
This item was submitted to [Loughborough's Research Repository](#) by the author.
Items in Figshare are protected by copyright, with all rights reserved, unless otherwise indicated.

Forget statistics - draw graphs instead

PLEASE CITE THE PUBLISHED VERSION

<http://dx.doi.org/10.1049/ic:20040400>

PUBLISHER

© IET

VERSION

AM (Accepted Manuscript)

LICENCE

CC BY-NC-ND 4.0

REPOSITORY RECORD

Dawson, Ray, and Mark De Chazal. 2019. "Forget Statistics - Draw Graphs Instead". figshare.
<https://hdl.handle.net/2134/13552>.

This item was submitted to Loughborough's Institutional Repository (<https://dspace.lboro.ac.uk/>) by the author and is made available under the following Creative Commons Licence conditions.



For the full text of this licence, please go to:
<http://creativecommons.org/licenses/by-nc-nd/2.5/>

Forget Statistics - Draw a Graph Instead

Ray Dawson¹ and Mark de Chazal^{1,2}

¹ Loughborough University

² Rolls-Royce plc.

R.J.Dawson@lboro.ac.uk

Abstract

This paper describes research carried out at the Rolls-Royce company in the UK, to develop a tool set to aid planning and decision making regarding the management of a portfolio of IT systems. The research was carried out over three years with one researcher working alongside company employees in teams developing and evaluating the tools. A number of empirical and non-empirical tools were evaluated for their usefulness within the teams for analysing the problems, and for their usefulness in putting the alternative options to senior management. It was found that the most successful tools were the simpler tools where it is easy to understand the output and how it has been derived. Graphical tools depicting non-empirical or simple empirical information were found to be particularly helpful. Statistical analysis, on the other hand, was not found to be useful as the results are generally mistrusted by senior management.

1. Introduction

Managing IT in a business environment is a complex combination of juggling and balancing. The IT manager must juggle multiple projects simultaneously as well as balance the business need for growth against the systems' need for maintenance. Not all companies have achieved this balance, and for many IT has been seen as a drain where money is poured in with little to show in return. As technology moves forward, IT managers are faced with difficult decisions as to whether the IT should be upgraded, replaced, expanded or just left as it is. Pressures come from individuals and sections of the company to invest in the latest technology for their individual needs, but these have to be balanced against the costs incurred, often in situations where the exact costs are difficult to discover until they occur. Other considerations, such as the need for standardisation to reduce maintenance, or the advantages and disadvantages of centralised versus distributed systems further complicate the issues.

At senior levels, this is a particular problem. The board may be asked to approve IT strategies and purchase requirements that can run into millions of dollars which

could make or break the company, yet are likely to have only as much information as can be put across in a two hour meeting to make the decision. Worse still, the arguments put forward are often complex and technical and are put forward in a way that only an IT specialist is likely to understand. It is not surprising, therefore, that companies have difficulties in this respect.

This paper gives an overview of a three-year research project carried out at Rolls-Royce Naval Marine at Derby in the UK to try and overcome the problems of decision-making on IT strategy and investment. The project aim was to create a tool set that would assist companies to make decisions on the management of their portfolio of IT systems. In particular the tool set was needed to:

1. Assist the IT function in the company to align with the business requirements, analyse the options available and, where appropriate, to produce recommendations for the board of directors to consider.
2. Assist the IT function to present the alternatives and recommendations to the board of directors in a form that can be understood quickly and easily.
3. Assist the board of directors in coming to a decision that is in the best business interests of the company.

Many tools and methodologies were considered for use within Rolls-Royce. Some of these were existing tools, some were modifications of existing tools altered to suit the Rolls-Royce environment, and some were new tools developed to satisfy a particular need.

2. Research Methodology

The project was one of action research. One of the authors and principle researcher in this project, Mark de Chazal, was based on the company premises and worked alongside the Rolls-Royce employees for the three years of the project. The placing of the principle researcher at the company was an important aspect of the methodology. Change management is fraught with complications, particularly in large companies, which tend to have a 'traditional way' of performing tasks, and the body of opinion against change can be quite large. Gaining acceptance of change, particularly when an organisation

can be experiencing 'change fatigue' is arduous, time consuming, and vitally important [1].

