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Engineering the future

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Philip Aylett
Clerk, Public Administration Select Committee
Committee Office, First Floor
7 Millbank
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Dear Mr Aylett

IEE EVIDENCE ON EFFECTIVENESS OF THE CIVIL SERVICE

In its evidence the IEE concentrates on creating appropriate career paths for professionals in the Civil Service and the causes of IT procurement problems in the public sector. We would like, in particular, to highlight the following points.

The key to improving the success rate of Government IT procurement is to view projects holistically as 'change projects enabled by IT' and to plan and budget for them accordingly. Fully planning and budgeting for the 'people' dimension of such business change projects would not only double the traditional costs but would also expose the true complexity of the project and raise the key issues to do with competency to deliver the intended outcome. This would however be likely to sharply reduce the true total lifecycle cost as well as dramatically improving the service delivered.

Appended to our evidence is that from the UK Computing Research Committee, (an expert group reporting to the IEE, British Computer Society and Committee of Professors and Heads of Computing). This describes the contribution to quality which could be made by adopting 'formal methods' for high impact IT systems. As the largest customer for IT systems in the UK, the Government has a responsibility to explore this approach more thoroughly.

The skills needed in Government to handle IT enabled change projects include professional IT skills and, in particular, more hybrid professionals with competency in management and project management. A more general culture of interchange between the public and private sectors should be encouraged. IEE recommends that it should be a fundamental requirement for progression in the Senior Civil Service that the candidate has spent a minimum of two years in the private sector.

The IEE is the largest professional engineering society in Europe and has a worldwide membership of around 130,000. It is an innovative organisation for electronics, electrical manufacturing and IT professionals. Around 20% of its membership is engaged in IT and it provides a range of specifically targeted products and services to meet their needs.

The IEE's detailed responses to the relevant questions are enclosed. Please let me know if the IEE can provide any further assistance to your enquiry.

Yours sincerely

Alf Roberts

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IEE Evidence to Public Administration Select Committee

on Efficiency of the Civil Service

Question 7 – Does the Civil Service have the right skills to help the Government deliver public services?

The Civil Service does not have ready access to the correct skills at senior levels (e.g. within the Senior Civil Service (SCS). Much has been made of the divide between generalists and specialists. This is to miss the point. The SCS needs individuals who are multi-skilled. Generalists who are also capable well trained managers/directors. Engineering specialists who are also highly competent project and programme managers – with all the 'people' and 'business change' skills that this implies. Lawyers who fully understand the implications for citizens and business of the policy options that they consider. Such people need careful selection, development and training. Typically they need experience across a range of roles during their career development. They need exposure to private as well as public sector practice. There has been much rhetoric but insufficient widespread action on these points from successive Cabinet Secretaries.

Question 8(a) – How does the performance of the Civil Service compare with that of its equivalents in other countries?

Whilst it would be wrong to lose sight of the strengths of the UK Civil Service, lack of corruption, political neutrality and strong commitment to public service, the Civil Service (and for that matter the Government) seems pre-occupied with top-down command and control. Sadly there can be a preoccupation with slavishly following the defined procedures whilst losing sight of the end goal – real deliverables on the ground.

In terms of successful deployment of public sector IT systems, other countries, notably Canada and Australia have better track records. However in the private sector the UK leads both Canada and Australia in the equivalent deployments (see Business in the Information Age – Benchmarking Study 2004 from DTI/Booz Allen Hamilton).

Question 8(b) Who or what is mainly to blame for the recent problems in government IT procurement and project management?

Our answer to this question is in two parts:

Whole project considerations:

The key problem in the UK public sector stems from a lack of recognition that, in the words of the CSSA report "Getting IT right for Government" in 2000: "there is no such thing as a computer project, merely business change projects mediated by new IT systems". This manifests itself as a failure to recognise the need to plan and budget properly for all the elements of business process change: training, internal communications, incentives, changes to performance management and measurements systems, and so on. This failure stems from the top, with inadequate definitions in the Treasury procurement guidance the 'Green Book'. Fully planning and budgeting for the 'people' dimension of such business change projects would not only double the traditional costs but would also expose the true complexity of the project and raise the key issues to do with competency to deliver the intended outcome. This would however be likely to sharply reduce the true total lifecycle cost as well as dramatically improving the service delivered.

