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Is It Time to Re-Evaluate the Connection Between Bounded Rationality and Requirements Elicitation?

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ABSTRACT

Bounded rationality has been a corner stone of understanding how organizations work. This view has heavily influenced information systems development discipline as well and end-users have been thought to know what they want from information systems. This has led to rather mechanistic approaches in use and development of requirements elicitation techniques. Lately, more and more information systems have been targeted to consumers, such as 3rd generation mobile phone applications. The change from user to consumer may also alter the rationality behind decisions. Therefore, the applicability of bounded rationality to might reconsideration. We conducted a literature review and focused to recognize how the concept of end-user has evolved in requirements elicitation in relation to the theory of bounded rationality. We found that it is evident that bounded rationality has had an effect on development of requirements engineering techniques. However, we also found that the alternative way of trying to understand how to seduce end-users has gained ground recently. As a conclusion we present that when developing a system for consumers we should reconsider whether to use the bounded rationality as an only basis for understanding end-users' needs. Moreover, we should look towards marketing science and consumer behavior literature to better understand the rationalities behind consumer decision making.

Keywords (Required)

Bounded rationality, information systems, requirements engineering, requirements elicitation, end-users, consumers, consumer behavior.

INTRODUCTION

Information systems (IS) discipline derives still much of its view from management science and operations research. One part of the heritage is the view towards the concept of end-user. In information systems development, and especially in requirements engineering (RE), it is common to think that end-users are there and ready for answering what they actually want (Pohl 1994). Hence, it can be said that the received view reflects to the bounded rationality ideal of Herbert Simon (1955). According to him members of organizations ultimately seek to improve their utility function in order to seek better efficiency for the organization. Lately, some researchers have been questioning this view (Jirotko et al. 1994; Lamb et al. 2003; Tuunanen 2003; Tuunanen 2005) in case of external end-users of information systems.

Bounded rationality is based on the traditional economic theory and rationality of man. It is said that the rational man is assumed to have knowledge of the relevant aspects of his environment which, if not absolutely complete, is at least impressively clear and voluminous (Simon 1955). This may have affected to a certain extent mechanistic view of classical theories of economic decision making within a firm (Simon 1979). Simon has viewed the problem from the perspective a choice situation. He tried to understand how organization works and how its goal can be reached (Simon 1957a; Simon 1964). Bounded rationality no doubt has had and continues to have a big effect on how management science and its descendents see the organizational decision making. Researchers have also been able to provide evidence to support this (e.g. Conlisk 1996). However, some researchers have also questioned its feasibility in situations where decision maker has an imperfect ability to choose (de Palma et al. 1994), like in the case of consumer choice process (Bettman et al. 1998; Hoch 2002). Researchers have, in fact, argued that bounded rationality would not apply in case of consumer choice process (Bettman et al. 1998).

Requirements engineering discipline has been focusing on the issues surrounding the problems in eliciting and managing the changing requirements (Dubois et al. 2003; Jarke et al. 1994). Requirements elicitation, in turn, is generally seen as the initial phase of requirements engineering that uses different techniques to capture the end-users' requirements. The literature offers many techniques to handle the problem associated with requirements elicitation and some researchers have listed more than

one hundred different techniques (Mathiassen et al. 2004). The received view (Kotonya et al. 2002; Pohl 1994; Tuunanen et al. 2004) has been that requirements are out there to be gathered by the requirements engineers, and firms have used managers and engineers as proxies for end-users to develop applications without knowing what the customers want or are willing to pay for (Peppers et al. 2002). Hence, we only have to find the right informants and use the right techniques to achieve the complete specification (Tuunanen et al. 2004). Researchers have (Kotonya et al. 2002; Pohl 1994) seen that by selecting and prioritizing the requirements into usable sets an agreement can be reached on the common goal.

