Starting on the right track

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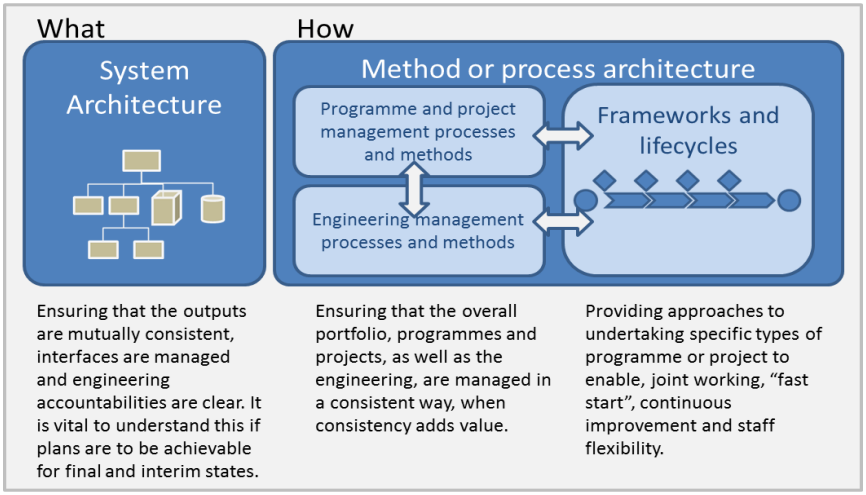
Teams directing major infrastructure programmes face many challenges, not least ensuring their engineering and programme management teams work together effectively. Advice from research centres on having a 'whole system' mind-set, interdisciplinary team working and processes to reflect this. By building integrated processes, those directing programmes will be better able to create the clarity and working practices needed to promote success. It cannot be left to each discipline to "hand-shake" with the others on an ad-hoc basis. This paper discusses these issues and how they can be addressed.

Excellence in project management is not enough

The reasons for project failure have been researched and documented for many years, yet success still seems elusive in far too many cases. A review of the literature highlights common themes such as those identified by the National Audit Office [1] including inadequate senior leadership, poor stakeholder engagement, and inadequate skills. It is, however, starting to be recognised that most causes of failure cannot be blamed on the project manager but are rooted in institutional factors. To address this, organisations are looking at using "maturity models", as research shows that more mature organisations perform better. Maturity assessments are used to assess an organisation as a whole, as described in Halcrow's report in 2012 [2] when P3M3 was used to assess Network Rail's programme management maturity. Yet even that is not enough; excellence in programme and project management does not necessarily lead to a successful programme. What is needed are working solutions; there is little point in having excellent management when the core disciplines a solution relies on are poorly practiced. Being good at programme and project management, is simply one necessary aspect that needs to be undertaken.

The merger civil engineering with the digital world

In today's world, digital systems have become essential; cars can park themselves, planes fly themselves and missiles can find their own targets. These innovations are built on a web of specialist suppliers, all providing their own expertise, which, together, provide a reliable, working solution. All these developments have at their root, the application of **systems thinking and system engineering** which aims to make sure the overall solution works as needed, where it is needed. The digital world is now [art of today's infrastructure programmes. What used to be essentially civil engineering projects have become a complex interaction of civil, mechanical, electrical and digital components in the operational environment.



The added complexity described above requires the promotors of infrastructure programmes to become "**system integrators**". This is a term which was never heard in reference to civil engineering in the past and comes from the discipline of system engineering. Civil engineering is by nature physical and civil engineers tend to be intuitive integrators; they design a solution to work as a whole. On the other hand, in IT, much of the "workings" are invisible and integration is a recurrent problem. System engineering was developed to make the "invisible" visible through modelling (system architecture) and thereby demonstrating how the entire solution works. For example, engineers need to ensure that the rolling stock, signalling, new stations and track can meet all needs (including number of passengers, target journey times, reliability and safety). Project management isn't enough, as major infrastructure developments are too large to be managed as a single project. Programme management is needed. Understanding this requires the use of comprehensive systems approach, across the whole programme, to analyse not only the traditional technical issues, but also the policy issues and the behaviour of the users.

McNulty's "whole system"

McNulty highlighted the integration issue in his report on whole-system programme management in 2011 [3]. His main thrust is to change to a mind-set of thinking "whole solution", not just of "my bit". The Challenger disaster taught us that even the smallest defect or error can be catastrophic.

Being the intelligent client

For the promoters of major infrastructure programmes to be successful, they need to take a whole system view. Being a "system integrator" is essential but that now requires a new level of capability. All infrastructure programmes are delivered by a range of specialist contractors and their sub-contractors, each providing particular skills and expertise. The promoter has to be the "system integrator" and the "**intelligent client**" for all these suppliers, understanding how the requirements as a whole will solve the business need in an economically viable way. Promoters need to know how requirements are allocated to the various suppliers, with interfaces defined, and assure the solution through continual oversight and validation. Contracts need to be written in a way that ensures engineers do not "jump to solutions", but allow for change in the early stages as a solution emerges, while tightening in the later stages thereby, progressively reducing risk.

