Goal-oriented RE for Handling Change Requirements: An Explanation of What Stakeholders Try to Avoid and What They Try to Achieve

Johan F. Hoorn
Vrije Universiteit
De Boelelaan 1081a
1081 HV
Amsterdam, NL
T: +31 20 598 7614
F: +31 20 598 7728
jfhoorn@cs.vu.nl

Elly A. Konijn
Vrije Universiteit
De Boelelaan 1081
1081 HV
Amsterdam, NL
ea.konijn@fsw.vu.nl

Hans van Vliet
Vrije Universiteit
De Boelelaan 1081a
1081 HV
Amsterdam, NL
hans@cs.vu.nl

Gerrit van der Veer
Vrije Universiteit
De Boelelaan 1081a
1081 HV
Amsterdam, NL
gerrit@cs.vu.nl

ABSTRACT
One of the reasons why requirements engineering (RE) is so difficult is that requirements change 'on the fly.' To investigate the sources of requirements change, 18 managerial supervisors of a logistic warehouse management system filled out a structured requirements-engineering questionnaire, the RE*quest*, which assessed the level of agreement to the current system, the future system, and the stakeholders' needs. The results confirmed the assumption in goal-oriented RE that requirements are tightly connected to goals. More importantly, however, we discovered a mechanism that rules the level of agreement to requirements, which we coin the *goal-to-requirements chiasm* or the *χ-effect*: Variance in what the system won't have is for 70% explained by goals stakeholders want to *achieve* with the system. Variance in what the system must have is for 90% explained by goal states that stakeholders want to *avoid*. Moreover, we found evidence for an emotional component (i.e. valence) in the requirements evaluation that has a moderating effect on agreement to requirements. The *χ-effect* emphasizes that won't requirements and goals to avoid are as important to requirements change as must requirements and goals to achieve with the system. In this light, structured questionnaire design is a systematic and controllable addition to common requirements-validation methods.

Categories & Subject Descriptors
H.1.2 [Models and Principles]: *User/Machine Systems–Human information processing*; K.6.3 [Management of Computing and Information Systems]: *Software Management–Software development*.

General Terms
Requirements Engineering, Human Factors, Theory.

Keywords
Requirements validation, requirements change, empirical software engineering, stakeholders' view, structured questionnaire.

1. INTRODUCTION
A major problem in developing a system is to know what functionality a system should offer, what goals it should support or what business processes it should facilitate. Requirements engineering (RE) is a series of organized activities to obtain and document such knowledge for system engineers as well as for other stakeholders who are involved in developing or using the system (e.g., the client, managers, end-users, and maintenance personnel).

The problem gets worse when stakeholders change their minds about what they want from the system. Particularly when a system is under development, a change request can have serious impact on the design of a system (cf. [11]). Moreover, the business situation sometimes changes so quickly that change requests repeatedly occur during the course of development. Redesign, however, is expensive, time-consuming, and often frustrating.

It is therefore important that we can anticipate a change request. If we know the sources of requirements change and the mechanisms that govern a change request, it might be possible to detect 'the danger zones' – the requirements most susceptible to change – in the early stages of requirements elicitation and gathering.

However, we are dealing with rapid changes. Therefore, we not only need to know which requirements on a specific system in a specific business case are changing and why, we also need generic knowledge on requirements change. With this type of knowledge, we – hopefully – can anticipate change requests while being less dependent of the particular system under construction and less vulnerable to the time aspect.

2. THEORY

2.1 The Type of Goals
In the area of goal-oriented RE (e.g., [26]), the cause of requirements change, requirements evolution [1], or requirements development [33] is sought in the goals that stakeholders want to achieve with the system or the concerns they may have with it. "Goals are ... essential elements for managing requirements evolution" [27]. Goals can range from high-level strategic mission statements to low-level operational targets that should be achieved with the system [27]. Goals are supposed to be more stable than the requirements that help

reaching them [25]. Moreover, the higher-level a goal is (e.g., a strategic business goal), the more stable the respective requirements will be [3] [1]. Thus, the reasons for requirements change should be sought in a change of lower level goals, such as improving a work process (e.g., higher efficiency, less costs), or advancing system performance, security, and reliability.

2.2 Valence

When stakeholders are involved in developing a system, they are – whether intentionally or not – also busy designing the future situation of their business or work environment. Therefore, they make evaluations of how much a requirement, once implemented as a feature of the system, will impact their goals.

In goal-driven RE, system development is centered on the stakeholders' concerns [21] [4] [2]. In the line of Frijda [16], we think that the requirements on the new system are judged for their usefulness or relevance to potentially satisfy or harm the stakeholder's concerns, goals, or motives. Positive expectations about the future situation result from requirements that promise a match, the actual or expected satisfaction of concerns. Negative expectations result from requirements that promise a mismatch, the actual or expected obstruction of realization of goals and concerns ([16] p. 277). Frijda ([16] p. 207) points out that valence refers to the implied outcome of the event: The intrinsic attractiveness or repulsiveness. In other words, valence (also [36]) refers to the expected match or mismatch between the potential gratification for or obstruction of stakeholder concerns and the possibilities or impossibilities offered by the new situation.

Stakeholders expect positive or negative consequences of the system for achieving their goals (cf. Technology Acceptance Model [13]). Whether stakeholders expect that a proposed feature will support or obstruct their goals may have an impact on the level of agreement or disagreement to a requirement. When the business environment changes, the direction of valence towards the future system may change accordingly, thus triggering a change request.

2.3 Not Only Must Haves

Although practitioners often work from a MuSCoW list,[1] the won't requirements are often put aside as irrelevant for further analysis. The focus is on the must haves, understandably, to help achieve the stakeholders' goals. However, whereas goals specify desired situations, so called "obstacles" designate goal states that are undesirable but yet possible [30] [25]. Apart from achieving goals, there is also an "avoid-mode" [33]. Thus, must haves may be important to achieve goals stakeholders want to approach, yet, won't haves are important to construe what stakeholders want to avoid with the system (e.g., instability, complexity). When a business model changes, a change request can concern the won't requirements just as well as the must requirements.

2.4 Variability in Agreement

When business goals change and the requirements change accordingly, the once agreed-upon requirements are disagreed-upon in the new situation. If we know which goals have changed it should be possible to predict the level of agreement to the related requirements from the level of agreement to the (changed) goals. We suspected that requirements that raise the most conflicts among stakeholders are most vulnerable to change. Such requirements should show more variability in the level of agreement (from agree to disagree) than requirements that raise no conflicts (a ceiling effect of either agree or disagree). Thus, we wished to investigate which type of goals (those to approach or those to avoid) best predicted the variability in the level of agreement to must or won't requirements. Our best guess was that (H1) goals to approach would predict agreement to the must requirements through the mediation of positive outcome expectancies (valence support). In opposition, we assumed (H2) that goals to avoid would predict (dis)agreement to won't requirements, mediated through negative valence (valence obstruct).