Procuring an IT system that is fit for purpose:

A recent study of problems of large scale projects by the Royal Academy of Engineering[1] reported that poor project definition is one of the major contributors to project failure. The Academy also observed that there is a greater tendency for poor project definition in the public sector, where systems are intended to meet political ends, and the practicalities often have not been thought through. It is also the case that this was a problem of large nationalised industry projects in the 1960s and 70s but which has been eliminated in the private sector by adherence to proper engineering discipline.

Recent work by the Office of Government Commerce has addressed the management failures that have contributed to failures of Government IT projects, with recommendations relating to the appointment of "senior responsible owners" and guidelines for Gateway Reviews. More recently, the OGC and Intellect (the trade association for companies in the IT industry) have collaborated on a Code of Conduct to improve sharply the professionalism of the relationship between suppliers and Government. These are worthwhile initiatives and we support them, but in our opinion they do not get to the heart of the problem.

Computer systems are intrinsically complex. This complexity is so great that it guarantees that any serious attempt to specify the system will contain errors, omissions and contradictions. Further mistakes will be made during design and programming. Many of the faults in the specification will only be discovered after a development contract has been agreed; the resulting changes to the specification will then be contract variations, leading to delay, cost overrun, and transfer of risk from the supplier back to the customer.

These problems are avoidable, by following disciplines analogous to those used in engineering industries when very complex products have to be developed. Such methods exist and have been shown to work repeatedly, and very cost-effectively. Unfortunately they are diffusing only at a snail's pace into the largest IT suppliers.

The companies that can offer these methods are disadvantaged in the market for two reasons:

- They tend to be small hi-tech companies employing a small number of very highly qualified people, but the sheer scale of Government IT contracts mean that only two or three of the very large IT suppliers are perceived to be credible bidders.
- They are often undercut by suppliers who bid an unrealistically low price for the job in the certain knowledge that further work will be required to make it perform as required and that contract revisions will restore their margins.

As the largest customer for IT systems in the UK, the Government has a responsibility to explore this 'formal methods' approach more thoroughly. For further information see the input to the IEE's evidence from the UK Computing Research Committee, appended.

Question 9 – …what are the advantages and disadvantages of tenure?

There are significant advantages to tenure – not least in helping to maintain the public service ethos of the Civil Service, however it can make the Service insular and isolated from the practicalities of private sector life. There should be extensive exchange of staff between the public and private sectors at a range of levels (to the benefit of both sectors). It should be a mandatory requirement for promotion to the SCS that a candidate has spent at least two years on one or more secondments to the private sector. The process of opening the more senior SCS roles (former grade three and above) to competition from private sector applicants should be extended, to ensure private sector expertise could continue to leaven the SCS.

[1] The Challenges of Complex IT Projects, A report of a working group from the Royal Academy of Engineering and the British Computer Society, April 2003.

Question 10 - …career anchors…

Such an approach, if fully implemented, would be likely to be effective. At present the SCS treats those (such as Agency Chief Executives) on contracts from the private sector with a degree of condescension – "not real civil servants" and seems quite surprised when they turn out to be more than capable of contributing more generally… A greater interchange would undermine such outdated attitudes.

Question 11 - …business rules…

So long as secondments are a matter of public record, the fears of undue influence by the private sector back into the public sector following such secondments are over stated. Given the visibility, it is more likely that the reverse will be true, the Civil Servant will bend over backwards not to favour the company with whom they have worked for fear of such an accusation. It should be made possible for Senior Civil Servants to more easily join quoted company boards as non-executive directors.

Question 14 – Does the Civil Service manage its staff effectively?

Management could certainly be improved. Indeed, the impression is often created that the Civil Service sees management as a second class activity [yet all the failures discussed above are failures of management].

The Civil Service may have a fear that giving staff more exposure to the private sector, through secondments and work placements, might lead to an unacceptable level of staff opting to leave for the private sector. This perception reflects poor communications of the benefits of public sector employment, most notably the high value of current public sector pension arrangements compared to typical private sector schemes. The benefits of civil servants gaining private sector experience, as part of their training and career development, would be substantial. To reinforce this, more could be done in these circumstances to support outward secondees seeking to return to civil service departments and make use of their acquired skills. Without that clear commitment, the civil service will indeed lose staff to the private sector. It should also be communicated more strongly that the Civil Service would welcome back those who have left, spent a spell in the private or voluntary sectors, and seek to return.

