What Influences the Requirements Process in Industry?
A Report on Industrial Practice

Ian Alexander[1], Suzanne Robertson[2], and Neil Maiden[3]
[1] *Scenario Plus Ltd; ian@scenarioplus.org.uk*
[2] *Atlantic Systems Guild Ltd; suzanne@systemsguild.com*
[3] *City University, London; cc559@soi.city.ac.uk*

Abstract

What influences the way people in industry (including commerce and government) do their requirements work? This survey, using a short questionnaire, found that the main influences were training, an organisation's own standards, tools, the regulator, first principles, and experienced colleagues. Sources of process knowledge outside organisations had little influence.

1. Introduction

Consultants work to improve the way people in industry do their requirements, providing consultancy, training courses, books, websites, and free tools and templates [1, 2, 3, 4] to help people engineer their requirements better. But little seems to be known on what influences people in industry to choose the requirements processes that they use; a major study of influence on software process [5] focuses on process improvement and organisational issues. Why do engineers do what they do? Industrial practice is very different from the elaborate techniques known to requirements researchers. Helping people do things better in industry demands knowing how the requirements decision process works.

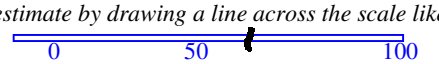
A possible approach was suggested by access to people with a wide range of different experience, training, nationality, and workplaces, namely past and present attendees on training courses. A survey could explore the influences on these people. This report presents the approach, and the findings on current industrial practice. It then considers threats to the validity of the findings.

2. Approach

The survey used a 29-question survey form occupying a single sheet of paper (two sides of A4). 23 of the questions were framed in terms of a 'sliding scale' from 'No influence' to 'Strong influence', to be marked by respondees with a single penstroke (or Word graphics line for emailed responses). All such questions were scored from 0 to 100 by measuring directly from the millimetre scale. 5 questions sought textual responses; one provided checkboxes. The aim was to maximise the rate of completion of forms by making the form appear attractively simple and quick to complete. The form consisted of the following text:

Influences on Your Requirements Process

For the 'sliding scale' questions, please indicate your best estimate by drawing a line across the scale like this:



How important were the following factors as helpful, positive influences on the Requirements Process you are using on your current / most recent development project? If there are specific events, documents, etc that strongly influenced you, please name them.

1) University-level Education? *(If strong influence) say which parts:*
2) Training Courses? *Say which:*
3) Books? *Say which:*
4) Conferences? *Say which:*
5) Professional Events, Lectures? *Say which:*
6) Your Organisation' s own Standards, Quality Procedures?
7) (Inter)national Standards (e.g. ISO, EN)? Say which:
8) Websites? *Say which:*
9) Consultancy?
10) Tools used on this or other projects? *Say which:*
11) Magazines, Newsletters, Journals? *Say which:*
12) Electronic Mailing Lists, Newsgroups, Discussion Forums?
13) Regulatory Environment (e.g. Industry Regulator, Safety Regulator)?
14) Industry Working Party, Task Force, Improvement initiative?
15) Research Institution' s collaboration with your Organisation?
16) Government Report, Advice to Industry?
17) First Principles (the project worked out its own process)?
18) Experienced Colleagues?
19) Any Negative Influences? *Please list them:*
20) Other Influences? *Please list them:*

About your Project

21) What is the name of your project?
(this will be kept confidential; we will use it only to avoid counting a project twice)
22) Which field is your project in
(e.g. Telecommunications, Aerospace, Banking)?
23) How many people were/will be involved in your project at its Maximum?
1 10 people 100 people 1000 people More
24) What is the likely duration of your project?
0 1 year 2 years 3 years More
25) Is your project *(check answer boxes that apply)*:
a) Safety-related b) Critical to your organization
c) Neither of these
26) Which country is (your part of) the project in?
If several countries, how many?

About you

27) How much formal education have you had?
School BSc, … MSc, … PhD More
28) How much training in Requirements have you had?
None a few Days a few Months More
29) How many years Requirements experience have you had?
0 1 year 2 years 4 years More

Table 1: Summary of Survey Responses (Questions 19-22, 25-26 were Non-Numeric)

The rows are in pairs. The first (white background) of each pair names the Dataset and gives its sample size, with the average on each of the 29 questions; the second (grey background) gives the standard deviation (labelled +/-). First are all the responses together, and then various subsets of the responses (eg people on safety-related projects, or not).

