maintain the number of people presently inside the zoo, which can help maintain security norms (preventing overcrowding, helping to insure complete evacuation in case of emergency and at closing time (another norm). Knowing about new norms of potential visitors, the turnstile can be made to accept cash, credit card and smartphone payments. It can allow quick admission of groups (a norm).

A more widespread use of maintenance goals as the highest-level goals that model an organization survival is therefore necessary.

Goal refinement and goal abstraction

All GORE methods place goals in a hierarchy. Goal refinement is used to identify lower-level goals by asking how a given goal is achieved. Goal abstraction is used to identify higher-level goals by asking why a given goal needs to be achieved.

GORE methods have very good constructs for formalizing more or less predefined goals but goal discovery is still a challenge. Hence, despite arguments to the contrary (e.g. (van Lamsweerde, 2001)), GORE publications often describe tools for goal refinement but very little goal abstraction. The problem may come from the difficulty in identifying the sought-out high-level goals.

Both goal refinement and goal abstraction create a rather simplistic model of human and organizational behaviour.

Consider goal abstraction, in Zave and Jackson's (1997) example of the zoo turnstile, the engineers ask themselves why questions and come up with higher level goals and alternatives. This is not usually the way requirements are identified. The engineers are supposed to ask the zoo employees or owners why they need a turnstile. In our experience, asking stakeholders why they need some solution that they identified is as likely to lead to answers such as, "because I want this other thing" as to answers such as "because I believe this." In the zoo example, asking the owners why they want to install a computer-controlled turnstile may yield answers such as:

- We want to have a more efficient admission system.

Or

- We believe that a computer-controlled turnstile will be more efficient than our manually controlled admission system.

Or

- The zoo in the neighbouring town recently installed a computer-controlled turnstile and are very happy with it.

These answers can be translated into higher-level goals (i.e. improve efficiency, match the competition) but this would mask the issue that this is just the owners' beliefs about their zoo. If these issues are captured as goals they are more likely to go unchallenged than if they are treated as beliefs.

Goal refinement can equally be improved by the use of beliefs. Remember that goals and beliefs are co-dependent as a result of the interlocking of the three judgments that form the appreciative system.

Consider asking the zoo owners how they would like to make their zoo more efficient. If they believe that the best way is to install a computer-controlled turnstile, they will ask for one. If they believe that cost cutting will yield better results, they will ask for cost cutting measures. If they think that both are needed, they will ask for both. Capturing the goal refinement as an and/or tree will result in the loss of these beliefs and more importantly in the opportunity to challenge them. For a more elaborate explanation of beliefs and their use in GORE methods, see (Regev and Wegmann, 2005). More research can be done on modelling reality and value judgments as beliefs.

A more widespread use of maintenance goals in conjunction with achievement goals and beliefs can help in modelling regulation and may help to better understand requirements. A beginning of a solution is proposed in our previous work (Regev and Wegmann, 2004).

5 RELATED WORK

Several conceptual studies of GORE methods have been published over the years, e.g. (Kavakli, 2002), (Kavakli and Loucopoulos, 2005). These studies assume a viewpoint from within the RE research paradigm. They do not ground their research in an external body of knowledge, which limits their explanatory power of goals. Moody et al. (2010) have studied the graphical language of i* and its fit with users' understanding. We have proposed an explanation of goals based on General Systems Thinking and Vickers's work in (Regev and Wegmann, 2005).

Our work is similar in nature to Checkland and Holwell's conceptual cleansing (1998) of the field of information systems. Checkland (Checkland and Scholes, 1990) has worked extensively to popularize Vickers's work with Soft System Methodology (SSM). Ours is a very short description of Vickers's appreciative system. More elaborate descriptions are available in Vickers's writings (Vickers, 1968), (Vickers, 1987), and in (Checkland and Scholes, 1990), (Checkland, 2005), (Regev et al., 2011).