We will analyze RE literature and provide a review of how researchers have approached the question of end-users' rationality. More specifically we use a literature review to understand how researchers have tried to resolve the problems of requirements complexity, uncertainty and availability and how this, in turn, reflects the view of end-users we have. We present two contributions arriving from this work. Firstly, we want to reopen up the discussion on the end-user concept within IS. We present that we should take a new view to the matter as more and more information systems are targeted to consumers and the end-users are not any more only in the bounds of organization. Thus, we might need to revisit the bounded rationality theory and see if literature in consumer behaviour can provide us new basis for creating suitable requirements elicitation techniques. This may lead to better understanding of consumers' needs and better success ratio of such IS projects.

Structure of the paper is following. Firstly, we revisit briefly the bounded rationality literature. Then we do a review of requirements engineering technique literature and conceptualize how researchers have seen the rationality of the potential end-user and how it has affected the way of RE is done. The synthesis of the review presented in the discussion section. Finally, we conclude and present future research directions.

BOUNDED RATIONALITY

Herbert Simon's research has contributed to the management science literature and to disciplines that are its off-springs, such as operations research and information systems. In following, we focus in one aspect of his research: bounded rationality (Simon 1957b). Simon defined the rational man to be something that has knowledge of the relevant aspects of his environment which, if not absolutely complete, is at least impressively and voluminous (Simon 1955). In his work he tried to understand the workings behind the way of organizations operate (Simon 1957a). He characterized the model of bounded rationality with six elements (Simon 1955). These can be summarized as following:

A person has a set of behaviour alternatives that include subsets of alternatives specific to individual occasions. The choice of an alternative creates a selection of possible future states of affairs (outcomes). These, in turn, provide certain pay-off or value to the person. In addition, information completeness varies between alternatives. Furthermore, he saw we could estimate the probabilities of the possible outcomes.

By using these elements Simon provided rules to define procedures of rational choice and he applied these ideas into his discussion of administrative behaviour (Simon 1957a). He considered that the dynamics of the elements could help us understand the way organizations work. Even though, this has been considered to be a nominal work, he also saw that there are some drawbacks in his thinking in real world situations. He put forward three major issues: 1) the lack of complete knowledge and anticipation of the consequences that will follow a choice, 2) the lack of not being to anticipate all values attached to the future outcomes, and 3) the lack of knowledge of all possible alternatives of choices (Simon 1957a). Later he simplified these to the concepts of **complexity** and **uncertainty**. He presented that people face these when trying to comprehend and compute the possible choices and alternatives in life (Simon 1979). According to him, we try to resolve these issues in order to maximize our utility through search and satisfying processes. Hence, if the alternatives are not initially given these must be searched and the search must continue until a person meets the choice that satisfies his or her needs.

Later on researchers have tried to apply bounded rationality to consumer decision making. Conlisk (1996) provides rather extensive literature review to this matter. He presents that single individuals often do not follow the ideas of bounded rationality. Marketing science researchers have furthermore speculated on this. Researchers have presented that due to limited processing capacity, consumers often do not have well-defined existing preferences, but construct them using a variety of strategies contingent on task demands (Bettman et al. 1998). Hence, consumers often are not sure how to off one alternative to another or which alternative is more important than other (Bettman et al. 1998). Moreover, researchers have present that in some cases it might be more interesting for consumer to minimize negative emotions or maximize ease of justification rather than maximize utility (Bettman et al. 1998). Actually, Hoch (2002) has even gone a little further and he has claimed that product experience is a play of seduction. Tuunanen (2005) has described this as a problem of requirements **availability** that refers to the communication gap between developers and end-users, which has been growing wider as more and more business applications target users are external to the organization (Barki et al. 1993; Dennis et al. 1988; Nunamaker et al. 1991; Tuunanen 2003).

Our study takes the focus of trying to understand how the problems of 1) complexity, 2) uncertainty and 3) availability of requirements have affected the research community within IS and specifically in RE discipline. In addition, we are interested of learning how the focus of requirements engineering technique development has evolved historically and if we can see the mark of bounded rationality and later “the seduction of users” evident in the literature. For this reason we have conducted a structured literature review.