Dataset	Sample Size	1 Education	2 Training	3 Books	4 Conferences	5 Events	6 Own Standards	7 International Stds	8 Websites	9 Consultancy	10 Tools	11 Journals	12 Lists	13 Regulator	14 Task Force	15 Research	16 Govt Advice	17 First Principles	18 Colleagues	23 People at Max	24 Duration	27 Yr Education	28 Yr Training	29 Yr Experience
All	152	42	57	42	26	27	62	35	27	30	42	20	20	34	27	23	25	45	65	34	52	36	35	57
+/-		30	27	30	27	29	27	30	25	29	30	22	21	32	28	24	27	30	27	18	35	21	23	36
Email	72	48	69	52	24	25	60	32	32	34	40	21	23	35	23	19	23	44	60	36	38	36	46	70
+/-		29	22	28	26	26	31	31	26	30	30	20	21	34	25	22	25	29	30	15	29	22	21	31
Not Email	80	37	47	32	28	28	64	38	22	25	43	19	17	33	32	26	27	47	69	33	64	36	25	45
+/-		30	26	28	28	31	22	29	24	27	30	24	21	31	30	26	28	31	24	20	35	19	20	37
Safety	30	37	49	31	26	27	63	42	21	28	35	18	15	47	31	24	34	47	68	37	71	37	30	58
+/-		29	28	25	24	28	25	29	23	26	28	20	18	36	30	24	27	33	27	18	33	22	25	37
Not Safety	122	44	60	44	26	27	62	34	28	30	44	20	21	30	27	23	23	45	64	33	47	36	36	56
+/-		30	26	30	28	29	27	31	26	29	30	23	22	30	27	24	26	29	27	18	34	20	22	36
Telecommunications	7	46	69	44	13	23	62	34	42	36	29	16	19	29	33	25	22	53	66	40	41	35	37	72
+/-		32	15	27	13	28	30	28	30	25	23	17	20	38	38	21	26	33	31	18	21	19	17	20
Aerospace	19	30	40	23	14	8	66	24	13	21	31	18	8	36	20	13	16	67	73	38	73	34	27	75
+/-		29	28	27	17	13	21	23	14	21	32	22	10	32	25	16	23	29	15	18	29	16	14	29
Defence	43	46	55	46	41	42	66	46	27	28	55	23	23	33	36	35	33	44	66	33	68	43	29	41
+/-		29	21	26	30	33	22	28	24	27	24	27	25	29	28	25	28	28	29	17	36	17	22	34
Government	8	21	62	36	7	12	63	11	15	13	11	3	7	14	13	7	12	28	46	25	46	14	32	33
+/-		23	22	40	5	15	30	23	19	28	18	3	8	24	22	8	20	32	34	28	44	9	21	45
City (Finance, etc)	21	52	75	53	23	35	71	27	27	29	42	20	24	44	23	14	24	41	68	34	28	34	47	76
+/-		29	16	30	24	30	29	27	27	29	28	19	21	32	25	14	23	27	24	13	21	18	18	29
UK	41	37	45	34	21	18	61	32	22	32	36	15	14	39	29	20	31	51	70	38	59	31	35	58
+/-		28	29	30	23	23	26	28	25	30	31	17	16	37	29	25	31	31	19	21	33	20	26	35
USA	20	43	66	41	23	13	67	19	27	25	29	18	18	37	21	17	17	44	56	40	47	30	42	72
+/-		28	27	31	28	17	26	28	27	34	28	21	21	35	27	24	26	34	33	12	37	17	21	32
Turkey	41	46	54	45	41	43	65	45	28	27	55	24	24	32	33	34	31	43	65	34	69	44	30	42
+/-		29	21	26	30	33	22	28	24	26	24	28	25	27	26	24	26	28	29	17	35	15	21	34
Australia	18	52	74	52	20	33	69	35	28	38	42	20	20	30	25	17	24	56	75	33	38	34	44	73
+/-		33	17	30	25	28	26	28	23	28	29	18	17	30	27	19	27	20	16	13	28	20	20	26

3. Results

Numeric Responses

Table 1 summarizes the numeric results.