The remainder of this paper is organized as follows. Section 3 describes the methods and tools we employed, i.e. the Requirements Engineering questionnaire RE*quest*, to gather the data for testing our hypotheses. Section 4 supplies the necessary statistical analyses and empirical results, which are discussed in Section 5. In Section 6, we relate our findings to some prominent studies in the goal-driven RE domain. Section 7 rounds off our paper by offering an outlook on future explorations.

3. METHOD

3.1 Participants

Managers (N= 18; 11 male, 7 female; age M= 46.4, SD= 10.9; years in service M= 14.4, SD= 11.7) from a provincial governmental institution in The Netherlands participated in a questionnaire study that concerned the (re)design of a logistic warehouse management system. These participants ranged from various services, sectors, and functions within the organization.

3.2 System

The state of the warehouse management system at the time of measurement was a mainly manually and personally driven order and delivery system without intensive automation. Errors occurred regularly but were corrected effectively although not fast. (Re)designing this system was directed at higher efficiency, cost-effectiveness, and fewer behavioral rules while maintaining the current flexibility. The future system aimed at introducing Intranet and e-mail facilities to handle orders and deliveries while reducing the number of human transactions [32].

3.3 Procedure

As part of an internship with the said provincial government [32], rapid ethnography [22] [28] in the early stages of design established a list of features of the current system, a list of requirements of the future system as well as a list of goals of the managers of the organization (not necessarily the same people who participated in the questionnaire study). Based upon these observations, a structured questionnaire, the RE*quest* [20], of 64 items was created (in Dutch), divided into 5 blocks. Three blocks were created for the purposes of the IT practitioner who performed the internship, one block was created for hypothesis testing, and one block concerned demographic information of the participants. The block for hypothesis testing was put in between the practitioner's blocks and the demographic block of items was put in last. Items were pseudo-randomly distributed over blocks. Thirty-five participants were asked to print and fill out this paper-and-pencil questionnaire, which was sent to them over the e-mail. After a few reminders, eighteen questionnaires were completed and returned, which took about a fortnight.

1 Requirements that Must be, Should be, Could be, or Won't be on the system) [15]. 'Could' requirements are comparable to Kano's "attractive" requirements ([6], p. 4). They are not necessary but they can increase customer satisfaction.

3.4 Measurements

3.4.1 Scale construction

For those who are unacquainted with structured questionnaire design [14], we want to introduce the notions of scales, indicative and contra-indicative items, and faceted scales [18] [19]. In Section 3.4.2 we explain how our measurements were done.

Scales measure a concept or construct that is not immediately visible in the concrete world (e.g., stakeholder goals). Scales consist of multiple items that more-or-less cover a variety of aspects of 'stakeholder goals' (e.g., efficiency, cost-effectiveness, etc.). The items approach the abstract concept of stakeholder goals not only from the positive side ("E-mail is fast") but also from the negative side ("E-mail is slow"). These statements form the indicative and contra-indicative items on the scale, respectively. Each item is scored for agreement. Taken together, the various items on a scale control for different interpretations of what 'stakeholder goals' might mean. Faceted scales [18] [19] systematically combine more single (sub) scales (e.g., requirements plus valence plus goals). A statement from a faceted scale can be formulated as a requirements statement (e.g., "Automated input helps me to do my work properly"). Each item is part of a larger set of statements that systematically combine, for example, the positive and negative aspects of the respective sub scales to see their different impact on agreement.

Albeit in different forms, the notion of indicative and contra-indicative items can sometimes be found in the RE literature but is hardly ever employed to construct scales with. Usually, requirements engineers confine themselves to indicative items. However, this may lead the stakeholder into an affirmative answering tendency [14]. Therefore, contra-indicative items are recommended to neutralize this tendency evoked by a measurement scale. In the present study, the need for contra-indications was also theoretically based. Our assumption was that features a system should *not* have are as important to assess the stakeholders' needs as the features that the system must have. A similar thought can be found with Kano (in [6], p. 5), who speaks of "functional" versus "disfunctional" forms of questions.

3.4.2 Scale construction in the case study

In helping to validate the MuSCoW list created by the practitioner involved in the internship, we developed two scales (Agreed-upon Requirements and Current System) as well as 5 single survey items. Agreed-upon Requirements consisted of 7 indicative and 7 contra-indicative items that pertained to ordering procedures, order handling, and checking available warehouse space. Current System consisted of 4 indicative and 4 contra-indicative items that pertained to the current way of handling orders, focusing on flexibility and efficiency. The 5 single survey items controlled for the level of acquaintance with the fact that after using $8m^2$ of warehouse space, users should pay a fee, which need not concern us here. All (5+14+8=) 27 items were presented in the form of statements about the system followed by a 6-point rating scale (0= completely disagree, 5= completely agree).

In addition to the scales that helped to validate the MuSCoW list, we also created a faceted scale [18] [19] for hypotheses testing, called Stakeholders' Needs. It consisted of three sub scales: Requirements, Goals, and Valence towards proposed features of the new system. The sub scale Requirements consisted of the same items as Agreed-upon Requirements but based on the ethnographical study during the internship, these items were categorized as either must have or won't have. Must have requirements covered aspects of automation and digitalization of operations whereas won't have requirements keyed manual aspects and human interference that was typical for the old system. Goals were divided into goals to approach (achieve) or goals to avoid. Goals were related to the work of the managers and included aspects of time efficiency, error reduction, and cost-effectiveness. Valence was operationalized as keying support or obstruction of goals by the proposed feature.

Together, items on the faceted scale Stakeholders' Needs combined a requirement with a certain valence to a goal. Items on the scale Stakeholders' Needs followed the structure:

<Requirement (must or won't have)> has <Valence (supports or obstructs)> towards a <Goal (that you want to approach or want to avoid) >

By systematically combining the three sub scales, we produced eight categories of items. For each type, 3 variants were prepared, resulting into 24 items on the scale Stakeholders' Needs.

1. Must requirement – supports – goal to approach (× 3)
2. Must requirement – supports – goal to avoid (× 3)
3. Must requirement – obstructs – goal to approach (× 3)
4. Must requirement – obstructs – goal to avoid (× 3)
5. Won't requirement – supports – goal to approach (× 3)
6. Won't requirement – supports – goal to avoid (× 3)
7. Won't requirement – obstructs – goal to approach (× 3)
8. Won't requirement – obstructs – goal to avoid (× 3)

An example of a category 1 item is "Notification by e-mail that an order will be delivered facilitates a good planning." "Notification by e-mail that an order will be delivered" was a must requirement, "facilitates" supposedly induced positive valence (is in support of), and "a good planning" was a lower-level business goal (that managers wanted to approach in their work).