The three years of the project allowed a four phase build up to the research:

1. Phase one involved working with and observing the existing methods in the company to understand how the company, and in particular the IT function worked.
2. Phase two involved a pilot study involving suggestions put forward and tried within one team in the company. This stage was important to build confidence in the company that the researcher was competent in making sensible suggestions and that the ideas tried were suitable for their own environment.
3. Phase three involved a wider spread test, where a number of working parties used the ideas developed in the first two phases and, based on the confidence built up in phase two, added new suggestions for further tools to be used.
4. Phase four involves the company adopting many of the tools from the recommended toolset as standards for use throughout the organisation. This last phase occurred after the end of the three year project, showing that the research has permanently altered the way the company operates.

This paper focuses on the implementation and results of Phase Three as this represents the main findings of the research project. This stage involved a number of separate teams across the business site applying the tools. All the teams had access to the tool kit, and kept the researcher appraised of what and how they were using, plus any comments. In an iterative approach, the tools and methods were updated and refined as this phase of the research progressed. The principle researcher was, by this time, viewed by the company as a valuable resource, as well as having quickly absorbed a large volume of business-specific knowledge. The combination of the business knowledge and the researcher's skills in utilising both his knowledge and other peoples, and being able to present this knowledge in a variety of useful ways, meant that the researcher was invited to be a member of all these teams by the Head of Engineering. However, time constraints meant that participation was possible in only some of these teams. Consequently, the teams were required to keep the researcher appraised.

Each team was composed of senior engineers, specialist experts and, where appropriate, senior business representatives from different business areas of Rolls-Royce. The principle researcher, Mark de Chazal, took part in the first four of the teams listed below acting as facilitator, specialist expert, minute taker or co-chair as required:

- *The Product Data Management (PDM) team* was instigated to evaluate PDM options for Rolls-Royce, in light of the new market conditions. The

responsibility of this five-member team was to examine the business requirements for product data management and recommend a way forward. This was a precursor of the strategy group mentioned below.

- *The Strategy team* was developed as a recommendation of the PDM team. This five-person group kept track of progress of all the groups and pulled all the IT infrastructure work together. This team met on a daily basis for three months to create the strategy document for Rolls-Royce. The strategy development team was also responsible for creating the work plan for implementing the strategy, and for defining the resources and timescales needed to make sure the work plan was accurate.
- *The Future Business Capability team* was put together at the recommendation of the strategy group. The capability group was responsible for detailing the requirements for future business, and feeding them back to the strategy group. The future business capability study group split into two parts. The full team was composed of representatives from all business departments, and the core team. The full team numbered approximately 15 individuals, in addition to the five-member core team. The core team met every day to discuss progress, and to make sure that information was being circulated to the full team as necessary. The full team met once a month to input progress to the core team (if it had not been directed to one of the business representatives between meetings).
- *The Database Rationalisation team* was also started at the request of the strategy group. This seven-member group was to look at how to rationalise configuration management databases within the Nuclear Business site of Rolls-Royce. This group had a limited remit, as so had a set deliverable and set requirements. .
- *The Configuration Management Process Rationalisation team* was a further group. This team also passed the conclusions to the strategy team. This team did not involve the researcher, due to time commitments to the other teams. However, all the teams maintained a high level of communication with the strategy team.
- *Additional 'Offshoot' teams* were also involved in the creation of the strategy, but were not part of the official strategy development process. These offshoots were temporary teams, set up as a form of brainstorming exercise, widening the breadth of business knowledge that was being input in to the various studies. This was part of the communications process, as it was necessary to deliver the intentions of the various teams mentioned above as widely as possible throughout the company.

3. Methodologies Used in The Teams

The first step for each team was a form of requirements analysis. It was necessary to determine what was actually needed to fulfil the company business objectives, rather than focus on what technology had become available or what new system salesmen were trying to promote.

Currently, Rolls-Royce uses the SSADM [2] process to document requirements. However, this process does not stretch back far enough to govern all requirements gathering. In practice it starts with a functional requirements specification and ignores many socio-political aspects of IS development and management. Consequently another methodology was examined for use, Checkland's Soft Systems Methodology (SSM) [3], on the grounds that it had been employed within Rolls-Royce previously, and people were familiar with the rather more flexible approach it allowed. However, even SSM was not flexible enough to introduce tools, and drop tools, as and when required. However, some aspects of SSM were very appealing, particularly the holistic approach to identifying variables and the use of rich pictures.