The service would also benefit from moving more to a culture of measuring 'outputs' rather than 'inputs', for example 'deliverables' rather than 'effort' and 'presence'.

Question 15 – Could the Civil Service do more to attract talented people…?

Yes it could. The Civil Service should make clear that the public and private sectors are not separated by an 'Iron Curtain' of public appointments rules. It should emphasise a 'mixed economy', encouraging transfers in <u>both</u> directions. It should emphasise training and career planning with a clear commitment to develop multi-skilled individuals.

IEE

15 December 2004

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UK COMPUTING RESEARCH COMMITTEE

Appendix to Evidence from the IEE

The UK Computing Research Committee (UKCRC), an Expert Panel of the British Computer Society, the Institution of Electrical Engineers (IEE) and the Council of Professors and Heads of Computing, was formed in November 2000 as a policy committee for computing research in the UK. Its members are leading computing researchers from UK academia and industry.

UKCRC has the expertise to address question 8 identified by the committee:

- How does the performance of the Civil Service compare with that of its equivalents in other countries? Who or what is mainly to blame for the recent problems in government IT, procurement and project management?

A recent study of problems of large-scale projects by the Royal Academy of Engineering[2] reported that poor project definition is one of the major contributors to project failure. The Academy also observed that there is a greater tendency for poor project definition in the public sector, where systems are intended to meet political ends, and the practicalities often have not been thought through.

Recent work by the Office of Government Commerce has addressed the management failures that have contributed to failures of Government IT projects, with recommendations relating to the appointment of "senior responsible owners" and guidelines for Gateway Reviews. More recently, the OGC and Intellect (the trade association for companies in the IT industry) have collaborated on a Code of Conduct to address some of the worst examples of unprofessional behaviour by suppliers to Government. These are worthwhile initiatives and we support them, but in our opinion they do not get to the heart of the problem.

A report published this month by the National Audit Office commends the OGC on the steps they have taken. In our opinion, the NAO report also fails to recognise that the OGC has failed to address a critical issue in software procurement.

Developing new computer software is an engineering task—often of extraordinary complexity. The software for a modern air-traffic control centre, or to support a Government Agency, will involve a million lines of computer program (often, several million lines) and will typically require tens or hundreds of person-years of effort to design. It is beyond the power of humans to create structures of this size and complexity without making mistakes, so the focus of software engineering has to be on reducing the number of errors made, finding as many as possible before the software is delivered, and designing programs that are resilient to the faults that remain. Unfortunately (and, as we shall see, unnecessarily) most software developers deliver systems that still contain more than ten faults in each thousand lines of program. A large system will therefore contain

[2] The Challenges of Complex IT Projects, A report of a working group from the Royal Academy of Engineering and the British Computer Society, April 2003.

upward of ten thousand faults, each waiting to cause a failure under the particular circumstances that cause that path in the software to be executed.

Engineering is much more than applied science, although the science is essential; engineers also use mathematics, codified experience, and judgement. They use mathematics to build models of their designs and to explore the properties of these designs before investing in further development. They capture experience of design methods and management in a form that can be taught as best practice engineering processes. They codify this experience in the form of standards, such as the international quality management standard, ISO9001. The best software engineers recognise the parallels between software design and classical engineering, and adopt similarly rigorous methods. Unfortunately, most suppliers do not follow these principles, and most Government Departments are not knowledgeable enough to hold them to account for their failure to reach levels of professional competence and responsibility that are taken for granted in other branches of engineering.

Much research has been done on software engineering, complementing the progress made in computer science. Yet, despite the many books and papers providing evidence of ways in which software (even very large and complex software) can be developed at low risk, most of industry has ignored the research and continued to waste huge amounts of money on projects that are late, over budget, and fail to deliver what the customer needs.

Two surveys illustrate the scale of the problem. In 1995, The Standish Group[3] reported that the average US software project overran its budgeted time by 190%, its budgeted costs by 222%, and delivered only 60% of the planned functionality. Only 16% of projects were delivered at the estimated time and cost, and 31% of projects were cancelled before delivery. Later Standish Group surveys show an improving trend, but success rates are still low. The Standish Group's "Chaos Chronicles" report for 2003 analyzed over 13,000 IT projects, and estimated that nearly 70% either failed completely or were "challenged" (i.e. although completed and operational, exceeded their budget and time estimates, and had less functionality than originally specified). This led to their estimate that in 2002 the US "wasted $55 billion in cancelled and over-run IT projects, compared with a total IT spend of $255 billion."