Moreover, upon request of the IT practitioner, two more indicative and two contra-indicative filler items were inserted. This made a total of (24+4=) 28 items on the scale Stakeholders' Needs, which entered the final questionnaire in a pseudo-random order [20]. Items were followed by a 6-point rating scale (0= completely disagree, 5= completely agree). Further, demographic information was sampled, such as sex, age, service, sector, function, and number of years in function.

Two staff members who were not involved in the actual test checked the items for readability and understandability. Given the time frame of system development and the duration of the internship, it was impossible to pretest the questionnaire on psychometric quality. Therefore, controls had to be performed post hoc.

4. ANALYSIS AND RESULTS

After the completed questionnaires were returned, the data were entered in an SPSS 11.0 data matrix for statistical analysis.[2] In depth details about the statistical procedures followed and intermediate results can be found in [20]. In Section 4.1, we evaluated the scales Agreed-upon Requirements, Current System, and Stakeholders' Needs for psychometric quality. In

[2] Statistical Package for the Social Sciences, SPSS Inc.

Section 4.1.3, manipulation checks and some preliminary hypotheses testing was performed with multivariate analyses of variance.[3] In Section 4.1.4, we explored the structure of the different variables on the Stakeholders' Needs scale with multiple regression analyses to test H1 and H2.

4.1 Scale Analysis

Two types of scales were analyzed for psychometric qualities: Agreed-upon Requirements and Current System on the one hand and Stakeholders' Needs on the other. We regarded Agreed-upon Requirements and Current System as conventional bipolar scales. That is, we summated the indicative and contra-indicative items and treated them as one scale with two opposite extremes or poles. Stakeholders' Needs was a faceted scale, needed to explicitly connect a system feature to an outcome-expectancy towards goals. For theoretical as well as methodological reasons (Section 4.1.2), we treated Stakeholders' Needs as a set of 6 unipolar sub scales. Here, the indicative items of one variable (e.g., goals) are considered a sub scale of their own (e.g., sub scale Goals to Approach), which is relatively independent of the sub scale formed by the respective contra-indicative items (e.g., sub scale Goals to Avoid).

4.1.1 Agreed-upon Requirements and Current System

The contra-indicative items of Agreed-upon Requirements and Current System were reverse-scaled: A score of 0 was transformed to a 5, 1 to 4, etc. We then tested whether items correlated with their own scale by means of Corrected Item-Total Correlations and Cronbach's alpha (indicating reliability). The degree to which items did not correlate with other scales was tested with Pearson correlations.

We conducted item analyses on the 14 items hypothesized to assess Agreed-upon Requirements and the 8 items to assess Current System. Initially, each item was correlated with its own scale (with the item removed) and with the other scale. In certain cases, items were more highly correlated with the other scale than with their own scale. Based on these results and additional item analyses, the psychometrically weak items were eliminated from their scales.

For these shortened scales, each item was again correlated with its own scale (with the item removed) and with the other scale. The results of these analyses are shown in Table 1. In support of the measure's validity, items always were more highly correlated with their own scale than with the other scale. Cronbach's alphas were computed to obtain internal consistency estimates of reliability for these two scales. The standardized item alphas for the Agreed-upon Requirements and Current System scales were .70 and .65, respectively, which is sufficient.

Table 1. Reliability of revised scales and correlations of each item with its own scale (in bold type) and with the other scale

	Scales	
Items	*Agreed-upon Require-ments*	*Current System*
Agreed-upon Requirements		
Direct ordering at warehouse	**.48**	-.12
Order (re)directed by computer	**.54**	-.25
Computer access to order status	**.53**	.03
Reply e-mail for delivery notification	**.41**	-.02
E-mail warning when ordering problems occur	**.23**	-.03
Check available storage room on ATRIUM intranet	**.33**	-.26
Access to order status via secretary	**.34**	-.15
Current System		
Current way of doing orders ignores my wishes	-.55	**.67**
Present flexibility of handling orders is bad	-.34	**.48**
The efficiency of currently doing orders is low	-.12	**.33**
Automatic signaling that my storage room is full is useless in saving time	.05	**.22**
Cronbach's alpha	.70	.62
Standardized Cronbach's alpha	.70	.65

4.1.2 Stakeholders' Needs

The 28 items on the faceted scale of Stakeholders' Needs consisted of a requirement (1) and the valence (2) towards that requirement in view of a goal (3) as related to the work. Ample empirical literature exists [8], [9], [24], [31], [10], providing evidence that concepts related to valence should preferably be treated as unipolar scales rather than bipolar. Therefore, the sub scales Requirements, Valence, and Goals were subdivided according to their item types (indicative vs. contra-indicative). This resulted in six unipolar sub scales of Requirements Must, Requirements Won't, Valence Support, Valence Obstruct, Goals Approach, and Goals Avoid. These 6 sub scales had systematically differing combinations of the items on the Stakeholders' Needs scale.

First, we correlated each item with its own sub scale (with the item removed) and with the other sub scales. In many cases, items were more highly correlated with another sub scale than with their own sub scale. Probably, this is because the items on the Stakeholders' Needs scale explicitly related requirements, valencies, and goals, which may explain the relatively strong interdependency of sub scales. Based on these results and additional item analyses, the psychometrically weak items were eliminated from their sub scales.

Each item on the shortened scales was again correlated with its own sub scale (with the item removed) and with the other sub scales. The results of these analyses are displayed in Table 2.

The measures' reliabilities were not extremely good. The 3 best items on a sub scale were not always more highly correlated

[3] Note that the GLM > Repeated measures option in the new releases of SPSS is more-or-less similar to the MANOVA procedures in the syntax editor. The latter option was used in this study.

with their own sub scale than with the other sub scales. Cronbach's alphas were calculated to attain internal consistency estimates of reliability for the 3-item sub scales (Table 2). Standardized item alphas were between .48 and .78, which is weak to good. However, scales with alpha > .60 are actually needed only for placing individuals on a standardized scale. With the necessary precaution, alpha around .60 may be acceptable [17] for grouped individuals like our managers.