REVIEW METHODOLOGY

The methodology for identifying literature seeks to include a clearly defined, complete, and relevant set of research articles. Webster & Watson (2002) emphasize the importance of a rigorous approach to identification of relevant literature recommending to: 1) identify relevant articles in leading journals, 2) go backward by reviewing the citations used by the articles in step 1, and 3) go forward by identifying articles citing the key articles identified in the previous steps. This review is a part of a more comprehensive effort reported in (Mathiassen et al. 2004).

In the first step, we used the Web of Science–service with access to scientific literature from 1990 and onwards to identify research that would help us understand the techniques in requirements engineering. In this process, we used broad key words to include as many potentially relevant papers as possible. On that basis, Web of Science helped us identify the 500 most relevant articles within software development as well as the 500 most relevant within requirements engineering.

In the second step, we selected those of the papers from step one that were published in leading software engineering and information systems journals. Several papers identify leading journals (Gillenson et al. 1991; Hardgrave et al. 1997; Holsapple et al. 1994; Mylonopoulos et al. 2001; Whitman et al. 1999). We chose two recent lists published in 2003. One focuses on information systems journals (Peffer et al. 2003), and the other on computer science and software engineering journals (Katerattanakul et al. 2003). By combining these lists, we arrived at leading journals that are relevant for our study, see Appendix 1. We then used the aggregate list to select articles from leading journals. The sets of papers generated by the two first steps still contained a total of 40 articles.

The first three steps do not include articles written before 1990 because of the Web of Science indexing limitations. As a fourth step, we therefore followed the advice of Webster and Watson (2002) and went backward through the reference lists of all articles included by step three. Within both steams of literature, we compiled an aggregate reference list sorted according to first author and included those articles that had two or more citations in the newer articles in leading journals, i.e. we included those older papers that had most impact in the newer literature.

The two lists of older literature were then in a fifth step filtered manually according to the rules of step three. In the final sixth step, we combined the lists of steps three and five to generate the total lists of relevant papers to be included in the review. In the following section we portray the analysis of the literature.

ANALYSIS OF THE LITERATURE

We analyzed the literature with descriptive statistics. Specifically, we reviewed the literature and found 96 individual requirements engineering techniques. For this we used the results of the previous research (Mathiassen et al. 2004; Tuunanen 2005). The study classified these techniques to eight groups: Formal, combined, pragmatic, iteration, collaboration, observation, group and cognitive techniques. Furthermore, researchers had divided these eight technique groups according three problems that the techniques seek to resolve. These are problems of requirements complexity, requirements uncertainty, and requirements availability (see Table 1).

Complexity	Uncertainty	Availability
Formal	Iteration	Observation
Combined	Collaboration	Group
Pragmatic		Cognitive

Table 1 RE Techniques groups

We continued the research by using frequency analysis to see how individual RE techniques had been distributed according the publication years. We decided to use first citation tactic in the analysis. Hence, we placed each technique to historical timeline according to the first citation in the selected literature according the problem they are mainly trying to resolve. We realize that this is not accurate measure technique as many of the articles were reviews, but we felt that at least this way we would be able to give an initial estimation of the distribution. The results the analysis is presented with Table 2 and Figure 1.

	Complexity	Uncertainty	Availability	Sum
-1985	5	1	2	8
1986-1990	0	3	1	4
1991-1995	21	7	26	54
1996-2000	17	0	2	19
2001-2004	4	3	4	11
	47	14	35	96

Table 2 RE Techniques distribution according Complexity, Uncertainty and Availability