As a result, a suitable framework was created for use within Rolls-Royce as a precursor to the SSADM process, based very loosely upon SSM. It was introduced within Rolls-Royce as a variant of SSM in order to ease uptake. It was the intent to continue to add tools to this tool set, within the framework, during the course of study. Tools that have already been used would be incorporated in the framework. The framework has three sections:

1. Problem definition – working out what is wrong
2. Option Development – working out possible ways of fixing what is wrong
3. Strategy Development – working out exactly how to fix the problem

One aspect of SSM that is carried over to this framework is the use of rich pictures [3]. A rich picture is a pictographic representation of a certain situation. Commonly, they are drawn on a whiteboard, although implementation in Rolls-Royce extended to the use of a graphical package on a laptop coupled to a projector. Rich picturing was a technique that was extensively employed for drilling down to the cause of the problem. A picture was very helpful in working out why things were happening and where inefficiencies were likely to be.

In order to obtain a consensus of views amongst the team members and the wider community they represented a modified version of the Delphi technique was used. According to Clare [4], the specific purpose of the Delphi technique is to obtain consensus from expert individuals concerning problems, future needs or directions. This would seem to suggest its use within the software engineering environment. Clare gives a high level view of

a traditional Delphi process [4], as championed by the US Government [5]. The process of achieving consensus being essentially; present, collect opinions, collate, analyse, present.

However, the formal Delphi technique is fairly long and involved, and requires the presence of a trained Delphi facilitator. For this research, therefore, the technique was modified. One weakness of the Delphi technique seems to be the opacity of the process. The participants are blind to the analysis, the analysis and conclusions being developed in seeming isolation from the participants. This does not aid in the implementation stages, as it is possible for the participants to feel unrepresented. It can also lead to the suspicions of collusion with senior management to produce a pre-determined outcome. To avoid this, the analysis was made more transparent. Simpler analysis was conducted, and the participants had full view of the analysis and were involved in the final report.

The rigid process was made more flexible. Questionnaires, as advocated in the formal technique, were still used to define the area to be addressed, but use was also made of other avenues of communication, such as telephony, focus groups, and individual interviews. This was to achieve greater support from the participants, and give the participants 'ownership' of the process which was invaluable at the later stage when any changes proposed were implemented.

4. Tools Developed and Used

A number of analysis and decision support tools were tried in the research project. The full description of all these tools is not possible within the constraints of this paper but can be found in the PhD thesis of Mark de Chazal [6]. For this paper examples of the tools are described to illustrate the main findings of the research.

The tools can be broadly categorised by input as to whether or not empirical data is required, and those that use data can then be further categorised by output as to whether graphical or statistical output is produced.

4.1. Non Empirical Tools

The quick architecture analysis tool is an example of a tool that does not require empirical data. This tool is used to compare capabilities of alternative proposed systems with the capabilities of the existing systems. The functions of each existing system are identified and the proposed systems are then examined to see which if any would handle each existing function. The new systems are then represented as bubbles on a graph showing what cover they provide for the existing systems. Importantly, existing systems with functions not covered are also shown outside these bubbles. An example is shown in Figure 1.