Table 2. Reliability of the 6 sub scales of Stakeholders' Needs and correlations of each item with its own sub scale (in bold type) and with the other sub scales. Suspect items have an asterisk

	Sub scales					
Items	*Require-ments*		*Valence*		*Goals*	
Requirements Must	*must*	*won't*	*sup-port*	*ob-struct*	*ap-proach*	*avoid*
Direct transaction	**.61**	-.30	.11	-.53	.14	-.41
*Order (re)directed	**.18**	-.28	.04	-.53	.21	-.34
E-mail announcement	**.66**	-.11	.56	.08	.25	-.52
Requirements Won't	*must*	*won't*	*sup-port*	*ob-struct*	*ap-proach*	*avoid*
*Knowing exactly where…	-.23	**.25**	-.49	.20	-.53	.28
*Checking on problems…	-.11	**.37**	-.23	.69	-.46	.20
*Checking free storage…	-.14	**.27**	.02	.52	-.37	.06
Valence Support	*must*	*won't*	*sup-port*	*ob-struct*	*ap-proach*	*avoid*
*Check available storage…	.55	-.78	**.41**	.05	.68	-.35
Direct transaction	.57	-.25	**.76**	.32	.27	-.39
Checking on problems…	.48	-.21	**.72**	.26	.21	-.32
Valence Obstruct	*must*	*won't*	*sup-port*	*ob-struct*	*ap-proach*	*avoid*
*Checking free storage…	-.14	.36	.02	**.11**	-.37	.06
Order (re)directed ...	-.21	.28	-.04	**.42**	-.21	.34
Administration of …	-.22	.35	-.08	**.48**	-.38	.02
Goals Approach	*must*	*won't*	*sup-port*	*ob-struct*	*ap-proach*	*avoid*
*Knowing exactly where…	.23	-.67	.49	-.20	**.33**	-.28
*Checking on problems…	.11	-.43	.23	-.69	**.57**	-.20
E-mail warnings …	.16	-.40	.21	-.60	**.70**	-.08
Goals Avoid	*must*	*won't*	*sup-port*	*ob-struct*	*ap-proach*	*avoid*
*Delivery notification …	-.28	.12	-.38	.03	-.05	**.16**
Direct transaction …	-.13	.30	-.11	.53	-.14	**.67**
Order (re)direction	-.21	.28	-.04	.53	-.21	**.62**
	must	*won't*	*sup-port*	*ob-struct*	*ap-proach*	*avoid*
Cronbach's alpha	.64	.48	.78	.50	.69	.64
Standardized Cronbach's alpha	.63	.48	.78	.50	.72	.61

4.1.3 MANOVA on Stakeholders' Needs

We treated the faceted scale of Stakeholders' Needs as a nested factorial design (within-subjects) of the 3-leveled factor Scales (requirements vs. valence vs. goals) and the 2-leveled factor Item Type (indicative vs. contra-indicative). In view of this setting, 6 within-subjects (dependent) variables were calculated from the 3 items per sub scale (Table 2): The grand mean average level of agreement to Requirements (must vs. won't have) vs. Valence (support vs. obstruct) vs. Goals (to approach vs. to avoid). Moreover, we calculated the grand mean averages over the items on the revised scales Agreed-upon Requirements and Current System. As a preliminary test, a One-Way MANOVA was run to see the effects of the fixed factors Service (4), Sector (7), and Sex (2) on the grand means of the 6 within-subjects (dependent) variables. The effects of Age (28-58), Number of Years in Service (1-36), Agreed-upon Requirements, and Current System were controlled for by treating them as covariates. Function (14) was not analyzed because each function had but one or two managers. Multivariate tests according to Pillai showed that none of the fixed or covariate factors were significant ($.36 < F < 1.59$; $.479 \leq p \leq .700$) for either of the dependents.

In addition, the main test consisted of a 3*2 MANOVA of Scales (Requirements vs. Valence vs. Goals) (within-subjects) and Item Type (indicative vs. contra-indicative) (within-subjects) on the grand mean average agreement to the 6 sub scales. Results can be found in Figure 1 and Table 3.

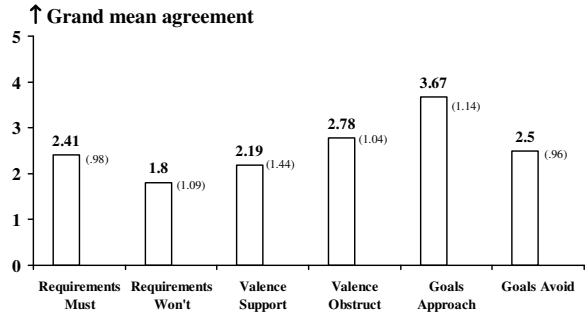

Figure 1. Grand mean average agreement to the 6 sub scales of Stakeholders' Needs (N= 18). Standard deviations are between parentheses

Table 3. Summary of results of MANOVA on Requirements Must, Requirements Won't, Valence Support, Valence Obstruct, Goals Approach, and Goals Avoid

Main effect of Item Type (indicative vs. contra-indicative)
$F(1,17)= 1.44$, $p= .246$
Main effect of Scales (Requirements vs. Valence vs. Goals)
Pillai's Trace = .44, $F(2,16)= 6.40$, $p= .009$
Parameter (Requirements vs. Valence) Coefficient= -.76, t= -1.55, p= .139, $\eta_p^2= .12$ Parameter (Requirements vs. Goals) Coefficient= -1.96, t= -3.57, p= .002, $\eta_p^2= .44$ Parameter (Valence vs. Goals) Coefficient= -1.20, t= -2.34, p= .032, $\eta_p^2= .24$
Interaction Item Type (indicative vs. contra-indicative) and Scales (Requirements vs. Valence vs. Goals)
Pillai's Trace = .51, $F(2,16)= 8.40$, $p= .003$
Parameter Item Type * (Requirements vs. Valence) Coefficient= 1.20, t= 2.51, p= .022, $\eta_p^2= .27$ Parameter Item Type * (Requirements vs. Goals) Coefficient= -.56, t= -4.04, p= .001, $\eta_p^2= .49$ Parameter Item Type * (Valence vs. Goals) Coefficient= -1.76, t= -3.25, p= .005, $\eta_p^2= .38$

The most important result of Figure 1 in combination with Table 3 is the significant interaction between Item Type (indicative vs. contra-indicative) and Scales (Requirements vs. Valence vs. Goals) (Pillai's Trace = .51, $F(2,16)= 8.40$, $p= .003$).

To start with the strongest significant contrast, parameter estimates showed that indicative items of Requirements ($M_{Must}= 2.41$) evoked higher levels of agreement than contra-indicative items ($M_{Won't}= 1.80$), which may be expected. This difference was larger, however, for Goals. Indicative items of Goals ($M_{Approach}= 3.67$) evoked the highest level of agreement in this study, more than contra-indicative items ($M_{Avoid}= 2.50$) (parameter coefficient= -.56, t= -4.04, p= .001, $\eta_p^2= .49$).

A less strong but also significant contrast was found for the indicative items of Valence ($M_{Support}= 2.19$), which surprisingly, elicited *lower* levels of agreement than the contra-indicative items ($M_{Obstruct}= 2.78$). As visible in the previous paragraph, the opposite happened for Goals (parameter coefficient= -1.76, t= -3.25, p= .005, $\eta_p^2= .38$).

The third contrast was only marginally significant according to Bonferroni ($\alpha= .05/3\approx .017$) and should be considered merely a trend. Parameter estimates showed that the level of agreement to indicative and contra-indicative items in Requirements had an inverse pattern as compared to Valence (parameter coefficient= 1.20, t= 2.51, p= .022, $\eta_p^2= .27$).