6 CONCLUSIONS

RE is about understanding peoples' desires and maybe designing some automated system to help them to obtain o maintain them. RE must therefore make the balance between what is desired and what is feasible. To understand what is desired, it is above all necessary to understand how people behave. GORE methods have made major contributions to the practice of RE but have modelled human and organizational behaviour in too simplified terms, mostly as goals to be achieved. In this paper, we have shown that goals can be seen as the visible part of regulation. Regulation models the way organizations (be they people or organizations) attempt to survive in a changing environment.

Regulation results in the establishment of norms, stable states that define the identity and therefore the survival of an organization. A long lasting organization manages its internal and external relationships in a way that controls the changes to these norms but still allows them to change when needed. Looking at regulation rather than goals shifts the attention to the way people manage stability and change by managing relationships.

To understand people's desires it is important to analyse this more fundamental aspect of their behaviour, which is regulation rather than goals. RE has already defined most of the useful concepts needed for the study of regulation, e.g. maintenance goals, and beliefs. What is needed is a paradigm change from goals to regulation. This paradigm change will hopefully result in the more widespread use of these goal-oriented concepts.

A useful stream of research with which to connect, is General Systems Thinking, which has most of the necessary constructs to understand regulation in all kinds of systems, e.g. (Weinberg, 1975), (Weinberg and Weinberg, 1988), (Ashby, 1956). Organizational Semiotics can also be useful because it is the study of norms in organizations (Chong and Liu, 2002), (Shishkov, Xie, Liu, Dietz, 2002).

REFERENCES

Anton, A.I., 1996. Goal-based requirements analysis. In *ICRE'96 Second International Conference on Requirements Engineering*, IEEE.

Anton, A.I., Potts, C., 1998. The use of goals to surface requirements for evolving systems. In *ICSE 98 International Conference on Software Engineering, IEEE.*

Ashby, W.R., 1956. *An Introduction to Cybernetics*, Chapman Hall. London.

Checkland, P., Scholes, J., 1990. *Soft System Methodology in action*, Wiley. Chichester, UK.

Checkland P, Holwell, S., 1998. *Information, systems and information systems - making sense of the field*. Wiley. Chichester, UK.

Chong, S., Liu, K., 2002. A Semiotic Approach to Improve the Design Quality of Agent-Based Information Systems. In Liu, K., Clarke, R.J., Anderson, P.B., and Stamper, R.K. *Coordination and Communication Using Signs: Studies in Organizational Semiotics*, Kluwer.

Cockburn, A., 2001. *Writing Effective Use Cases*, Addison-Wesley. Reading, MA.

Constantine, L., 1995. Essential modeling: Use cases for user interfaces. In *ACM Interactions,* 2(2), 34–46.

Dardenne, A., Fickas, S., van Lamsweerde, A., 1991. Goal-directed concept acquisition in requirements elicitation. In *IWSSD '91, Sixth International Workshop on Software Specification and Design*, ACM.

Dardenne, A., van Lamsweerde A., Fickas, S., 1993. Goal Directed Requirements Acquisition. *Science of Computer Programming*, 20(1-2), 3–50.

Dubois, E., 1989. A Logic of Action for Supporting Goal-oriented Elaborations of Requirements. In *IWSSD '89, Fifth International Workshop on Software Specification and Design*, ACM.

Gause, D.C., Weinberg, G. M., 1989. Exploring *Requirements: Quality BEFORE Design*, Dorset House, N.Y.

ITU-T, Telecommunication Standardization Sector of ITU, 2008. *User requirements notation (URN) – Language definition (Z.151)*.

Kavakli, E., 2002. Goal-Oriented Requirements Engineering: A Unifying Framework. *Requirements Engineering*, 6(4), 237-251.

Kavakli, E., Loucopoulos, P., 2005. Goal Modeling in Requirements Engineering: Analysis and Critique of Current Methods. *Information Modeling Methods and Methodologies,* 102-124.

Loucopoulos, P., Kavakli, E., 1995. Enterprise Modelling and the Teleological Approach to Requirements Engineering. *Intelligent and Cooperative Information Systems*, 4(1), 45-79.