The challenges in system engineering

Just as the programme and project management community is realising excellence in their discipline is not enough, the system engineering community is coming to a similar conclusion. INCOSE in their annual report [4] highlights many new interdisciplinary and integration-related challenges. If both the system engineering and programme management disciplines are identifying the same problems, then it is an imprudent manager who dismisses their advice.

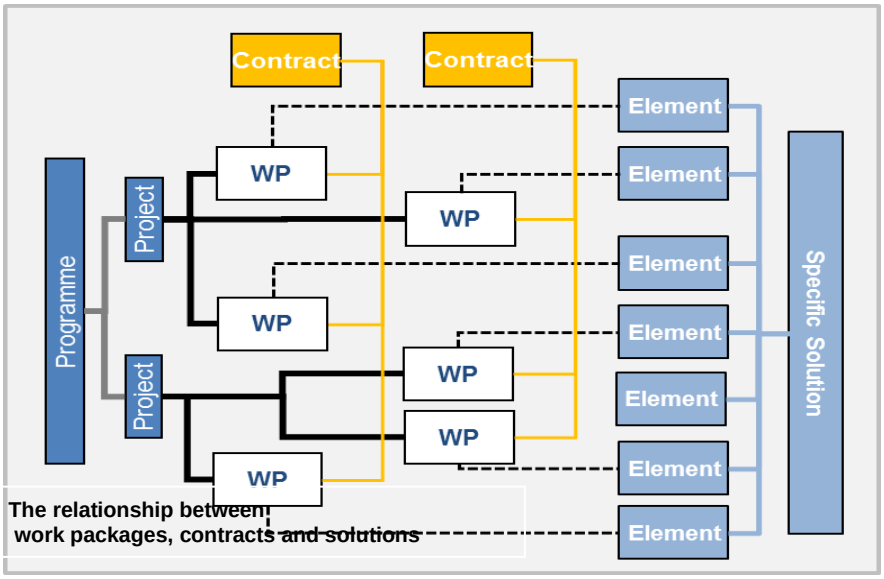
INCOSE and PMI published a report on the benefits of LEAN enablers in integrating programme management and system engineering [5]. The authors identified a set of challenges that LEAN thinking can help address. Some of these problems will be familiar, but many relate to the importance of processes. When used by skilled people, processes form the basis of good practice and add clarity. They are fundamental to raising an organisation's maturity and hence performance and reflected in all maturity models. However, good process cannot solve everything, but combined with accountability and the right mind-set, will go a long way towards creating a self-improving organisation.

Integrating engineering and programme management disciplines

It is easier to state what the problems are than to address them in practice, but that does not mean to say the task is too onerous. McNulty [2] brings some perspective to this "*Build on examples of good programme management and reform poor practices*." Essentially, most of what we need already exists in some form, however in most organisations, the engineers build the engineering processes and the project managers build the project management ones, using different approaches, systems, web sites, tools and terminology. We need to drive people from different cultures and disciplines (often with no shared history, knowledge or understanding) to work together. We therefore need to appreciate how those different worlds relate and show, through good processes and common language, how they rely on each other. The best time to address the problem is at the start of a major programme, but the benefits can be almost as great for those that are well under way.

Integration of work outputs

System engineers work in terms of system architecture and its civil, mechanical, digital and other components (or elements), ensuring the solution meets the requirements.



The relationship between work packages, contracts and solutions

Programme and project managers work in terms of work packages, costs, resources and schedules, to ensure the solution can be delivered viably. They need to ensure every element of the solution is included in the work packages in their plans.

Procurement managers work in terms of "contracts" defining who will undertake to build part of the solution. They need to develop a contract strategy, covering all the work packages, which provides not only a good price but is also workable "on the ground".

The diagram above [7], shows these relationships. Furthermore, all parties need to understand the risks, not only relating to their own work, but also how others are impacted and vice versa.

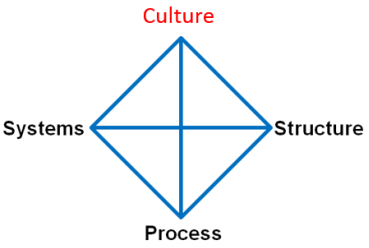
Process and role integration

If inter-disciplinary working is the aim, a programme's set of processes have to be designed as a "system", using common approaches and terminology, ensuring the interfaces are defined and the roles clear. They should be available in "discipline" sets, so each discipline can see and use those relevant to them, but importantly, they should be viewable as an integrated whole, showing how each discipline has to work with others to achieve a result. The "project lifecycle" is an invaluable and underused tool for achieving this [8]. Not only does it summarise the whole story for a project but is key to managing risk and fundamental to good governance.