The highest scores (Figure 1) indicate that respondees felt that Training, Own Standards, Tools, the Regulator, First Principles, and Experienced Colleagues were the main influences on their requirements process. Most of the other factors, which are mainly sources of process knowledge external to their organisations, had little influence. This pattern (see section 5 "Conclusions" for possible explanations) is stable however the data are divided (eg by country or by industry sector – see below), though there are also interesting and suggestive differences between industry sectors, for example when considering whether safety is involved or not.

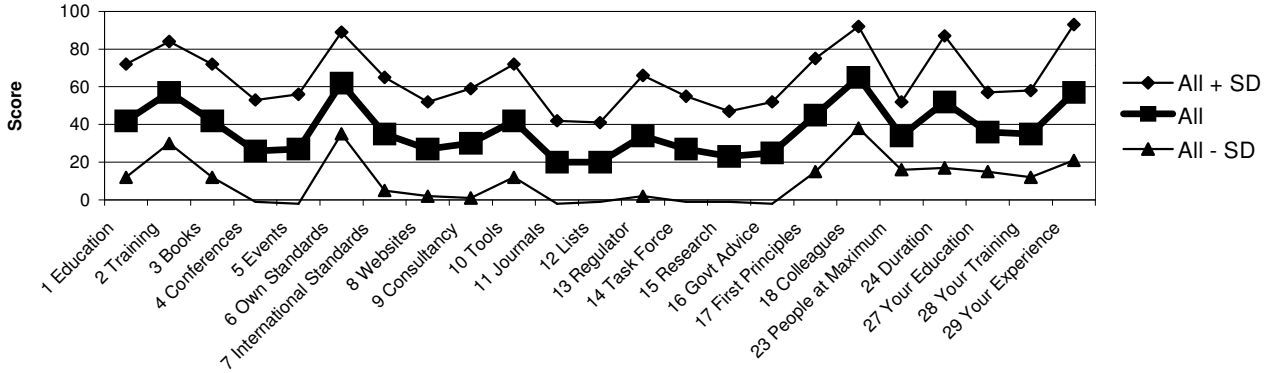


Figure 1: Overall Findings by Question (Mean Score +/- Standard Deviation)

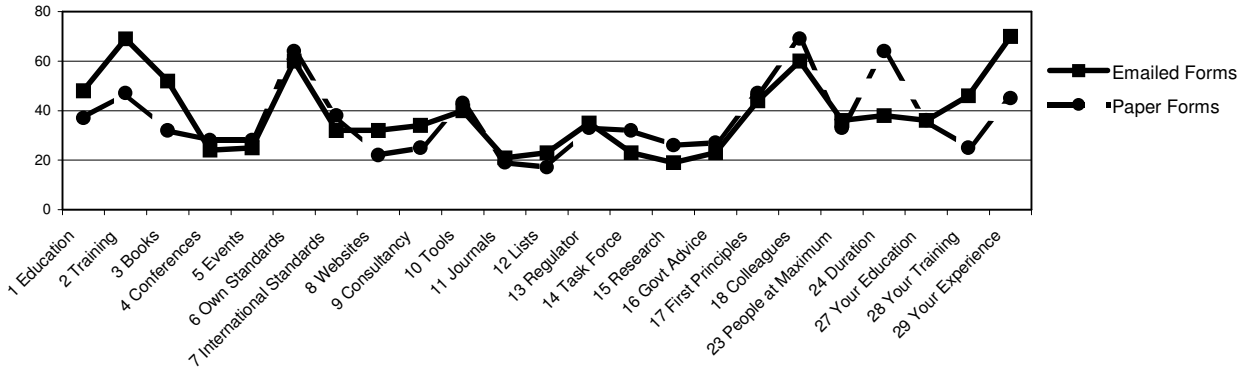


Figure 2: Independence of Survey Method
(Emailed forms to participants on past courses, Paper forms on current courses)

The collective findings of Figure 1 conceal substantial variation between individual respondees. The lowest-scoring individuals (13, or 7%) score 'No Influence' (taken as a score below 20) on each of questions 3, 4, 5, 7, 8, 9, 10, 11, 12, 14, 15 and 16 (ie essentially all external sources of information except training).

On the other hand, 80 (53%) respondees (see "Non-Numeric Responses" on page 4) named a specific book, website or tool that had influenced them, and thus plausibly claimed strong influence from these factors. 12 (7%) well-informed and perhaps highly self-motivated individuals scored over 50 on each of the questions 3, 8, and 10 (ie books, websites, and tools).