These interactions were sustained by a significant main effect of Scales (Pillai's Trace = .44, $F(2,16)= 6.40$, $p= .009$), which was mainly based on the contrast between Requirements and Goals (parameter coefficient= -1.96, t= -3.57, p= .002, $\eta_p^2= .44$). The difference between Valence and Goals was much smaller and only marginally significant (parameter coefficient= -1.20, t= -2.34, p= .032, $\eta_p^2= .24$) according to Bonferroni ($.05/3\approx .017$). In other words, the strongest interactions and main effects were produced by Goals in combination with Requirements, whereas the weaker interactions and main effects were generated by Valence in combination with Goals.

The following observations can be done from these results. First, the three variables Requirements, Valence, and Goals could be successfully applied during the requirements engineering of a logistic warehouse management system. Requirements, Goals, and Valence all produced significant (interaction) effects on how much the managers agreed to a requirements statement about the (planned) system. Goals Approach had the strongest positive effect on agreement whereas Requirements Won't had the most negative effect. Moreover, Requirements, Goals, and Valence were not independent but affected one another (significant interactions). Missing out on one weakens the explanation why requirements are (dis)agreed upon.

Second, goals (i.e. those that the managers wanted to achieve) played a leading role here, inducing the largest effects. This implies that the stakeholders' concerns [21] are indispensable for requirements validation. Interestingly, the goals these managers pursued in their work all pertained to efficiency and not, for example, cost-effectiveness. The sub scale of Goals Approach pertained to the goals 'quick order processing' (a speed aspect), 'accurate order handling' (an accuracy aspect), and 'efficient work' (high speed and high accuracy combined).

The third observation concerns the valence towards the warehouse management system. That is, the manager's expectancy whether a system feature would support or frustrate certain of his or her goals and concerns. In this study, the managers felt that the proposed features would obstruct their goals rather than support them. The finding that Valence Support had less effect on the level of agreement than Valence Obstruct, moreover, counters a possible bias towards positive answering tendencies.

Fourth, from a more general point of view, we see that goals (i.e. those to be achieved) have the largest impact on agreement, followed by the emotional component of valence, and only then by the proposed requirements. This underscores that RE should indeed be goal-driven. Moreover, the results suggest that requirements engineers should look into the motivational aspects of stakeholders to gain more insight in why requirements are agreed upon or not. This can be done by explicitly connecting a proposed system feature to a (lower-level) goal and asking what positive or negative outcome stakeholders expect (valence) with regard to achieving their goals with the system.

4.1.4 Regression on Agreed-upon Requirements, Current System, and Stakeholders' Needs

H1 and H2 predicted that requirements are explained by valence (as a mediator), which in turn is directed by lower-level business goals. Yet, certain constellations could counter those predictions, such as (dissatisfaction with) the current system or direct contributions of goals to requirements without interference of the emotional component of valence. Due to the small number of respondents (N= 18) a Structural Equation Model could not be performed. Instead, the analysis was restricted to a set of multiple regressions. The research question (RQ) ran as follows:

RQ1. How well do valence and goals predict agreement to requirements, controlling for agreement to the current system?

To execute a first multiple regression analysis (Method Enter), RQ1 was restated as:

RQ1a. How well do Valence Support, Valence Obstruct, Goals Approach, and Goals Avoid predict Agreed-upon Requirements, controlling for agreement to the Current System, Requirements Must, and Requirements Won't?

Agreed-upon Requirements acted as the dependent variable in the regression with four ordered sets of predictors, using the items as displayed in Table 1 and Table 2. Current System was entered in the first step as categorical independent variable, Requirements Must and Requirements Won't were entered in the second step, Valence Support and Valence Obstruct in the third step, and Goals Approach and Goals Avoid in the fourth.

None of the (sets of) predictors accounted for a significant amount of the variability of Agreed-upon Requirements [20].

A second multiple regression analysis followed the research question:

RQ2a. How well do Valence Support and Goals Approach, Valence Obstruct and Goals Avoid predict Requirements Must, controlling for agreement to the Current System, Agreed-upon Requirements, and Requirements Won't?

RQ2b. How well do Valence Obstruct and Goals Avoid, Valence Support and Goals Approach predict Requirements Won't, controlling for agreement to the Current System, Agreed-upon Requirements, and Requirements Must?

With regard to RQ2a, Goals Avoid and Valence Obstruct together accounted for a significant amount (90%) of the Requirements Must variability, $R^2= .93$, $R^2_{adj}= .90$, $F(5,12)=$

30.30, p= .000. Goals Approach and Valence Support did not significantly increment the percent of explained variance of Requirements Must, R^2_{change}= .01, F(2,10)= .33, p= .728. We also assessed the relative importance of Goals Avoid and Valence Obstruct in predicting Requirements Must. It seemed that Goals Avoid was most strongly related to the Requirements Must (standardized β= -.97, t= -9.48, p= .000). Supporting this conclusion is the height of the standardized Beta coefficient and the strength of the correlation between Goals Avoid and Requirements Must, partialling out the effects of all other predictors ($r_{partial}$= -.94, r_{part}= -.74). Valence Obstruct offered little or no additional predictive power beyond that contributed by the Goals Avoid measure.

Regarding RQ2b, Goals Approach and Valence Support, accounted for a significant amount (70%) of the Requirements Won't variability, R^2= .79, R^2_{adj}= .70, F(5,12)= 9.01, p= .001. Goals Avoid and Valence Obstruct did not increment the percent of explained variance of Requirements Won't, R^2_{change}= .07, F(2,10)= 2.28, p= .153. We also assessed the relative importance of Goals Approach and Valence Support in predicting Requirements Won't. It seemed that Goals Approach was most strongly related to Requirements Won't, standardized β= -.96, t= -5.31, p= .000. Supporting this conclusion is the height of the standardized Beta coefficient and the strength of the correlation between Goals Approach and Requirements Won't, partialling out the effects of all other predictors ($r_{partial}$= -.84, r_{part}= -.70). Valence Support offered little or no additional predictive power beyond that contributed by the Goals Approach measure.

H1 and H2 further predict that valence is explained by goals. Therefore, RQ3a and RQ3b ran as follows:

RQ3a. How well do Goals Approach predict Valence Support, controlling for Goals Avoid and Valence Obstruct?

RQ3b. How well do Goals Avoid predict Valence Obstruct, controlling for Goals Approach and Valence Support?

No significant results were obtained in the respective regression analyses [20].

Based on the series of multiple regression analyses, the first remark that can be made is on the bipolarity of variables. Regression on the bipolar Agreed-upon Requirements scale yielded no significant results what so ever, whereas regression on the unipolar sub scales Requirements Must and Requirements Won't did. Second, in a bipolar conception important information is lost: H1 was refuted because the level of agreement to must requirements was best explained by goals stakeholders wanted to avoid (!) and H2 was refuted because won't requirements were best explained by goals stakeholders wanted to approach (!). Third, these findings are in line with the literature on attitudinal ambivalence [8] [9] [24] [31] [10].