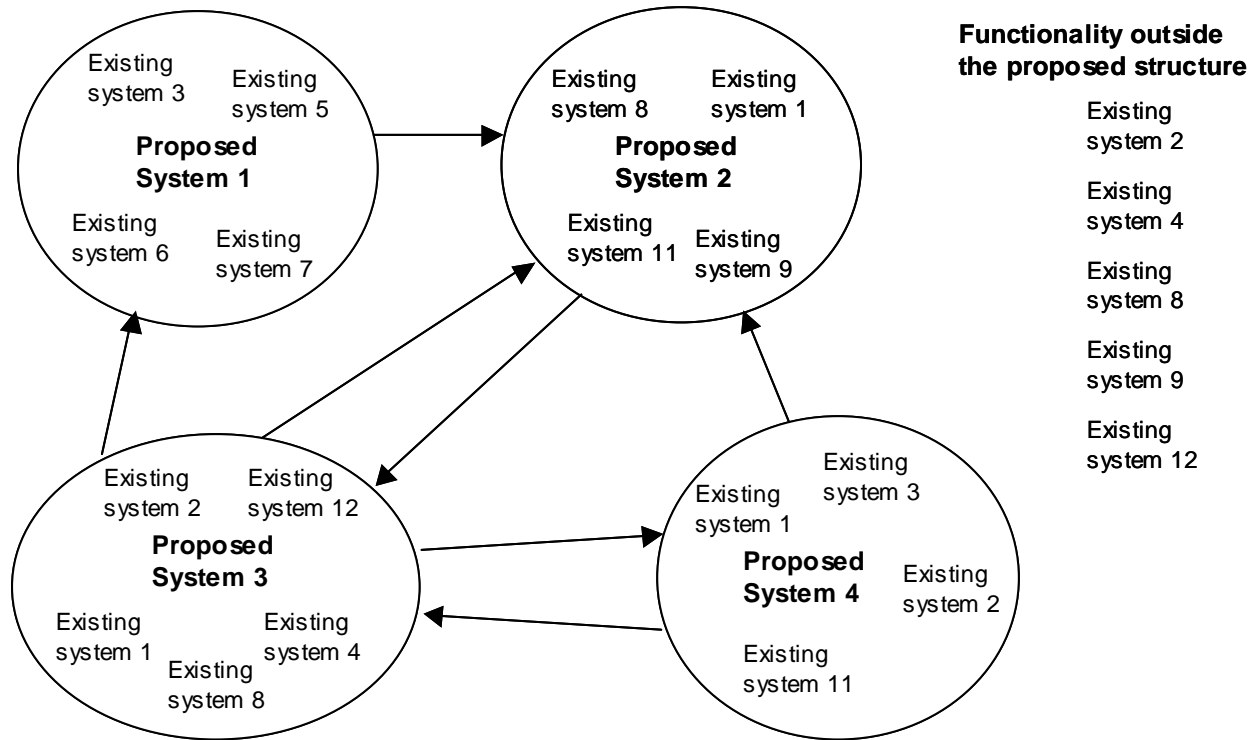


Figure 1. Quick Architecture Analysis Tool

The most notable feature of this tool is its simplicity. However, it allows the relationship between the existing and proposed systems to be seen 'at a glance', it is easy to use and is understandable by everyone whether they have a background in IT or not. This tool was very well received whenever it was used, both within the teams and when the team needed to present the options to the higher management. The simplicity of the tool was a major aspect in its adoption and acceptance.

Other successful non empirical analysis methods had similar characteristics. For example, modified versions of entity relationship diagrams and data flow diagrams were used. These were used at the high level with the rules of the standard methods being relaxed so that, for example, relationships between systems were included. Additional annotations in the style of rich pictures were allowed to broaden the use of the techniques. The relaxing of the rules and the high level nature of the diagrams, again, kept their use at a simple level where they could be readily understood and used by non IT specialists, and could be presented to higher management without detailed explanation.

4.2. Tools Using Simple Empirical Data

Some tools used very simple empirical data. Another simple, but very successful tool was the stakeholder management tool. As part of any requirements capture exercise, identification of stakeholders is a key activity. There are several tools and methodologies available for this process described by Mason and Mitroff [7], Mitroff and Linstone [8] and the prescribed creation and collation of a list of stakeholders for ISO 9000 certification. However, these were not found to give the required information in a format that is useful for decision-makers. A tool was therefore developed that facilitated the analysis of the stakeholders to determine the levels of interest and influence on the project under review and to determine why these stakeholders have practical influence.

The first stage is the identification of relevant stakeholders in a brainstorming session. This list is then divided into quadrants based on influence and interest, as shown in Figure 2. Each quadrant is identified by a combination of high and low interest and influence. This type of diagram would generally be drawn on a whiteboard, so that names can be moved around easily.

| | |
|---|---|
| High Interest / Low Influence Stakeholder A Stakeholder B Stakeholder C | High Interest / High Influence Stakeholder D Stakeholder E |
| Low Interest / Low Influence Stakeholder F Stakeholder G Stakeholder H Stakeholder I | Low Interest / High Influence Stakeholder J Stakeholder K Stakeholder L |

Figure 2: Example of a Stakeholder Matrix

While accepting that all stakeholders are important, given limited resources, it is practical and pragmatic to focus stakeholder management on those stakeholders with the most influence. Some instances of use generated large numbers of influential stakeholders – in these cases stakeholders were further divided into internal and external stakeholders. Internal stakeholders have different methods of management and contact to the external stakeholders and the analysis provided an insight into the extent of the relative influences of external and internal stakeholders.

