



TESTING AND COMMISSIONING

– THE SYSTEMS APPROACH TO A VITAL BUT OFTEN OVERLOOKED AREA OF MAJOR PROJECTS

Report of seminar 142 held on 14th May 2008
at the Institution of Civil Engineers, London

SUMMARY

KEY CONCLUSIONS

- Testing and commissioning must test potential failure mechanisms and the processes should explore this necessity.
- For 'time critical' industries, testing and commissioning needs to be carefully planned, because customers may require new products to be in service as little as 30 days from ordering.
- When feedback shows up problems it is tempting to design and bolt on a new solution, though it might be better to examine whether the individuals involved clearly understood the original processes.
- Software upgrades can be dangerous as they often lose the vital integration achieved during earlier stages.
- Regression events and lessons are incorporated to make improvements, but when things are fixed they may break something else.
- For major programmes a key lesson from earlier multiple testing is to combine testing into a single testing centre.
- No symptoms of problems remain static and testing in advance should provide information on what might happen.

John Hudson, the seminar Chairman, defined testing and commissioning as: *'taking a product or a system and trying to demonstrate that it operates in a safe manner, meets the design intent, is fit for purpose and satisfies stakeholder expectations.'*

As projects become increasingly complex, and as more stakeholders and more disciplines become engaged, the process of validation, integration and testing becomes very much more significant and is a critical driver in major project strategy.

In addition, pressures on the budget and the schedule, increasing levels of technology, greater risks and the difficulties of scarce resources mean that the benefits of a well planned and well managed testing and commissioning phase should be apparent for all major projects. Testing and commissioning can be the defining moment between success and failure of a major programme – the last thing any project wants is a systems failure at the vital moment of delivery.

The seminar explored all aspects of the testing life cycle within a systems context, from initial requirements and project planning through to design, build, integration and engineering test, culminating in client acceptance and successful entry into service. It provided valuable insights and best practice examples from a range of sectors and from different perspectives – owner, operator, prime contractor and supplier as well as those responsible for insurance and safety.

The classification of ships has its origins in the coffee houses of London in the 18th century, surveying merchant ships and advising underwriters of their condition. Ships are still classed, and a worldwide system of classification provides the commercial shipping industry with an independent assurance of quality and safety.

The presentation from Lloyd's Register Group outlined how the merchant shipping industry works and the development of the classification process. It went on to describe how this system deals with testing, commissioning and progressive assurance of safety for new and existing ships, and some of the issues that can arise. The need to reduce risk throughout the product life cycle, by verifying design, materials and the integrity of the construction was emphasised, and it was noted that with the adoption of more intensive automated systems, the role of software and the human operator has to be considered very carefully when testing and commissioning are carried out.

Ships are classed principally in relation to vital elements relating to the safe operation of a vessel. These elements are judged against the Rules a set of standards that have been developed from technical knowledge and feedback. A 'classed ship' means that it has been built under the watchful eye of surveyors, who make sure that the construction process is carried out in accordance with the Rules and that the testing, commissioning and surveying processes are adequate. A class notation is then assigned, which sets out which Rules apply and gives geographical limits and conditions of service. To maintain class once a ship is in service, it is subject to periodical surveys.

The classification process ensures that:

- The basic design complies with the Rules
- The manufacturers' works have been approved and products assured based on demonstration by testing
- Surveys have been carried out during construction to maintain traceability of basic material through to the completed vessel
- Surveys have been carried during installation of products with progressive testing
- There has been verification by sea trials
- A survey has been carried out when the ship is in service to verify condition

SYSTEMS, PEOPLE AND PROCESSES

The provision of air traffic control systems is a high integrity, complex and safety critical undertaking. NATS, the organisation which provides air traffic control services to aircraft flying in UK air space and over the eastern part of the North Atlantic, discussed the challenges this presents from a systems, people and process perspective.

The approach in dealing with the challenges includes building dual redundancy into the systems and deliberately planning for the advent of failure; the design incorporates redundant fallback systems based on the analysis of possible compound failures. Processes and procedures are put in place to deal with any outfall, and operators are trained in what to do in the event of occurrences happening in ways they do not expect.

To illustrate the complexity and interdependency of systems, people and processes within the air traffic control industry, two project management case histories were outlined. These involved the move of the area control services from West Drayton to Swanwick, near Fareham in West Hampshire. The lessons learned from both projects included:

- A big system requires a lot of integration, so small is beautiful and more controllable
- Strategic changes are easier to make with smaller projects
- Incremental change is more easily managed on smaller projects
- Invariably, large change is always optimistically estimated, with little thought for the alterations and reworking that will inevitably occur
- Interdependencies between systems, people and processes can be better understood with smaller projects
- Smaller projects introduce large scale change incrementally and allow easier accommodation of changes in the business/customer relationship
- Small projects are less likely to receive distracting media attention
- Small projects are more easily tested and commissioned

Over the last decade, system testing has progressed from being an afterthought to a complex and structured enterprise activity, where everything is expected to cooperate and coexist on shared hardware while sharing the same data. This interconnectedness and interdependency of systems has largely meant that software can no longer be developed and tested independently.

