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APPLYING DSM IN THE ENERGY SECTOR: PRACTICAL PROBLEMS AND INSIGHTS FROM INDUSTRY

Tomas Flanagan
BP Sunbury, London

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1 INTRODUCTION

The successful (re)design and manufacture of energy-sector mega-structures necessitates effective management of both product and process complexity. Even when compared to other complex projects, their scale, interconnectivity, duration and technology-novelty place oil platforms and refineries in a league of their own. Rising oil prices have fuelled an increase in the number of such projects which are currently being undertaken and this increase in demand has been accompanied by an associated rise in the cost of delays and errors. In this context, proficient complexity management is paramount in differentiating performance against competitors and delivering stakeholder value.

DSM has long been recognised as a tool for modelling and analysing complex systems [1,2] but its application to the oil and gas sector has been limited. This paper aimed to 1) explore how both product and process DSMs could be applied in the energy sector 2) to establish what insights could be obtained from such DSMs and 3) to identify practical barriers to their industrial adoption.

2 METHOD

Two DSMs were elicited for a Floating Production Storage and Offloading (FPSO) system (effectively a floating oil-rig with associated hydrocarbon processing capabilities). Both DSMs were analysed and used to inform senior project management and partner companies.

The first DSM focuses on engineering change propagation [3] associated with a refurbishment option and consists of 53 systems. The model was build during a concentrated two-day session based on input from five experts with a combined experience of over 100 years. The likelihood of change propagation between these systems was quantified as high, medium or low. Some "possible links" were also captured which depended on which refurbishment option was chosen from a group of alternatives.

The second DSM concerns task interdependencies during the early stages of the FPSO refurbishment and includes 92 tasks. The matrix was build incrementally by a team of approximately ten project managers over the course of three weeks. Analysis of the DSM was performed iteratively and new changes to the task order were realised between different model updates.

3 RESULTS

Insights were obtained from both the model elicitation process and from the subsequent analysis of the DSMs. The change DSM (Figure 1) was more consistent than the process DSM because the same people were involved for its entire construction. Further, errors were identified during analysis of the process DSM which arose due to the misinterpretation of the causality of dependencies. Nonetheless both modelling teams found that the model-building exercise was a worthwhile undertaking in its own right – even before any simulation analyses were carried out – because the resulting discussions highlighted oversights and assumptions and explicitly captured much previously-tacit knowledge.

Analyses of the change DSM identified which systems were likely to act as change absorbers and change multipliers [3] and which clusters of systems should be refurbished simultaneously. The matrices also graphically illustrated the complexity of the envisaged refurbishment – it thus informed senior management about the potential risks associated with refurbishment as opposed to new-build options. Analysis of the process DSM highlighted large rework cycles and informed an improved task order which reduced exposure to rework and hence de-risked the project.

Overall, both DSMs were considered useful team by the project team and but improved tools for both model elicitation and analysis would be valuable in accelerating industrial penetration of the DSM approach within the energy sector. In particular, there is an opportunity for tools that allow the faster construction of more consistent DSMs.

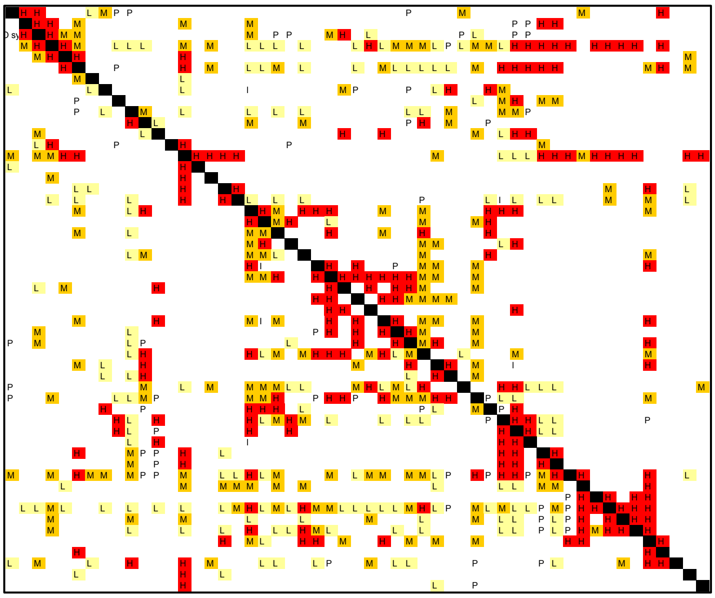

Figure 1. FPSO Change Propagation DSM (red indicates strong dependency, orange for medium and yellow for low)

4 KEY CONCLUSIONS

Project risk associated with complex super-structures is a multifaceted issue and resulting problems are a concern for management. This paper explored how DSM could be used to model such systems, with a particular focus on model elicitation and insights obtained from DSM analysis.