The high influence stakeholders identified were then subjected to further analysis to identify stakeholder roles and functions. The differentiation between roles and functions were that: a stakeholder is defined by its role, whereas a function is defined and determined by the stakeholder. Roles and functions are terms that would be defined by a study team, and would be relevant to the particular project that required stakeholder management. However, the principles of definition are generic. An example of a role could be that of a provider – the stakeholder provided goods to Rolls-Royce, while an example of a function could be that of design – the stakeholder could influence the design of the RR product.

Figure 3 shows an example of the graphical summary of splitting the internal stakeholders according to their functions. Further analysis can also be done with the production of various summary pie charts, counting the number of stakeholders with a given number of functions and/or roles.

The stakeholder analysis graphical output was very valuable. It showed exactly which stakeholders were critical to project success, and why they were critical. It tells the team leader exactly why stakeholders are influential, and what their interests are likely to be. It was noticed that some of the stakeholders were extremely influential in one area, but had no interest or influence in other areas. Identification of external stakeholders allowed for mitigation of their influence to be planned in to the project at an early stage. The analysis revealed that there were many stakeholders that combined several influential roles.

Once again, the simplicity of this tool and its ‘at a glance’ graphical output proved to be key to its success. The empirical aspect was no more than a simple count of influences and interests but when presented in simple graphs and tables this proved to be one of the most useful decision making and planning tools for use within the team and for presenting options to higher management.

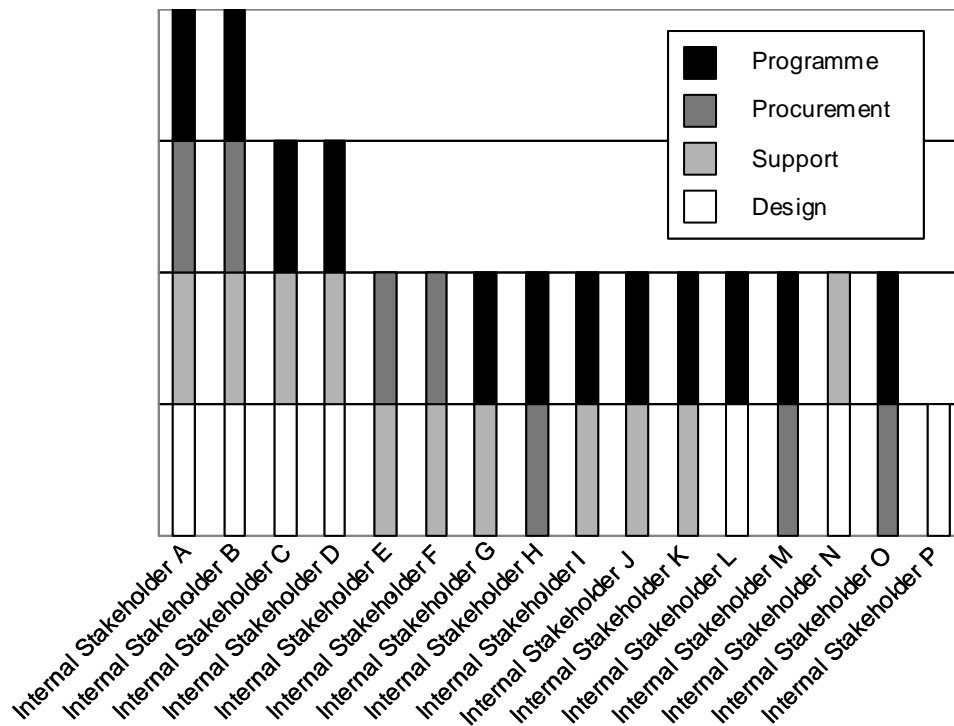


Figure 3: Example of a Summary Graph – Internal Stakeholders by Function

4.3. Other Tools Using Empirical Data

A modified form of feature analysis for the evaluation of systems against the set of features, was one of the most successful tools used at Rolls-Royce. The core of feature analysis, as it is intended to be used, is described by Kitchenham *et al* [9]. However, the feature analysis tool was extended to cover other aspects of business requirements, and not be used merely to compare system capability. Other modifications were in the weightings applied and in the presentation of the results.

The use of this tool is described in detail in a paper presented at the EASE 2002 conference [10] but for readability a summary is provided here.

Functionality requirements were developed from the development records of the existing systems, the Rolls-Royce Quality Management System and associated Local Operating Procedures, the business contracts and from interviews with the users. Derived functionality requirements were then divided into groups. The groups represented several levels of abstraction. At the top level (Level 0), only generic functional topic areas were addressed, such as ‘configuration management’ and ‘change control.’ Level 1 requirements embody more detailed functionality than Level 0. Level 2 requirements embody more detail still.