If we take historical perspective to the analysis, we can see that the focus of the research has been with dealing with the requirements complexity problem. Nearly half of the described RE techniques (49%) focused on this issue. The emphasis is notable during the whole time span, with the exception of years 1986-1990. During that time, the requirements uncertainty problems played a key role in the selected literature. However, we should note that the number of specific RE techniques was only four for the whole era. After that time complexity again reigned until recent days. In its heyday, years 1991-1995, the complexity problem oriented RE techniques presented 89.5% of the data points. Furthermore, the years 1991-1995 seemed to be the golden years of technique development as more than half of the all techniques from this era (56.25%). In addition, we found that there was also a timing variety between the three groups. Especially, we noted a noticeable amount of techniques in availability technique group. Recently, the balance has been balancing between the groups. Finally, we found that the number of techniques has demised compared to earlier times and we listed only eleven new techniques since year 2001 until the time of the review effort (May 2004).

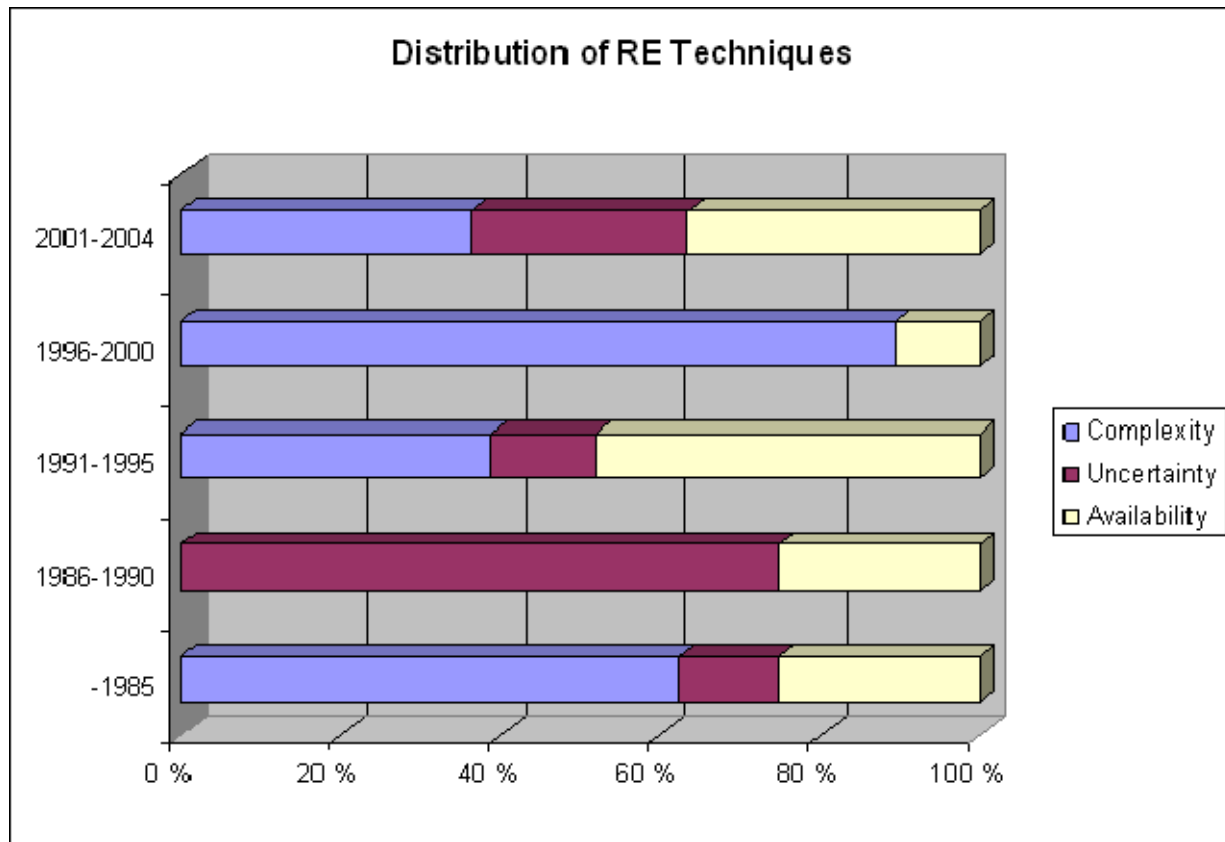


Figure 1 Distribution of RE techniques

Table 3 and Figure 2 give more precise view to the matter. From there we can learn that the focus has shifted from pragmatic techniques, like business process planning (Davis 1982) and Data flow diagrams (Larsen et al. 1992; Marakas et al. 1998; Ramesh et al. 1999), to collaboration techniques. Different collaboration techniques dominate years 1986-1990 and many of the fine examples these techniques were introduced then, such as rapid application development (Salaway 1987). The emphasis clearly shifted from the analyst to the development team and participation of different stakeholders to the development effort. The golden era of technique development produced a variety of techniques. Observation techniques emerged during these years and produced many techniques that are used today, like contextual design (Holtzblatt 1995; Jones et al. 1993; Kujala 2003). This was also the time when formal techniques began to be visible in the scene. The formal approach pursued to formalize the requirements in order to resolve the problem of complexity. These techniques dominated the field during next five years. However, researchers found that extreme formalization of requirements will not be the answer to all questions. Hence, we see a shift of focus towards more flexible techniques, and collaboration and group techniques showed the way to the next millennium.

	Formal techniques	Combined techniques	Pragmatic techniques	Iteration techniques	Collaboration techniques	Observation techniques	Group techniques	Cognitive techniques
-1985	0	0	5	1	0	0	1	1
1986-1990	0	0	0	0	3	0	0	1
1991-1995	4	0	17	4	3	8	8	10
1996-2000	9	3	5	0	0	0	1	1
2001-2004	2	1	1	0	3	0	3	1
	15	4	28	5	9	8	13	14

Table 3 RE Technique distribution in the selected literature according first citation