Making processes simple to use, maintain and improve is essential and, thanks to modern tools, is not as onerous as it once was, where productivity gains of a factor of ten over traditional process mapping are not unusual.

One key recommendation is to design the processes on the assumption that the organisation will change; be role driven, not job title driven.

Finally, always bear in mind that "process" is just one dimension: how people behave, the tools and systems they use and the structures they work within are also important and each affects the others. By building processes which are easy to access, understand and use, and which encourage the right behaviours, you will be on the right path to addressing the challenges described in this paper [9].



The interaction between processes, systems/tools, structure and culture; change one and it will impact the others.

References

[1] National Audit Office, Delivering successful IT-enabled business change: Case studies of success. 2006.
Common causes of project failure cited were:

1. Lack of clear link between the project and the organisation's key strategic priorities, including agreed measures of success.
2. Lack of clear senior management and Ministerial ownership and leadership.
3. Lack of effective engagement with stakeholders.
4. Lack of skills and proven approach to project management and risk management.
5. Lack of understanding of and contact with the supply industry at senior levels in the organisation.
6. Evaluation of proposals driven by initial price rather than long term value for money (especially securing delivery of business benefits).
7. Too little attention to breaking development and implementation into manageable steps.
8. Inadequate resources and skills to deliver the total delivery portfolio.

[2] Network Rail Project and Programme Management Capability, Office of Rail Regulation, Halcrow, 2 May 2012.

[3] Whole system programme management summary, Realising the Potential of GB Rail, May 2011.
Recommendations:

1. understanding the problem first,
2. no jumping to solutions too soon,
3. taking a progressive approach to reducing risk,
4. sufficient integration of elements of project design,
5. having an integrated team,
6. clarity on roles and functions,
7. whole system governance.

[4] A World in Motion. SE Engineering Vision 2025. 2014 International Council on Systems Engineering.
Key challenges:

8. Mission complexity is growing faster than our ability to manage it . . . increasing mission risk from inadequate specifications and incomplete verification.
9. System design emerges from pieces, rather than from architecture resulting in systems that are brittle, difficult to test, and complex and expensive to operate.
10. Knowledge and investment are lost at project life cycle phase boundaries . . . increasing development cost and risk of late discovery of design problems
11. Knowledge and investment are lost between projects . . . increasing cost and risk: dampening the potential for true product lines.
12. Technical and programmatic sides of projects are poorly coupled hampering effective project risk-based decision making.
13. Most major disasters such as Challenger and Columbia have resulted from failure to recognize and deal with risks. The Columbia Accident Investigation Board determined that the preferred approach is an "independent technical authority".

[5] Oehmen, Josef, (Ed.). 2012. The Guide to Lean Enablers for Managing Engineering Programs, Version 1.0.Cambridge, MA: Joint MIT PMI INCOSE Community of Practice on Lean in Program Management.
Key challenges, of which process related ones are in bold, are as follows:

1. Firefighting —Reactive programme execution
2. Unstable, unclear, and incomplete requirements
3. **Insufficient alignment and coordination of the extended enterprise**
4. **Processes are locally optimized and not integrated for the entire enterprise**
5. **Unclear roles, responsibilities, and accountability**
6. Mismanagement of programme culture, team competency, and knowledge
7. Insufficient programme planning
8. **Improper metrics, metric systems, and KPIs**
9. **Lack of proactive programme risk management**
10. **Poor programme acquisition and contracting practices**

The LEAN enablers are:

1. Respect the people in your programme
2. Capture the valued fined by the key customer stakeholders
3. Map the value stream and eliminate waste
4. **Flow the work through planned and streamlined processes**
5. Let customer stakeholders pull value
6. **Pursue perfection in all processes**

[6] Buttrick R A (Jan 2014) Connected, Project.
Advice from BT on developing a process implementation:

7. Design your method architecture and then build the component parts in priority order.
8. Don't expect to please everyone, all the time.
9. Make the method independent of your organisation structure. You will reorganise, so plan for it.
10. Write the content for long shelf life.
11. Make a website or internal portal for people to access the method.
12. Ensure it is two-way to attract feedback and respond quickly and openly when it comes. This will help you to build trust.
13. Ensure those who develop your method have experience and credibility.

[7] Buttrick R A (2020) Chapter 24, Developing a quality solution, The Programme and Portfolio Workout, Routledge.

[8] Buttrick R A (2019) Part II, A walk through a project, The Project Workout, Routledge.
This explains the importance of project lifecycles or frameworks

[9] Buttrick RA, Fig 2.2 in The Project Workout (2019) and The Programme and Portfolio Workout (2020), Routledge

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