To enable the relative significance of each requirement to be evaluated, weightings were added to the Level 2 requirements on a 1 – 10 scale determined by user

and developer interviews and based upon significance to the business being effective. These were:

- 1-3: Useful
- 4-7: Important
- 8-10: Essential

Having a classification below “useful” was not considered to be informative, as identified requirements would, by definition, be useful. Level 1 and Level 0 weightings were determined by using the modal average of the requirements that they enclose. Changes to the higher level weightings were permitted if users/developers felt that the modal average did not reflect the importance (or lack of importance) attached to that group though this only happened for one Level 1 requirement.

It was then a matter of determining what requirements were fulfilled by each of the systems under evaluation. The weightings allowed each of the systems to be evaluated graphically, on the various levels. The categories of acceptance also included a “To Be Done” (TBD) category where the system did not have that functionality, but there were plans that were already in motion to satisfy that requirement. The inclusion of the TBD acceptance allows a very quick ‘planned functionality’ measure to be evaluated, allowing a look beyond the status quo for future capability.

Figure 4 shows the hierarchical nature of the features, and how the features nest within each other for one Level 0 feature.

| Functionality Requirements | Weightings | System 1 | System 2 | System 3 |
|----------------------------|------------|----------|----------|----------|
| Highest Level Requirement | 4 | | | |
| → Level 1 Requirement | 6 | | | |
| → Level 2 Requirement | 5 | Yes | Yes | Yes |
| → Level 2 Requirement | 5 | Yes | Yes | Yes |
| → Level 2 Requirement | 7 | Yes | No | Yes |
| → Level 2 Requirement | 3 | Yes | Yes | Yes |
| → Level 2 Requirement | 8 | Yes | No | Yes |
| → Level 2 Requirement | 8 | Yes | No | Yes |
| → Level 1 Requirement | 5 | Yes | No | Yes |
| → Level 2 Requirement | 4 | Yes | No | No |
| → Level 2 Requirement | 6 | Yes | No | Yes |
| → Level 1 Requirement | 7 | No | Yes | TBD |
| → Level 2 Requirement | 9 | Yes | ? | Yes |
| → Level 2 Requirement | 5 | No | TBD | TBD |
| → Level 1 Requirement | 2 | No | ? | ? |
| → Level 1 Requirement | 8 | | | |
| → Level 2 Requirement | 7 | Yes | Yes | Yes |
| → Level 2 Requirement | 7 | Yes | Yes | Yes |
| → Level 2 Requirement | 9 | Yes | ? | Yes |
| → Level 2 Requirement | 9 | Yes | Yes | Yes |
| → Level 1 Requirement | 2 | TBD | No | Yes |
| → Level 1 Requirement | 7 | | | |
| → Level 2 Requirement | 4 | Yes | Yes | TBD |
| → Level 2 Requirement | 9 | Yes | Yes | No |
| → Level 1 Requirement | 1 | | | |
| → Level 2 Requirement | 1 | No | No | Yes |
| → Level 1 Requirement | 2 | TBD | TBD | Yes |