The findings in the regression analyses on Requirements Must and Requirements Won't can be summarized and interpreted as follows. Agreed-upon Requirements and Current System did not explain agreement to Requirements of either sort. This teaches us two things. *It is better to explicitly connect a requirement to a (lower-level business) goal and state the expected outcome valence than to have an agreement score to a requirement (or goal) without more. In addition, (dis)agreement with the current system does not predict agreement to the requirements of a future system.*

The variables that did explain Requirements Must and Requirements Won't formed another constellation than expected. H1 expected that requirements the system must meet are explained by a positive outcome valence of the proposed features towards goals the stakeholder wants to achieve in his or her work. The opposite was the case, however. Goals Avoid significantly accounted for 90% of the variability in agreement to Requirements Must. A similar structure was found for the requirements of features the system won't have. H2 anticipated that what the system won't have is predicted by a negative outcome valence of the proposed features towards states and situations the stakeholder wants to avoid in his or her work. Again the reverse happened, because Goals Approach significantly accounted for 70% of the variability in agreement to Requirements Won't. *Probably, requirements the system must meet had a baseline agreement that was pushed down by the disagreement of the stakeholder to an undesired future situation. Mirroring this, requirements of things the system won't have, evoked a baseline disagreement that was pulled up by the agreement of the stakeholder to a desired future situation.* This is why goals to avoid predicted 'must haves' better than goals to approach did. It is the same reason why goals to approach predicted 'won't haves' better than goals to avoid. These findings for the future – for these managers still somewhat fictional – system corresponds to what [31] called 'subjective ambivalence,' that is, a conflict between simultaneously occurring positive and negative attitudes towards a feature or object (also called evaluative tension or attitudinal ambivalence). Similar positive-negative asymmetry effects are also repeatedly confirmed in the field of impression formation, e.g., [34].

As another matter, H1 and H2 assumed that valence was a mediator between agreement to requirements and goals. This was not demonstrated by the regression results, however. The relative importance of Goals Avoid to Requirements Must was significantly higher than for all other predictors, including Valence (standardized β= -.97, t= -9.48, p= .000, $r_{partial}$= -.94, r_{part}= -.74). Likewise, the relative importance of Goals Approach to Requirements Won't also was significantly higher than for all other predictors, including Valence (standardized β= -.96, t= -5.31, p= .000, $r_{partial}$= -.84, r_{part}= -.70). *This means that there is a direct link between the situation a stakeholder wants to avoid and the requirements that the system must have to achieve that. In addition, there is a direct link between the goals a stakeholder wants to approach and the requirements that should be left out from the system. Valence, expectations of support or frustration of goals by the proposed features, plays a moderating role in explaining agreement to requirements.*

Valence moderates the relational strength between goals and requirements. On the one hand, MANOVA (Table 3) showed that valence was involved in a significant interaction with goals on agreement. On the other hand, valence had no significant main effect according to Bonferroni. Additional multiple regressions indicated that Goals Approach did not significantly predict Valence Support and that Goals Avoid did not significantly predict Valence Obstruct. Therefore, valence should be regarded a moderating rather than a mediating variable.

5. CONCLUSION/DISCUSSION

The needs of the stakeholder should be modeled as a unipolar constellation. Situations a stakeholder does not want to get into, directly and to a large extent explain what the system must offer. This mirrors the finding that situations a stakeholder *does* want to reach, directly and to a large extent explain what the system must *not* offer. Valence, the expectation of the stakeholder whether a proposed feature might harm or sustain a

goal at work, appears not to be a necessary step in the initial stage of RE. It does, however, have a moderating effect, increasing or decreasing the level of agreement to a requirements statement.

The most important information an IT practitioner could extract from a system's stakeholders are covered by four questions, then. What are the things in life or work that you do not want? What can the system offer to avoid those things? What are the things in life or work that you do want? What should the system *not* have in order to support that? In view of the relative importance of features the future system should not have, it seems that analysis of the won't requirements is underestimated in industrial practice.

"To identify possible inconsistencies between what is wanted and what is possible to meet" [2], we analyzed the matching between requirements and managerial goals. We did so by querying the 'subjective judgments' [2] of a group of managers with regard to the positive or negative valence they attached to the requirements in view of their lower-level business goals. In so doing, we succeeded in our RE*quest* '… to align system function with stakeholder values...' [4].

The structured requirements-engineering questionnaire RE*quest* assessed the actual level of agreement to requirements that were supposedly agreed upon in earlier negotiations (Agreed-upon Requirements). Moreover, the agreement to the Current System was assessed as well as the Stakeholders' Needs. The latter scale was subdivided into items that measured the positive and negative outcome expectancies (valence) the managers had of requirements to goals.

The results revealed that Requirements, Valence, and Goals had a significant impact on the level of agreement. These variables are affecting one another so that combining these three variables into one scale of Stakeholders' Needs seems to be an addition to common RE methods (e.g., [12] [29]). The goals had the strongest impact on the level of agreement. Therefore, requirement engineers are recommended to always take these into account.

With respect to valence, the managers that evaluated the requirements of the future system thought that rigorous automation and fewer behavioral rules would harm their goals on the workfloor rather than sustain them. A finding like this is most informative for the management of change. It suggests that in this group of managers implementing the features as agreed upon in earlier negotiations will lead to non-acceptance of the technology. In this light, it is plausible that the sub scale of Requirements within the Stakeholders' Needs scale had the weakest effects on the level of agreement. Putting a score to a requirement without more (e.g., Kano in [6], p. 5) apparently is not the most informative way to do requirements engineering. Requirements should be coupled to a goal while explicitly asking for the direction of the stakeholders' expectations (valence). In addition, (dis)satisfaction with the current situation is not a good predictor of the level of agreement to requirements in a future situation.

A sequence of multiple regressions shed further light on the structure of requirements change. It turned out that the sources of change should be conceived of as unipolar dimensions. That is, requirements should be treated separately as 'must have' versus 'won't have' because these are explained differently from the underlying goals and concerns of the stakeholders. To arrive at such an explanation, valence and goals also should be treated as unipolar. In fact, we have found two sub models of requirements change: Variance in agreement to must requirements is best explained by goals stakeholders want to avoid (sub model 1) and variance in won't requirements are best explained by goals stakeholders want to approach (sub model 2). In line with the literature on emotional biases and action tendencies, stakeholders maintain a baseline agreement to must requirements, which is regulated by the 'threat' to goals in the future ('cover your ass'). In opposition, won't have requirements evoke a baseline disagreement that is governed by agreement to possible support of desirable goals in the future ('make life easier').[4] We coin this mechanism the *goal-to-requirements chiasm* or *χ-effect* (CHI-effect) on the stakeholders' agreement to requirement statements. The direct explanatory relation between positive or negative requirements and their respective inverse counterparts in goals is moderated by valence (positive or negative expectations). Valence can increase or decrease the influence of goals on requirements. In Figure 2, a graphical display of the two sub models of requirements change is exhibited as they emerge from the empirical findings.