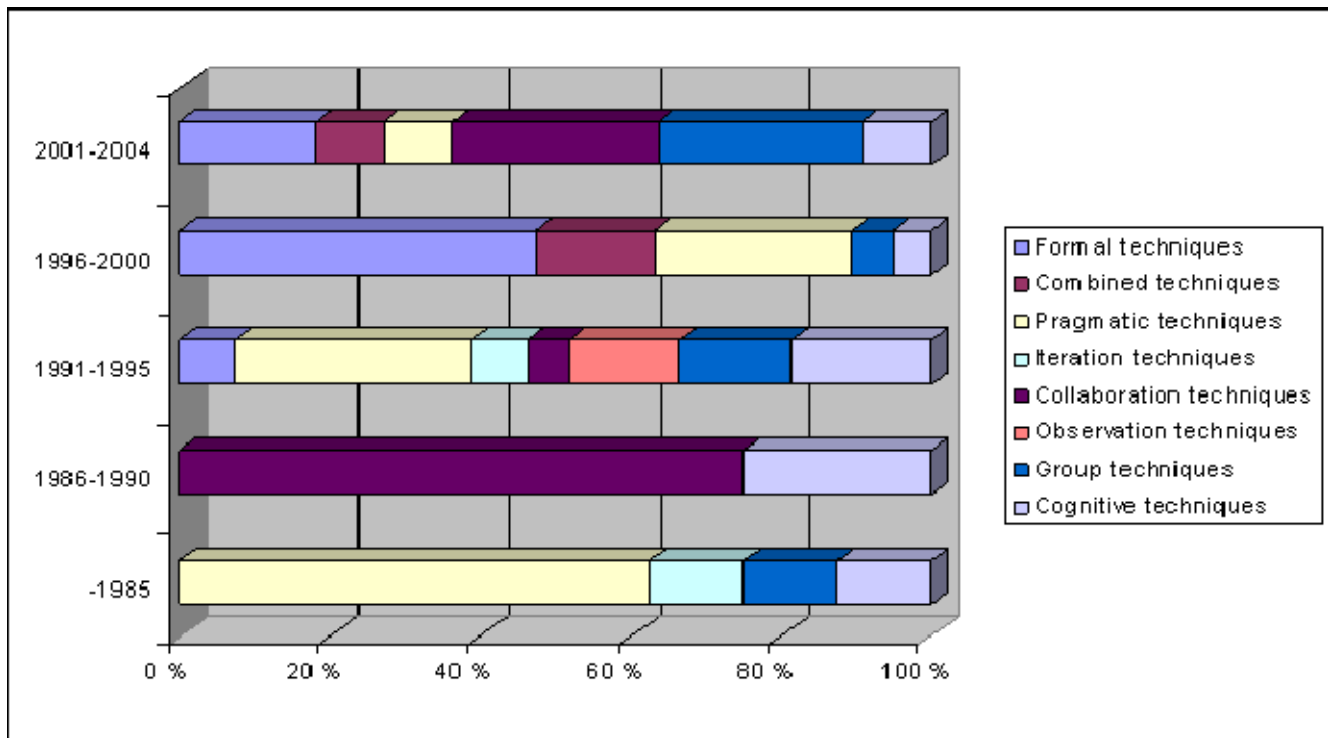


Figure 2 Graphical presentation of RE technique distribution

DISCUSSION AND CONCLUSION

We found that bounded rationality is with us, but maybe the emphasis of requirements engineering technique development is turning towards more unpredictable vision of end-users. The bounded rationality (Simon 1955; Simon 1957a; Simon 1957b; Simon 1979) has dominated the perspective on end-users' rationality. Most of the requirements engineering techniques have

aimed to resolve the two problems arriving complexity and uncertainty of end-users' requirements. Figure 1 demonstrates these trends well. From it we can learn that these two problems have dominated the development efforts of researchers with the exception years 1991-1995 and 2001-2004. During the early phase of availability emphasis, the researchers found that we should interact and involve the end-users to the development work. This was also the golden era of RE technique development in general as more than half of the techniques were introduced in the selected literature during that time. This led to massive amounts requirements information and the emphasis of the research shifted to managing the complexity. Recently, the number of development techniques has decreased and the emphasis has been more balanced.

We present that our findings support the claim that Simon's bounded rationality has had a great impact on the view of end-users to information systems researchers. This has in turn affected the way requirements engineering as a discipline has evolved. Simon's influence has probably been one of the reasons leading to emphasis of resolving complexity and uncertainty issues in RE. The vision of rationality of the user has authorized the analyst the use these techniques. If we believe that end-users can express their needs why should only model them as suggested by many researchers who have developed very