Electronic Data Systems (EDS) provided an insight into how these challenges have been addressed, and how the business of testing management and consulting services has grown. The presentation explored some of the factors to be considered to ensure a successful outcome.

It was explained that testing is a mainly requirements driven activity that operates at three levels:

- The enterprise level, which addresses the objectives of the organisation such as a government department, bank or power station
- The programme level which encompasses a particular operation such as purchasing or human resources
- The project level, which is a particular activity

The methods of testing at the different levels were outlined. For example, the enterprise test method includes the testing and integration of applications, middleware, off-the-shelf components, operating systems and configuration of hardware. The test levels run from static and unit testing through system integration, service operational acceptance and simulation modelling to a consolidated integration test run at the programme and enterprise level.

Consolidated integration testing (CIT), which includes the end-to-end testing of all software, including interfaces, and its importance and function were explored in some detail. It was noted that CIT can be expensive if the requirements are over-ambitious, and that critical areas of commercial and technical business need to be assessed pragmatically to decide an acceptable level of capability.

SYSTEMS APPROACH TO TESTING AND COMMISSIONING

The Merlin helicopter was first developed in the 1980s as a replacement for the anti-submarine warfare Sea King helicopter, which had one very clear objective – the protection of ships by hunting and destroying enemy submarines. The presentation from Lockheed Martin, the prime contractor for the Merlin Mk1 helicopter programme, provided an overview of the Merlin Integrated Weapon System roles and its evolving operational missions. There was an insight into the development of the Merlin Mk1, and the subsequent upgrade to the Merlin Continuous Sustainment Plus programme. This programme, which is delivering the Mk2, requires increased flexibility, interoperability and capability. Defence safety standards are driving a significant amount of redevelopment in a number of programmes and the level of test and certification associated with them is very high.

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The Mk1 approach to integration and test (I&T) and release to service (RTS) in a concurrent development environment was considered, and the issues and lessons learned were examined. It was noted that duplication of testing was the single biggest cost factor, and also meant the duration of the test programme was extended by about two years.

The presentation then considered the ways in which the upgrade to the Mk2 programme redefined the traditional I&T and RTS models in order to mitigate the problems encountered during the Mk1 programme.

Results of improvements to the testing and commissioning process were discussed, and some conclusions offered:

- Test and commissioning must be integral at the very start of the programme, not a back end function.
- Customer and major sub-prime contractor buy-in to combined testing and sell-off dramatically reduces testing, high impact problem tracking reports (PTRs), cost and schedule.
- Risk assessment is important for early identification of critical and high risk test areas such as human machine interface, installation control drawings and installed performance; actively mitigate risks during the system design and development phase.
- Every PTR impacts budget, schedule and resource; discovering high impact PTRs during integration and testing phase risks programme success.

PREDICTING THE CUSTOMER EXPERIENCE

At BT, the nature of testing has undergone an evolution in recent years, driven by a number of forces such as product complexity and the increasing expectation of a reduced product cycle time – sometimes to as little as 30 days. This presentation provided a personal view of the significant challenges experienced by BT, and how these are driving the need to question the way in which testing is done.

To respond to these challenges, BT has developed an approach to evaluate and predict the customer experience of new products or capabilities. This change places very different demands on test professionals and the test process. In the past, integration testing was withheld until the development of a product was complete. Component level testing was done as part of the development process as standard, integration testing was done separately and then, at a very late stage, process testing or field trials were carried out.

Although the same fundamental principles of testing are still used, the aim now is to give projects the option to launch, based on when the results of continuous testing indicate the product will provide the requisite level of customer experience – independent of task completion. The role of the tester has also evolved, becoming less investigative and more analytical.

The move towards using a risk-based testing system was discussed, and the importance of an ‘end-to-end’ process, where every step of a project is simulated and tested, was emphasised. Initial analysis of the changes – which are ongoing – has provided positive findings.

In summarising the seminar the Chairman reminded the audience not to overlook the vital importance of people: people must understand what they are doing, both as testers, or operators of the product or service. He emphasised that rigorous testing and commissioning is required throughout the product life cycle, and reflected on the role that it plays in the initial design.

Potentially, the failure to test and commission properly represents a huge risk to business – in safety and programme terms, cost terms and reputation. Testing and commissioning should not be the ‘Cinderella’ activity of the systems engineering business, because it makes an enormous contribution to a successful outcome.



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