This suggests that respondees include very different kinds of people. Similarly, they work in diverse organisations and industries, so there are many possible causes of variation. Here is an analysis of the data to provide assurance that the findings are genuine, to characterise the major effects, and to suggest possible causes on the basis of the evidence.

Effect of Different Sampling Methods

The responses from emails to past attendees (Suzanne Robertson's Mastering the Requirements Process, square symbols), and paper forms to present (Ian Alexander's, various courses, circles) are nearly indistinguishable (Figure 2) especially when variation (SD, see Table 1) is considered.

This is reassuring as it shows that the results do not depend on where or how the results were collected. In particular, people on current training courses did not indicate that training was more important – rather the reverse, though as they had not finished the courses (or made use of what they learned) that might be expected. The differences in Duration are linked to the greater number of Defence and Aerospace people in the paper forms sample; differences in Your Training/Experience could indicate a bias – perhaps older hands are more willing to reply to emailed forms, for instance.

The Effect of Safety-Related Work

Figure 3 shows the results divided between people on safety-critical projects (30, circle symbols) and the rest (122, squares). It appears that when safety is involved, the Regulator is understandably much more important in driving the requirements process, and projects are of much longer Duration; Government Advice is slightly more important. Other factors, including training, books, websites, tools, and mailing lists are all less important than on non-safety-related projects. Standards are of broadly similar importance. This suggests that safety-critical projects have distinctive and relatively fixed processes.

The Effect of Industry Sector

Figure 4 shows the results by industry sector. The overall pattern remains visible, with some apparent variations. Defence scores highest on influence from Conferences, Professional Events, International Standards, Tools, Research collaborations, and Government Advice. If this finding is repeatable, it would suggest that this advanced sector demands and obtains process knowledge from a wider range of sources than other sectors.

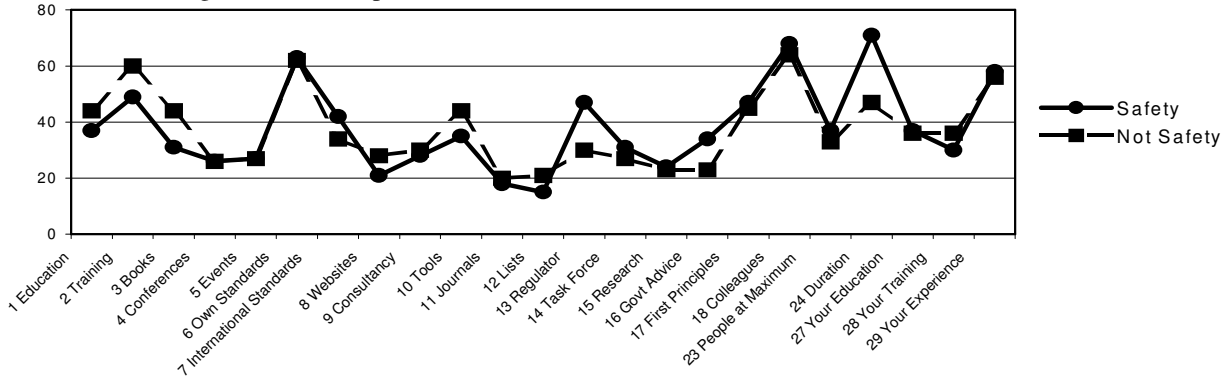


Figure 3: Safety-Related Differences
(respondees working on 'Safety-Related' Projects compared to the rest)