Figure 4 Feature Analysis - System View for One High Level Function

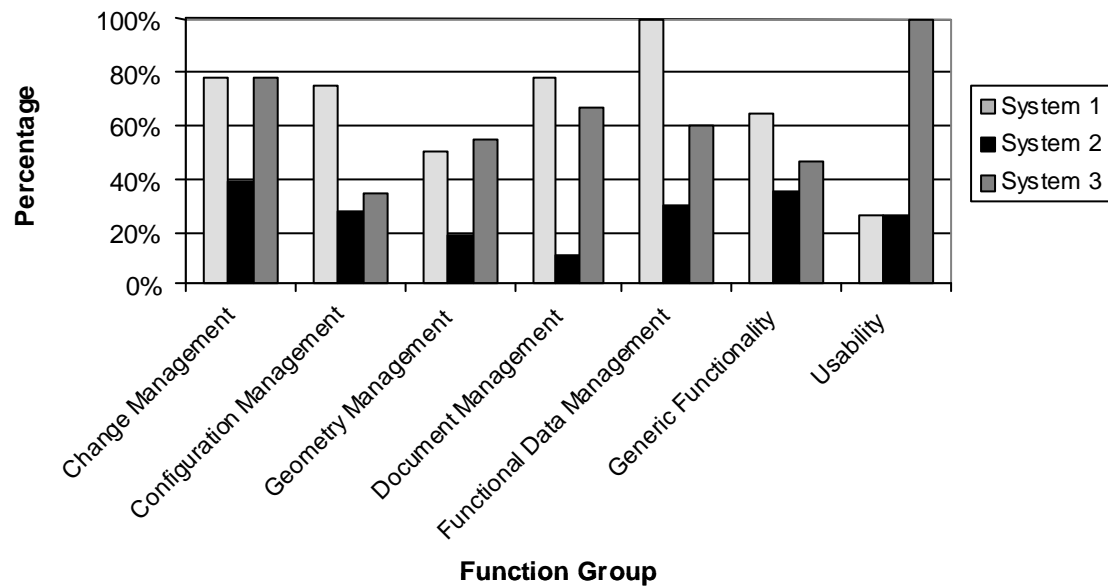


Figure 5. Summary Graph of Feature analysis System Comparison

The aggregation of requirements under the headings of Level 0, such as usability, could then be presented in a graphical form to give a simple yet effective view for comparing alternative systems as is illustrated in Figure 5.

These views were found to be very useful as they encapsulate the strengths and weaknesses of each system in a way that is immediately understandable. It is possible to see immediately why some systems are unsuitable. It is also possible to extract features that are essential and examine whether the systems cater for these requirements. This tool was particularly successful for use in presenting the analysis of alternatives to higher management.

4.4. Tools Using Statistical Methods

Defect management is an important part of IS management. Maintenance costs can consume significant proportions of the overall budget. When considering a change to the status quo, the maintenance costs must be considered. More importantly, future maintenance costs must also be considered, as it will be these future incurred costs that will determine whether a system is still returning value to the enterprise.

There are many statistical tools available for use and a number were tried in the second phase of the research. For example, failure data collected from the existing systems were subjected to regression analysis, to determine if there was any detectable pattern. The result of the analysis showed that there did not seem to be any detectable pattern to the defects, other than the expected J-curve following the initial implementation.

The actual results of the statistical analysis were, however, not as significant as the reaction to them. On review of the results with Rolls-Royce management, the researcher encountered a high degree of non-interest in the statistics, verging on disbelief. There was a high degree of scepticism regarding statistics in general, and the researcher would not employ this particular tool again.

The results of the statistical analysis seemed to be mistrusted for three main reasons:

1. Statistics can be difficult to use if you don't understand the details of derivation. Clearly statistics can be very useful if you know exactly what you are doing with them but very few senior engineers and managers have the level of knowledge required to appreciate the value or limitations of the results.
2. Statistics are often used to hide details from senior management – the more complex the statistics, the less likely it is that senior management will catch the problem data, as it is buried deeply in analysis. Therefore senior managers generally distrust complex statistics due to deep rooted survival instincts.

3. “Lies, damn lies, and statistics” is a common association of terms. It is recognised that a sufficiently skilled statistician can prove or disprove practically anything, especially if there is no-one with sufficient knowledge to question the results.

5. Conclusions

The results of trials of the tools described above were typical of the various planning and decision-making tools tried. Over all the tests a very strong message becomes immediately apparent - *keep it simple*. It was very noticeable the tools that were received the best by the senior engineers analysing the options and the senior management considering the analysis were those that were:

- simple to understand, cutting through the volumes of information detail to provide a clear message
- easy to see how the results presented were derived

Graphical output was particularly well received. Although the information each tool provided varied in usefulness, the fact that each was relatively simple to understand allowed users to quickly establish the relevance of the graph to the problem being considered.

There is an interesting anomaly that while there was a repeated management demand for empirical data, the tools found to be most useful usually had either no empirical data or the empirical data was of a very simple nature. It appears that while managers demanded figures to validate an argument, this demand can be satisfied with any tool that gives a clear presentation of facts whether these are based on empirical data or not.

Empirical results had to be presented in a simple manner to have an impact. Often this involved using graphs to present the alternatives though not necessarily so. For example, in the various financial models tested, though not described in this paper, a simple time duration for a return on investment was better received than more complex models giving rates of return, through life costs and other inflation corrected data.