Moody, D., Heymans, P., Matulevičius, R., 2010. Visual syntax does matter: improving the cognitive effectiveness of the i* visual notation. *Requirements Engineering*, 15(2), 141-175.

Mylopoulos, J., Kolp, M., Castro, J., 2001. UML for Agent-Oriented Software Development: The Tropos Proposal. In *UML 2001, Fourth International Conference on the Unified Modeling Language*, Springer.

Mylopoulos J., 2006. Goal-Oriented Requirements Engineering: Part II. Keynote Talk, *RE'06, 14th IEEE Requirements Engineering Conference*, Minneapolis, MS, September 2006. http://www.ifi.uzh.ch/req/events/RE06/ConferenceProgram/RE06_slides_Mylopoulos.pdf, accessed May 2011.

Nilsson, N.J., 1971. *Problem Solving Methods in Artificial Intelligence*, McGraw-Hill.

Nuseibeh, B., Easterbrook, S., 2000. Requirements engineering: a roadmap. In *ICSE '00, International Conference on The Future of Software Engineering*, ACM.

RE04, 2004. *Requirements Engineering International Conference 2004*, http://www.re04.org/, accessed May 2011.

Regev, G., Wegmann, A., 2004. Defining early it system requirements with regulation principles: the lightswitch approach. In *RE'04, 12th IEEE International Requirements Engineering Conference*, IEEE.

Regev, G., Wegmann, A., 2005. Where do Goals Come From: the Underlying Principles of Goal-Oriented Requirements Engineering. In *RE'05 13th IEEE International Requirements Engineering Conference*, IEEE.

Regev, G., Hayard, O., Gause, D.C., Wegmann, A. 2009. Toward a Service Management Quality Model. In *REFSQ'09, 15th International Working Conference on Requirements Engineering: Foundation for Software Quality* Springer.

Regev, G., Hayard, O., Wegmann, A., 2011. Service Systems and Value Modeling from an Appreciative System Perspective. In *IESS1.1, Second International Conference on Exploring Services Sciences*, Springer.

Robinson, W. N., 1989. Integrating multiple specifications using domain goals. In In *IWSSD '89, Fifth International Workshop on Software Specification and Design*, ACM.

Rolland, C., Souveyet, C., Ben Achour, C., 1998. Guiding goal modeling using scenarios. *IEEE Trans. Software Eng*., 24, 1055–1071.

Sutcliffe, A.G., Maiden, N.A.M., 1993. Bridging the Requirements Gap: Policies, Goals and Domains. In *IWSSD '93 7th International Workshop on Software Specification and Design*, IEEE.

Shishkov, B., Xie, Z., Liu, K., Dietz, J.L.G., 2002. Using Norm Analysis to Derive Use Cases from Business

Processes, In *OS 2002, 5th Workshop On Organizational Semiotics*.
van Lamsweerde, A., 2001. Goal-Oriented Requirements Engineering: A Guided Tour, in *RE'01, 5th IEEE International Symposium on Requirements Engineering*, IEEE.
Vickers, Sir G., 1968. *Value Systems and Social Process*, Tavistock, London.
Vickers, Sir G., 1987. *Policymaking, Communication, and Social Learning*, eds, Adams, G.B., Forester, J., Catron, B.L.,Transaction Books. New Brunswick NJ.
Weinberg, G. M., 1975. *An Introduction to General Systems Thinking*, Wiley, New York.
Weinberg, G. M., Weinberg, D., 1988. *General Principles of Systems Design*, Dorset House.
Yu, E.S.K., 1997. Towards modelling and reasoning support for early-phase requirements engineering. In *RE'97, Third IEEE International Symposium on Requirements Engineering*, IEEE.
Zave, P. and Jackson, M., 1997. Four Dark Corners of Requirements Engineering, *ACM Transactions on Software Engineering and Methodology*, 6(1), 1-30.