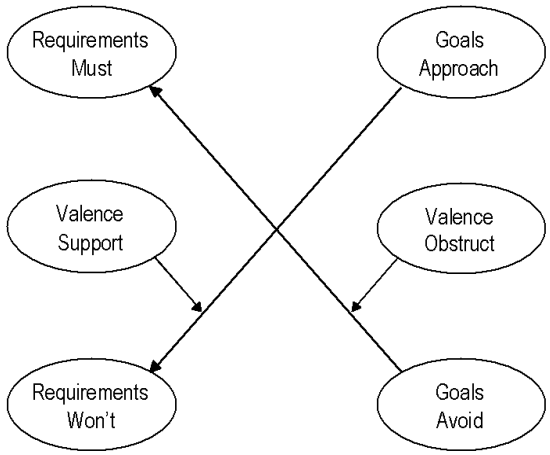

Figure 2. The goals-to-requirements chiasm or χ-effect as derived from the empirical data

6. RELATED WORK

In system design, requirements change as the situation in which these systems function evolves [1]. Situations change as a result of certain events, a change of tasks, adopting another business model or a change in (organizational) culture [12]. Stakeholders call for or dismiss requirements and errors should be repaired [1]. However, different stakeholders may have conflicting requirements [35], which points at opposing goals or different means of achieving them in the new situation. While situations, and subsequently, requirements develop, uncertainty can be managed and the new situation controlled as soon as requirements are again agreed-upon [1]. To manage a change request, goals are fundamental for discovering conflicts among (the new) requirements [26]. "Goals provide the rationale for requirements i.e. requirements represent one particular way to achieve high-level goals" [1] (e.g., strategic business goals).

To manage conflicting requirements and requirements change, system developers need to comprehend the sources of conflict and the mechanisms by which conflicts emerge [2]. We showed that constructing a measurement tool that systematically uses conflicting goals, contradictory requirements (and opposite valences for that matter) can be successful in pinpointing the

[4] We owe the "make life easier, while covering your ass" interpretation to Jo Geraedts, Industrial Design Dept., Océ-Technologies.

sources of conflict. In system development, questionnaires have already been applied (e.g., [23], [7], [12]) but these mainly worked from single one-response survey items.[5] However, constructing items on a scale that indicate and contra-indicate a certain concept as well as statistically assessing the psychometric quality of items is a more reliable and valid approach [14] to requirements-questionnaire design.

In our questionnaire RE*quest*, we followed the strategy of [2] to deal with requirements as alternatives to operationalize goals. The results indicated that variance in the level of agreement to goals of stakeholders is one of the main sources of requirements change. It predicted the largest part of variance in agreement to requirements. The strength of this relation (70% and 90%) indeed supports the assumption that requirements are refinements of goals [1]. The results of our study indicate that stakeholders evaluate the risks and benefits (Kano in [6], p. 9) of the new system in terms of emotional valence towards proposed features. Assessing the valence of requirements and features towards goals is important because valence modulates the level of agreement to a list of requirements.

The empirical results of running the RE*quest* also made us identify the mechanism by which conflicts in requirements emerge (cf. [2]). The χ-effect suggests that stakeholders have a baseline agreement to requirements that the system must meet ("Of course, my system is UNIX-based because I want it to be reliable"). This finding links up with the work of Kano (in [6], p. 4), who states that customers have so called "must be" requirements on a product. Customer satisfaction decreases if the product does not satisfy the must be requirements (e.g., breaks on a car) but remains neutral if the respective functionality improves (e.g., breaks with ABS). What we can add to Kano's proposal, then, is that changes in agreement to requirements are directed by goal states the stakeholders want to avoid with the system ("On the other hand, the UNIX system should not be all too difficult to operate"). Furthermore, and as a counterpart of Kano's "must be" requirements, stakeholders have a baseline disagreement to proposed features the system should not include ("Of course, my system is not Windows-based because I hate its instability"). Following Kano, we could coin these features the "won't be" requirements. Changes in disagreement, then, are predicated by goal states the stakeholders want to achieve with the system ("But I do like to work with an easy-to-handle graphical user interface"). When engineers merely investigate the baseline agreement to must requirements as related to positive goal states (UNIX guarantees reliability) and the baseline disagreement to won't requirements as related to negative goal states (Windows promises unreliability) it seems that there are no conflicts. However, the wish list stakeholders put forth can yet contain conflicting requirements because they want UNIX for reliability but not for usability and they want Windows for usability but not for reliability.

7. FUTURE WORK

The main focus of our research is to repeat our finding of the goal-to-requirements chiasm. We are currently involved with the Dutch police force to do RE on a capacity management system (CMS) for planning and allocating personnel. To date, the Dutch police undergo a major business model change in moving from a public service to a self-supporting business-like organization. We will explore whether the requirements on the CMS can be explained from the officers' goals and concerns in the predicted constellation (avoid-to-must and approach-to-won't). We will do this from two points of view. One group of officers works from a business perspective (requirements as related to business goals) and one group will work from a personal perspective (the same requirements as related to personal goals).

A second replication study is currently administered with interaction designers and software engineers from 6 different countries who are asked to assemble a computer off-the-shelf (COTS). Two types of systems are offered from which they can pick their features. One with software and hardware that is outmoded (e.g., a cathode ray tube monitor and a 5¼" floppy drive) and one that is state-of-the-art (e.g., 63" wide screen plasma monitor and an AMD Athlon 64 processor). Again, the question is whether we can produce the goal-to-requirements chiasm.

Stakeholder participation and psychological involvement foster satisfaction with the system and improves the development of products [5] [33]. It would be interesting to find out if adopting the approach proposed in this paper will actually increase customer satisfaction and whether it ensures a more correct alignment between business and IT. If we can repeat our findings, this is something we intend to investigate in the future.

In this study, we employed theory and methods of psychology, invited a group of managers as participants in our requirements validation test, and used the results to improve the logistic warehouse management system [32]. On our way, we gained more insight into the sources and mechanisms of requirements conflicts and requirements change.

8. ACKNOWLEDGMENTS

This paper is part of the Innovation Oriented research Program (IOP) for Human-Machine Interaction entitled *Integrating Design of Business Processes and Task Analysis,* granted to the first author by the Senter*Novem* Agency of the Dutch Ministry of Economic Affairs in The Hague, grant Mmi99009. Johan F. Hoorn, Hans van Vliet, and Gerrit van der Veer work in the Faculty of Sciences, Dept. of Computer Science, Section Information Management & Software Engineering. Elly A. Konijn works in the Faculty of Social Sciences, Dept. of Communication Science. Sandra Pronk is acknowledged for her help in administering the survey and for sampling the data.