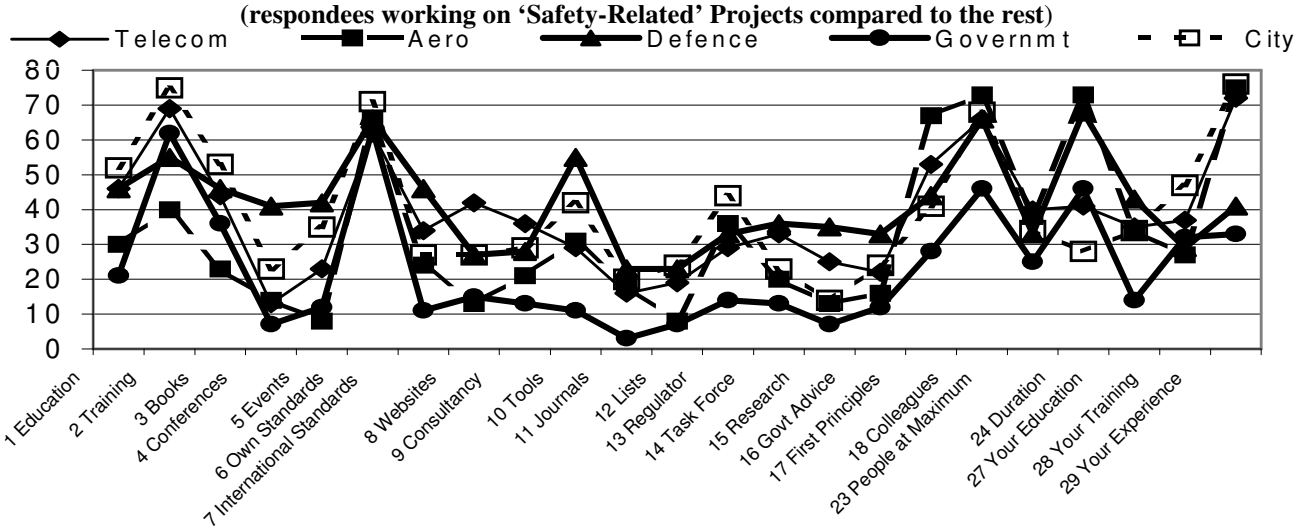


Figure 4: Industry Sector-Related Differences
(respondees grouped by their answers to 'Which field is your project in?')

At the other end of the spectrum, a small sample (8) from the Government sector suggests that internal Standards are the main influence on the requirements process in this rather closed environment: the group scored the lowest on most of the factors – only Own Standards and Training were scored highly. It also had by far the lowest level of education in the survey. Cause and effect are hard to elucidate here, but the combination of apparently rigid procedures, low education and limited use of available process knowledge suggests little scope for progress or use of initiative.

Telecommunications workers (7) scored by far the highest on the influence of websites. Three of them named these as "Manufacturers" (presumably of specialist hardware and software), [4], software-engineering.org, and RosettaNet. Their work is often strongly web-centred (both in process and in product) and indeed they have long worked with wide-area networks. Hence, they may be more likely than other engineers to make use of the world-wide web.

The highly-regulated City sector, including Banking, Insurance and Finance, unsurprisingly rates Standards and the Regulator higher than do all other sectors; they also gave the highest scores on Training (75%, compared to 40% for Aerospace) and Books – perhaps City firms are more willing to invest in training and educational materials.

As just stated, the Aerospace sector rates training low as an influence, possibly simply because they have received little (Your Training 27%, less than any other sector). Conversely, they are highly experienced (Your Experience 75%, more than any other sector). Perhaps, therefore, the Aerospace sector considers that people should learn on the job, not in training courses. The sector has projects of long duration (73%), and in keeping with the emphasis on experience over training, both First Principles (67%) and Experienced Colleagues (73%) are rated as powerful influences on the requirements process.

The Effect of Geography

There are some variations between countries that may reflect real differences among requirements people (see Table 1). The Australia average is 74 on the importance of training, with USA 66, UK 37 and average 57. On the other hand, while Australia scored the highest again on Colleagues, at 75, USA was lowest at 56. Tools scored highly in the Turkey group: 55, (against average 42), but this is probably because that group works in Defence (with DOORS) rather than an effect of geography.

Non-Numeric Responses

Two thirds of forms (106) named at least one specific influence (text attached to the numeric questions), helping to indicate the wide range of influences that are sometimes important.

A third of respondees (46) named books or authors, (including [1, 2] about which no conclusion can be drawn, because of possible influence), Karl Wiegers (5), Alistair Cockburn (4), Kent Beck's Extreme Programming (2), Donald Gause & Gerald Weinberg's Exploring Requirements (2), Tom Gilb's Software Engineering Management (2), and several mentioned just once (eg Hooks, Buzan, Hatley & Pirbhai). These are clearly widely different, with little consensus.

A fifth of respondees (28) named a wide range of websites (including [3, 4]: again, no conclusion can be drawn about these), INCOSE (3), RUP/Rational (3), and several mentioned just once, with little consensus.

A third of respondees (53) mentioned tools including DOORS (23, of which 11 were in the homogeneous Turkey group), Requisite Pro (5), Rose (3), CORE (3), Cradle (2), home-grown tools, or simply Word or Visio.