formal ways of accomplishing this (e.g. Lee et al. 1998; e.g. Liu et al. 1998; Rolland et al. 2003; van Lamsweerde et al. 2000). Others have taken more prudent approach and they have presented that we cannot take the rationality as granted (Salaway 1987; Trammell et al. 1996). Moreover, we should try to interact with the end-users in order to resolve uncertainty of the requirements.

We found that the selected literature supports our view of giving more emphasis to the availability problem of requirements. The earlier mechanistic view is perhaps passing and the focus has again shifted towards understanding end-users' needs. However, not many researchers have recently been actively developing RE techniques that would take a more consumer behaviour stance to technique development (Table 3). Our review found only one technique that had been introduced after year 2001. Hence, it remains mostly unanswered how we should deal with individuals who do not anymore follow the ideas bounded rationality (Conlisk 1996), i.e. consumers. This might call for more emphasis in the cognitive RE technique development. Could we try to use these techniques in the cases where consumers often do not have well-defined existing preferences, but construct them by using a variety of strategies contingent on task demands (Bettman et al. 1998)? This calls for future research in the area of requirements engineering technique development.

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APPENDIX 1 - JOURNAL LIST

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|-----|--|-----|--|
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| 3. | ACM Trans. on Database Systems | 38. | Int. Journal of Electronic Commerce |
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| 7. | Australian Journal of Information Systems | 42. | Journal of Computer Information Systems |
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