9. REFERENCES

[1] Alves, C., and Finkelstein, A. Challenges in COTS-decision making: A goal-driven requirements engineering perspective. *Workshop on Software Engineering Decision Support* (Ischia IT, 2002).

[2] Alves, C., and Finkelstein, A. Investigating conflicts in COTS decision-making. *International Journal of Software Engineering and Knowledge Engineering, 13* (2003), 1-21.

[3] Anton, A.I., Cracken, W., and Potts, C. Goal decomposition and scenario analysis in business process reengineering, in *Proceedings of CAiSE '94* (Utrecht NL, 1994).

[4] Anton, A.I., Earp, J.B., Potts, C., and Alspaugh, T.A. The role of policy and stakeholder privacy values in requirements engineering, in *Proceedings of RE'01: International Symposium on Requirements Engineering* (Toronto Canada, 2001).

[5] In the Damian et al. study [12], question 9 could be seen as a scale for Perceived Immediate Benefit but was not analyzed that way vide the discussion of their Figure 8.

[5] Barki, H., and Hartwick, J. (1989). Rethinking the concept of user involvement. *MIS Quarterly, 13*, 1 (1989), 53-61.

[6] Berger, C., Blauth, R., Boger, D., Bolster, C., Burchill, G., DuMouchel, W., Pouliot, F., Richter, R., Rubinoff, A., Shen, D., Timko, M., and Walden, D. Kano's methods for understanding customer-defined quality. *Center for Quality of Management Journal, 2,* 4 (1993), 2-36.

[7] Burke, B. *Evolving Architecture Maturity*. META PRACTICE, META Group Inc., 2002.

[8] Cacioppo, J.T., and Berntson, G.G. Relationship between attitudes and evaluative space: A critical review, with emphasis on the separability of positive and negative substrates. *Psychological Bulletin, 115* (1994), 401-423.

[9] Cacioppo, J.T., Gardner, W.L., Berntson, G.G. The affect system has parallel and integrative processing components: Form follows function. *Journal of Personality and Social Psychology, 76* (1999), 839-855.

[10] Carroll, J.M., Yik, M.S. M, Russell, J.A., and Feldman Barrett, L. On the psychometric principles of affect. *Review of General Psychology, 3* (1999), 14-22.

[11] Coakes, E., and Elliman, T. Focus issue on legacy information systems and business process engineering: The role of stakeholders in managing change. *Communications of the AIS, Volume 2,* 1, 4 (July 1999), 1-30.

[12] Damian, D., Zowghi, D., Vaidyanathasamy, L., and Pal, Y. An industrial case study of immediate benefits of requirements engineering process improvement at the Australian Center for Unisys Software. *Empirical Software Engineering, 9,* 1-2 (2004), 45-75.

[13] Davis, F.D., Bagozzi, R.P., and Warshaw, P.R. User acceptance of computer technology: A comparison of two theoretical models. *Management Science, 35* (1989), 982-1003.

[14] Dillman, D.A. *Mail and Internet Surveys: The Tailored Design Method.* Wiley, New York NY, 1999.

[15] eRA. *Program Portal Scope Document v1.4.* (Tech. Rep.). National Institutes of Health, Bethesda MD, 2002. Available at http://era.nih.gov/Docs/Pgm_Por_Scope_4-02.doc

[16] Frijda, N.H. *The Emotions.* Cambridge University Press, New York NY, 1986.

[17] Garson, D. *Scales and Standard Measures.* Available at http://www2.chass.ncsu.edu/garson/pa765/standard.htm

[18] Guttman, L. An outline of some new methodology for social research. *Public Opinion Quarterly, 18* (1954), 395-404.

[19] Guttman, L. A faceted definition of intelligence. *Studies in Psychology, 14* (1965), 166-181.

[20] Hoorn, J.F. *Validating Stakeholders' Needs of a Logistic Warehouse Management System.* (Tech. Rep.). Free University, Amsterdam NH, 2004.

[21] IEEE Standard 1471. *IEEE Recommended Practice for Architecture Description*, 2000.

[22] Jordan, B. Ethnographic worksplace studies and computer supported cooperative work, in D. Shapiro et al. (eds.) *The Design of Computer-supported Cooperative Work and Groupware Systems.* North Holland/Elsevier, Amsterdam NL (1996), 17-42.

[23] Juristo, N., Moreno, A.M., and Vegas, S. Reviewing 25 years of testing technique experiments. *Empirical Software Engineering, 9,* 1-2 (2004), 7-44.

[24] Kaplan, K.J. On the ambivalence-indifference problem in attitude theory and measurement: A suggested modification of the semantic differential technique. *Psychological Bulletin, 77* (1972), 361-372.

[25] Van Lamsweerde, A., and Letier, E. Handling obstacles in goal-oriented requirements engineering. *Software Engineering, 26*, 10 (2000), 978-1005.

[26] Van Lamsweerde, A. Goal-Oriented Requirements Engineering: A Roundtrip from Research to Practice, in *Proceedings of the Requirements Engineering Conference, 12th IEEE International (RE'04)* (Kyoto JP, 2004), Volume 00, 4-7.

[27] Letier, E., and Van Lamsweerde, A. Agent-based tactics for goal-oriented requirements elaboration, in *Proceedings of 24th International Conference on Software Engineering* (Orlando FL, 2001).

[28] Norman, D. *The Invisible Computer.* MIT Press: Cambridge MI, 1998.

[29] Nurmuliani, N., Zowghi D., and Williams S.. Using card sorting technique to classify requirements change, in *Proceedings of the 12th IEEE International Requirements Engineering Conference (RE'04)* (Kyoto JP, 2004).

[30] Potts, C. Using schematic scenarios to understand user needs, in *Proceedings of DIS'95 - ACM Symposium on Designing Interactive Systems: Processes, Practices and Techniques* (Michigan MI, 1995).

[31] Priester, J.R. and Petty, R.E. Extending the bases of subjective attitudinal ambivalence: Interpersonal and intrapersonal antecedents of evaluative tension. *Journal of Personality and Social Psychology, 80* (2001), 19-34.

[32] Pronk, S. *From Static Store to Organized Warehouse.* (Tech. Rep.). Free University, Amsterdam NH, 2004.

[33] Robinson, W.N., and Pawlowski, S. Managing requirements inconsistency with development goal monitors. *IEEE Transactions on Software Engineering,* (Nov/Dec 1999).

[34] Skowronski, J.J., and Carlston, D.E. Negativity and extremity biases in impression formation: A review of explanations. *Psychological Bulletin, 105* (1989), 131-142.

[35] Spanoudakis, G., Finkelstein, A., and Till, D. Overlaps in requirements engineering. *Automated Software Engineering, 6*, 2 (1999), 171-198.

[36] Sutcliffe, A. *User-centred Requirements Engineering. Theory and Practice.* Springer, London UK, 2002.