A quarter of respondees (41) named some Negative Influences. These included management resistance to requirements (16), requirements drift, lack of tools (4), customer attitudes (4), poor user requirements (3), scope creep (3), poor techniques (3), lack of experience (3),

schedule cuts (2), negative stakeholders (2). All of these are well-known issues in industry.

Qualitatively, the overall impression is that most respondees use few sources of process knowledge, while some respondees use a wide range of sources. In other words, many people seem to use the process they are given (by training, in standards). Several would like to improve the requirements process, if only their managers allowed it.

4. Validity Threats

There are unavoidable validity threats to a survey of industrial practice, especially how to obtain a representative sample, and how to minimise influence on results. These were handled as described below.

Obtaining a Representative Sample

Two complementary sampling methods were used:

i) paper forms were distributed by course tutors to requirements engineering course groups (82 responses);

ii) word-processed forms were distributed by email addressed personally to people who had earlier attended such courses (70 responses).

Neither approach guarantees a random sample, but since the methods are different, they should skew in different ways: course participants are often instructed to attend rather than being self-selected as email respondees were. The email group had received requirements training; the paper group had not, but was about to do so. However the results are similar (Figure 2). So, while training should be assumed to be non-randomly sampled as the survey was based on participants on training courses, the findings may perhaps be valid even for that factor.

Minimising Influence on Results

To minimise influence on responses, results were anonymous and confidential, and the questionnaire asked all questions in the same way. If some answers are consistently higher than others, those differences should be valid, though if (as is likely) one factor influences others in a ripple effect, the true cause of the differences might not be visible.

Opinions of course attendees can be influenced by the recency of the course itself; this was minimised by giving out questionnaires early in the courses. Also, the effect does not apply to the email approach with past participants.

5. Conclusions

The findings suggest that on most projects, regardless of geographic location or industry sector, the same short list of factors contains the main influences on the requirements process. These factors are: the organisation's Own Standards, First Principles, and Experienced Colleagues; and to a lesser extent Tools and the Regulatory Environment. This survey cannot say whether Training is important overall.

The relatively low scores for Tools may be a surprise; but requirements tools more specialised than Microsoft Office are still rare in industry, except eg in Defence where large, long-lived projects are the rule (and tools score more highly). In any case, tools ought to follow process, and not vice versa.

There seems to be intuitively satisfying evidence that industries approach process in different ways. The example of Aerospace's relying on extensive personal experience and knowledgeable colleagues to work processes out from first principles is interesting, and appears to characterise that industry sector. Naturally, 'first principles' may often be influenced unconsciously by conventional practices such as the waterfall life-cycle model.

In the special case of safety-related projects, the regulatory environment and standards are paramount. In a safety-related domain like railway, non-functional requirements are mostly codified in standards, while processes are largely imposed by regulations and standards, so this result makes sense intuitively. One can expect a conservative attitude to process in safety-related work.

A wide range of factors such as books, conferences, professional events, websites, consultancy, journals and magazines, mailing lists, industry task forces, collaborations with research organisations and government advice all have little effect on industrial practice in general. Both the responses and our experience show that while some projects do benefit from these factors, many do not. Perhaps the effort put into these factors has yet to bear fruit.

The implication for teaching is simple: if the current generation of engineers cannot be reached inside their organisations (except perhaps for the lucky few who get on to training courses), the next generation should be taught process thinking in universities. They should be taught how to search the Internet, and how to find things out for themselves: though perhaps such skills will improve naturally as today's children grow up with the Internet. When they become engineers, they will gather process knowledge from many sources. Wider issues like the negative influences of management and organisation are well-known but remain worrying; the non-numeric findings suggest that these issues continue to be serious.

Finally, we hope that the findings of this survey will encourage people in industry to reflect on their own practice, and maybe to review the situation on their own projects. Perhaps the findings could even help persuade management to take requirements more seriously.

References

[1] I. F. Alexander & R. Stevens, Writing Better Requirements, Addison-Wesley, 2002.

[2] S. Robertson & J. Robertson, Mastering the Requirements Process, Addison-Wesley, 1999.

[3] Scenario Plus Website, http://www.scenarioplus.org.uk

[4] Volere Website, http://www.volere.co.uk

[5] I. Sommerville & T. Rodden, Human, social and organisational influences on the software processes, in Software Process, Vol. 4 of Trends in Software (A. Fuggetta and A. Wolf, editors), John Wiley, 1996.