Results show that there is strong support from management for using the DSM but that challenges remain in terms of building DSMs and analysing results. Both a model-building methodology as well as software support would be valuable in overcoming these challenges as would more robust analysis tools which are more tightly interfaced with existing software packages such as MS Project and MS Excel. Notwithstanding these issues, the DSM is set to become a useful tool in complex system evaluation within the energy sector.

Future work will focus on the analysis of a more extensive range of projects, the development of software tools and templates, and the comparison of DSMs from different projects with the goal of better supporting engineering change management, standardisation and project planning and control.

5 REFERENCES

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Contact: Tomas L Flanagan
BP, Concept Modelling and Development,
Bldg C, Grnd Floor, Chertsey Rd,
Sunbury, Middlesex, TW16 7LN, UK
Phone: +44 1932 762774
e-mail: tomas.flanagan@bp.com

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Applying DSM in the Energy Sector: Insights from Industry and Practical Problems

Tomas Flanagan
BP London

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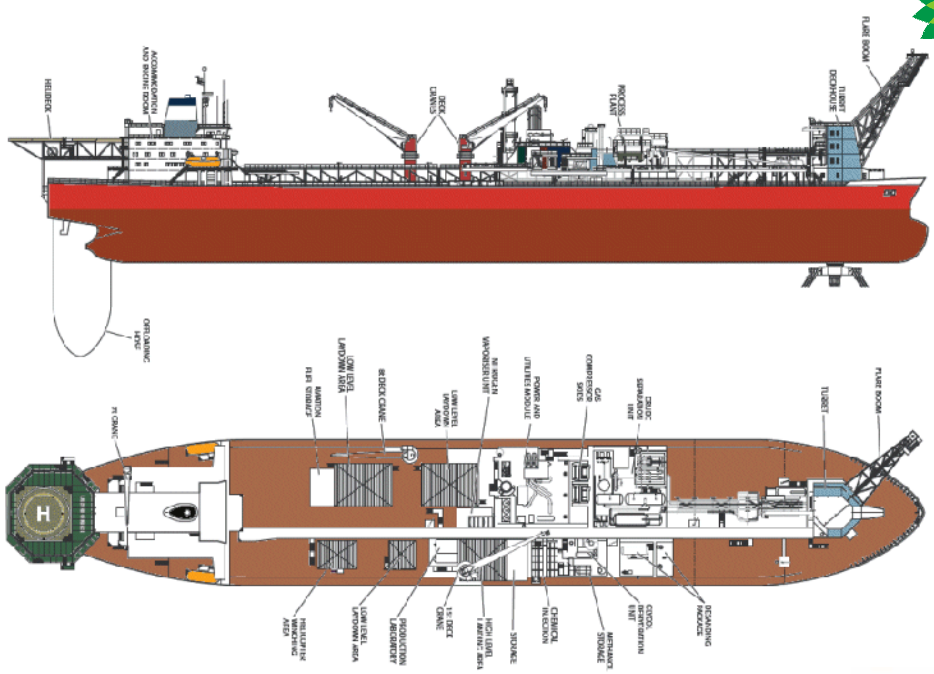
Section overview

- Introduction: DSM application context
- Change modelling
- Project modelling
- Future work
- Summary

DSM Application Context

- Complex, large-scale engineering projects
  - Floating Production Storage and Offloading (FPSO) systems
    - Basically floating oil rigs
  - Refineries
  - Large-scale software redesign
- Projects are often one-off, highly customised
- Some systems/concepts are standardised across multiple designs
- Many projects require the development of high reliability solutions for extreme conditions
  - Deep sea
  - Offshore
  - Alaska, Siberia, Gulf of Mexico

More on FPSOs



DSM model building context

- DSM is coming into BP through Projects Academy (a training course for middle managers run by MIT)
- DSMs get built in three ways
  - Middle managers build the DSM
  - Middle managers get team leaders to build the DSMs
  - DSMs are build by an internal consultancy group
- Implications
  - People building DSMs often have
    - Limited time
    - Limited experience
  - There is management support for using DSMs

Objectives

- Explore alternative refurbishment options
- Understand the implications of changing some systems on other parts of the design
- Create a shared understanding of how different components are connected
- Convey to senior management the complexity of different options