The problem with statistical results was that statistics are not perceived as being simple. Even a single figure result was not considered simple as managers could not appreciate its true meaning and had no clear picture of how the figure was calculated. This perception of complexity leads to mistrust and a consequential refusal to accept the output as a significant argument. Does this mean that statistical methods of analysis should be abandoned? No - the authors would not recommend such a drastic step. Indeed, statistics can be very useful in helping to derive value from large quantities of data and can provide a level of confidence in resulting conclusions being meaningful. However, they do need to be used in moderation and for the correct purpose. Even so, a conclusion from this paper is that any statistical analysis

undertaken should not be used to present alternatives or a case for change to team members or management unless they happen to have a background in statistics. The mistrust generated could be counterproductive. An alternative method needs to be found to present the information - definitely simple and preferably graphical in nature.

The authors believe the fact that this research has produced these findings is a result of the research methods used. Working alongside the company employees over three years had three significant effects:

1. The researcher came to know the company environment as well as most of the company employees.
2. The company employees accepted the principle researcher as a trusted member of their team
3. There was time to try the developed tools over a few iterations evolving the tools as experience dictated.
4. The involvement of Rolls-Royce employees in the development and evaluation of the toolset gave the employees an added interest and ownership of the tools recommended.

This first hand, "insider" experience enabled the researcher to better appreciate the reaction to ideas across different levels of the company. The usual mode of university-industry research cooperation involves the university representatives acting as an external agency such as if they were consultants advising the company. When acting in consultancy mode there will be an inevitable desire to impress the 'customer' company, even when the university and company are supposed to be equal partners in the research. The authors suggest that this subconscious desire to be seen to be knowledgeable could lead to complex argument, such as when present rigorous statistical analysis. Such a presentation of ideas may be suitable for an academic journal, but it appears to make little impression on industry employees who would prefer simple arguments derived from transparent metrics and processes, presented in a clear and understandable way. Could this be why university research in software engineering is so often considered irrelevant?

The research project has been successful as several components of the developed toolset will be included in the Rolls-Royce Quality Management System for future use in the company. As a result of decisions based on the use of the toolset, expenditure on legacy systems on the Naval Nuclear site of Rolls-Royce has decreased, but

capability has actually been extended, with existing systems being used in innovative fashions, with various types of modification applied.

The research has shown that the simpler tools and methodologies were the most successful and had the biggest impact. Developing simple tools is not simple, as the situations they have to describe are often highly complex. However, it seems to be worth doing, as the tools and methodologies that have been suggested for inclusion in the RR QMS are all the simpler ones.

Simplicity is a singularly powerful argument. Gaining management support of any project is crucial, and simple explanations aid this enormously. The temptation to use complex statistics and formulae should be resisted at all costs!

6. References

- [1] Hampden-Turner, C. and Trompenaars, F., *Riding the Waves of Culture: Understanding Cultural Diversity in Business*, Nicholas Brealey Publishing, 1997
- [2] Downs, E., Clare, P. and Coe, I., *Structured Systems Analysis and Design Method – Application and Context*, Second Edition, Prentice Hall International, 1992
- [3] Checkland, P. and Scholes, J. *Soft Systems Methodology in Action*, Wiley and Sons, Chichester, 1992
- [4] Clare, M. "Delphi Technique," <<http://www.cce.cornell.edu/admin/program/documents/delphi.cfm>> (Accessed 13/09/02), Cornell Cooperative Extension, Cornell University, 1994
- [5] Cline, A., "Prioritization Process Using Delphi Technique" <<http://www.carolla.com/wp-delfh.htm>> (Accessed 13/09/02), Carolla Development, 2000
- [6] de Chazal, M., *Development and Use of an Industrial IT Portfolio Management Toolset*, PhD Thesis, Loughborough University, Loughborough, to be published 2004
- [7] Mason, R. and Mitroff, I., *Challenging Strategic Planning Assumptions*, Wiley, New York, 1981
- [8] Mitroff, I. and Linstone, H., *The Unbounded Mind: New Thinking for the 21st Century*, Oxford University Press, 1993
- [9] Kitchenham, B. A. et al (1996-7), "Evaluating Software Engineering Methods and Tools" Parts 1-8, *ACM SIGSOFT: Software Engineering Notes*, 21(1) to 22(5), Jan 1996 to Sep 1997
- [10] de Chazal, M., Pearce, H. and Dawson, R.J., "Business Needs Driving IT Decisions - Using Feature Analysis and Stakeholder Evaluation in Rolls-Royce", *Proceedings of the Empirical Assessment in Software Engineering Conference (EASE)*, Keele, 2002