A UK survey, published in the 2001 Annual Review of the British Computer Society[4] showed a similarly distressing picture. Of more than 500 development projects, only three met the survey's criteria for success.

The US National Institute of Standards and Technology published a report in 2002 that estimated the annual cost of poor quality software to the US economy as $60B[5]; we imagine that the cost to the European economy is of a similar order.

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[3] http://www.standishgroup.com

[4] http://www.bcs.org.uk

[5] The Economic Impacts of Inadequate Infrastructure for Software Testing, RTI Project Number 7007.011, Final Report, May 2002

Unfortunately, we do not know the detailed sampling methods used by these surveys, nor have we seen their raw data; we are therefore unable to comment on the statistical significance of the results. Even if the survey results exaggerate the situation somewhat, the general state of software development is depressingly amateurish.

For example, few projects capture the users' requirements using notations and methods that make it possible to analyse them rigorously to find contradictions and omissions, even though these are among the most common causes of project delays and failures. Such analysis ensures that the requirements have been properly considered and that conflicts and contradictions are not hiding behind vague statements and jargon. It also has a powerful effect in persuading customers and suppliers not to be too ambitious, which is another frequent cause of failure.

Across Europe, there are a few companies who deliver software projects significantly more quickly and more cheaply by using "formal methods"—software engineering methods that are soundly based in computer science—and mature engineering processes[6]. These companies are increasingly willing to offer warranties, because they know that they can deliver software with 0.1 to 1 fault per thousand lines, instead of the 10-20 faults per thousand lines that are more typical. Such companies are able to analyse the requirements that they have been given by their customers, to reveal the inconsistencies and to draw out the deeper requirements that would otherwise result in late changes to the project requirements.

Late changes to requirements are very damaging. The customer has to renegotiate the project cost and timescales, usually at a point where competitive bids cannot be obtained. The project risk is transferred back to the Government Department, and the project slips and runs over budget. Naturally, some changes may be unavoidable: the world is a dynamic place and there may be reorganisations and changes to legislation or tax structures that affect a project between the time that the contract was signed and the time when the system was delivered and implemented. Nevertheless, very many changes to requirements are not of this nature: instead, they are changes that could have been discovered or foreseen before the contract was signed, if there had been a rigorous approach to requirements specification and adequate analysis of the implications of the stated requirements.

The use of these formalisms also allows the engineer to specify precisely a useful degree of imprecision, and so plan the implementation so that (some reasonably foreseeable) late changes can be accommodated without impacting the sound structure of the product. Those that do require a major re-write (and that can never be completely avoided) can be identified rapidly, and can be accommodated by rescheduling.

Mature engineering professions, such as mechanical, structural and electrical engineering, have developed mature processes and mathematically-based methods over very many decades, but the IT industry is already too important for Government to be able to tolerate its current slow rate of progress towards maturity. With political targets regularly put in

[6] See, for example, http://www.sparkada.com/publications.html#industrial

jeopardy, £Billions wasted annually on poor quality software, and failing projects in the news most weeks, investment in transferring best practice in computer science and software engineering into routine use in industry could have an enormous payoff for the UK. There are models that could be followed: in the USA, the Department of Defense commissioned the Software Engineering Institute (SEI) at Carnegie Mellon University to develop an audit regime that would allow them to judge the maturity of their suppliers' software engineering processes. This "Capability Maturity Model" has been widely adopted, and a recent report from the Royal Academy of Engineering[7] proposes that an organisation similar to the SEI should be established in the UK.

To summarise: the UK may be no worse than other countries in the ability of the Civil Service to procure effective IT. Unfortunately this does not mean that the situation is acceptable; the international state of practice is woefully inadequate, and the UK seems to be more complacent than, for example, the USA in believing that recent improvements in procurement practices have solved the problems.

UKCRC would be happy to answer follow-up questions on any of these points.

Martyn Thomas

for UKCRC. November 2004.

[7] The Challenges of Complex IT Projects, A report of a working group from the Royal Academy of Engineering and the British Computer Society, April 2003.