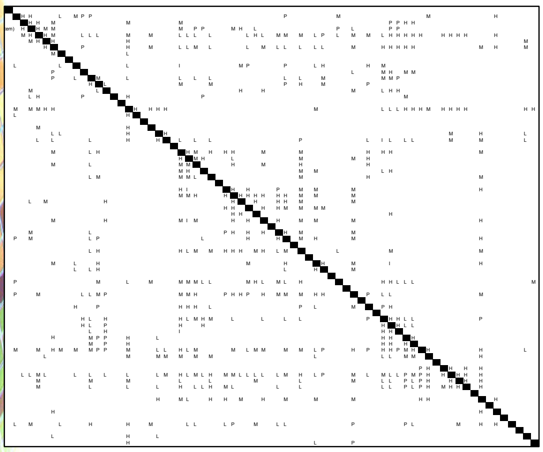
Model building

- Five senior engineers
- Two days
- Facilitated discussion
- 53 systems based on the ship's BoM
- Dependencies ranked as high, medium and low
- Links colour-coded for strength of dependencies
- Matrix is not symmetric because of the directionality of change
- System names are not included in this presentation for sensitivity

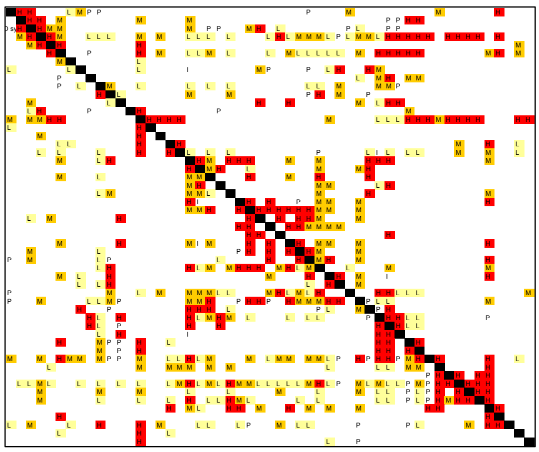
IN COOPERATION WITH BMW GROUP
CAPITALIZE ON COMPLEXITY

Model building

GM Engine DSM (before clustering)

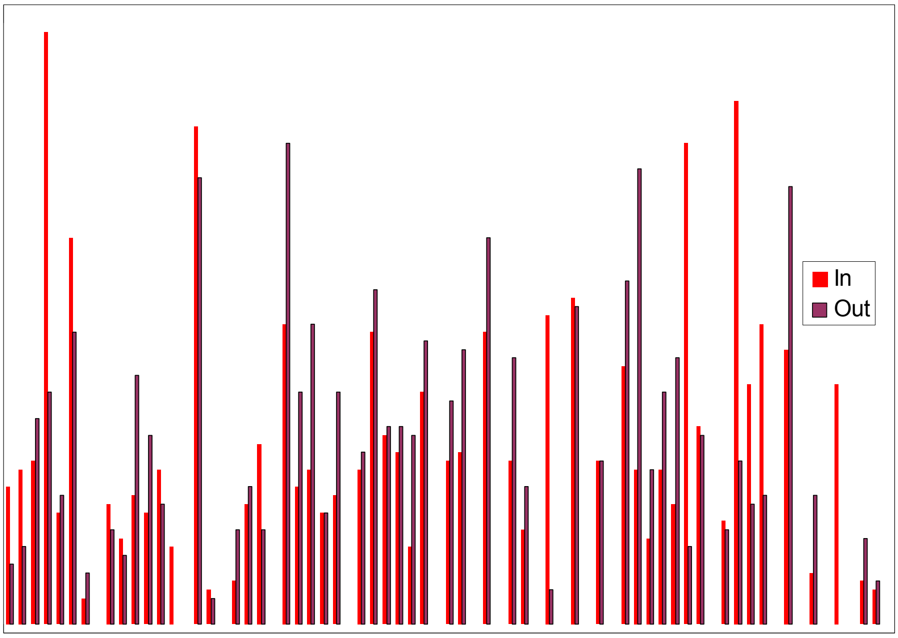


GM Engine DSM (after clustering)



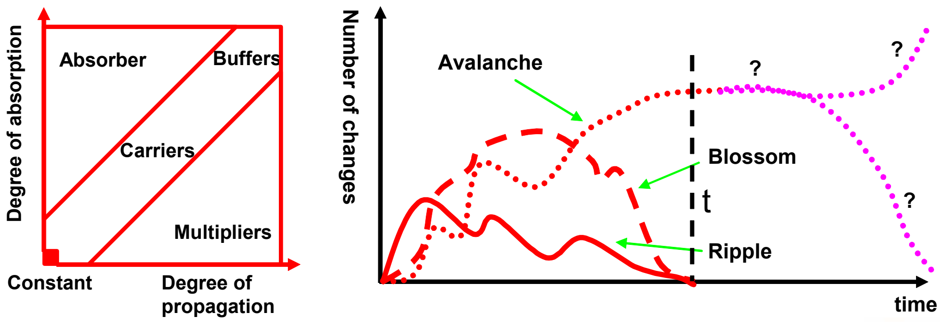
Product Development
Technische Universität München

Degree to which systems cause and receive change



Lessons from the modelling exercise

- The DSM clarified the underlying system structure
- Showed how different systems interact
- Informed the selection of components to redesign
- Highlighted change absorbers and multipliers (Eckert et al)
- Demonstrated the complexity of the envisaged changes to management



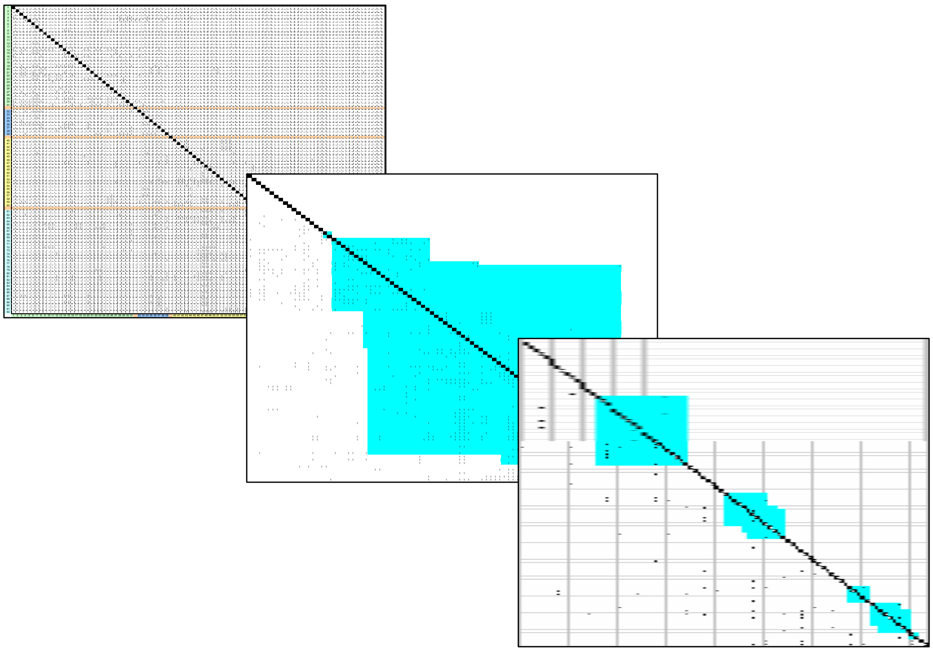
Objectives

- Provide confidence to project partners and senior management that a rigorous approach was being taken towards project management
- Create a mapping of task interdependencies
- Understand the implications of delays to tasks downstream
- Highlight potential rework cycles and reorder design tasks to remove the resulting dangers

Model building

- Roughly ten senior engineers and managers
- Initial meeting followed by individual session with experts
- 92 tasks
- Matrix also included design teams responsible for task execution
- Matrix was analysed using sequencing algorithms
- Model-building was an iterative process
- Task names are not include in this presentation for sensitivity

Task matrices



Lessons from DSM modelling

- Illustrated the value of DSM modelling activity as a useful outcome in its own right (even without the subsequent analysis)
- Highlighted some dangers associated with misinterpretation of DSMs
- DSM added an extra degree of rigour to the project planning activity
- Highlighted large rework cycles due to a small number of dependencies, which were subsequently torn
- Improved the project team’s understanding of task interdependencies
- Led to an improved task order

Further work

- Support for DSM model-building
  - A methodology for model-building would be useful
  - Robust software tools would also help
- Support for model analysis
  - Some tools exist but cannot be accessed by industry
    - DSM to network visualisation tools
    - DSM to Gantt chart tools
    - DSM simulation tools
  - DSM tools should interface seamlessly with MS Excel
  - DSM to Systems Dynamics tools could also be useful

Summary

- DSMs have some useful applications in the energy sector
- Even with support from management, there still exist major challenges in increasing industrial uptake of DSMs
- Despite these challenges, DSMs are being used
- Better DSM tools are needed to support model-building and simulation analysis of industry-scale DSMs