



26th annual **INCOSE**
international symposium

Edinburgh, UK
July 18 - 21, 2016

Issues in Conceptual Design and MBSE Successes: Insights from the Model-Based Conceptual Design Surveys

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MBCD – A Definition



- Model-based Conceptual Design (MBCD) is the application of MBSE to the Concept Stage of the generic life-cycle defined by INCOSE
 - Definition used by the MBCD Working Group

MBCD WG Charter



- **Vision** – Concept stages realised through model-based conceptual design
- **Purpose** – To advance the body of knowledge and practice of systems engineering (SE) through the development and application of model-based systems engineering (MBSE) methodologies to the and Concept stage of systems engineering.
- **Missions**
 - Enhance the practise of problem definition and identifying capability needs
 - Develop modelling practise in support of the Concept Stage

Outline



- Background
- 2014 Survey
- 2015 Survey
- Comparisons between surveys
- Insights from the surveys
- Activities and challenges for the MBCD WG
- Acknowledgments

Background



- Survey Activity commenced following discussion at INCOSE IS2013 MBCD WG meeting.
 - Need to identify problem areas of MBCD.
 - Are issues shared amongst practitioners?
 - These could be topics for future MBCD WG activities.
- Survey Goal

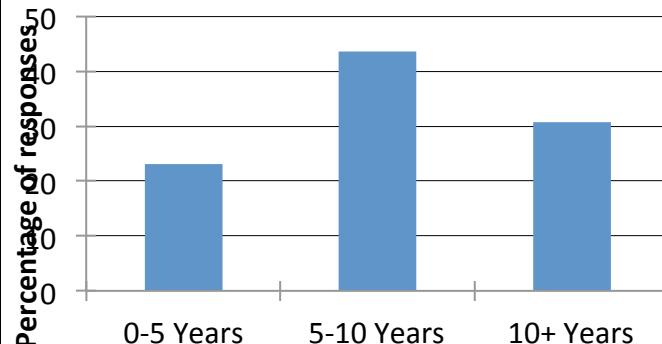
“To identify the issues associated with performing MBCD”

- Two surveys completed
 - Phase 1 in 2014
 - Open ended questions, 39 responses, possible non-response bias?
 - Phase 2 in 2015
 - Closed ended questions (based on phase 1 themes), 40 responses

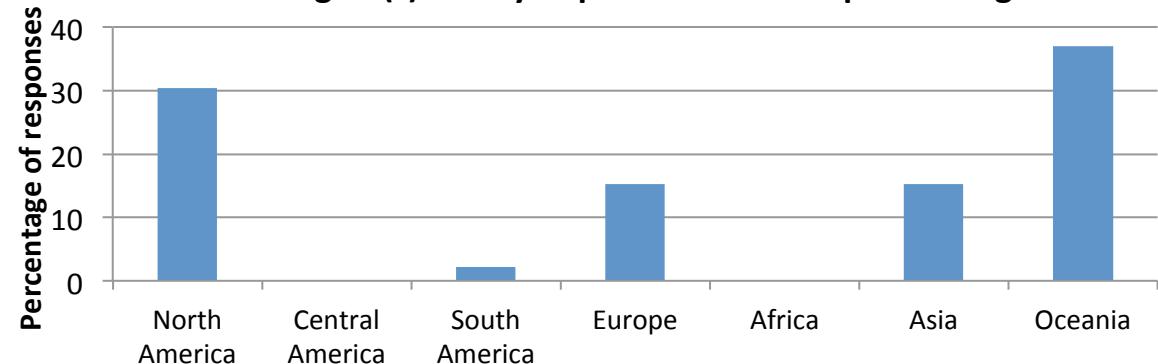
2014 Respondent Data



Respondent Experience?



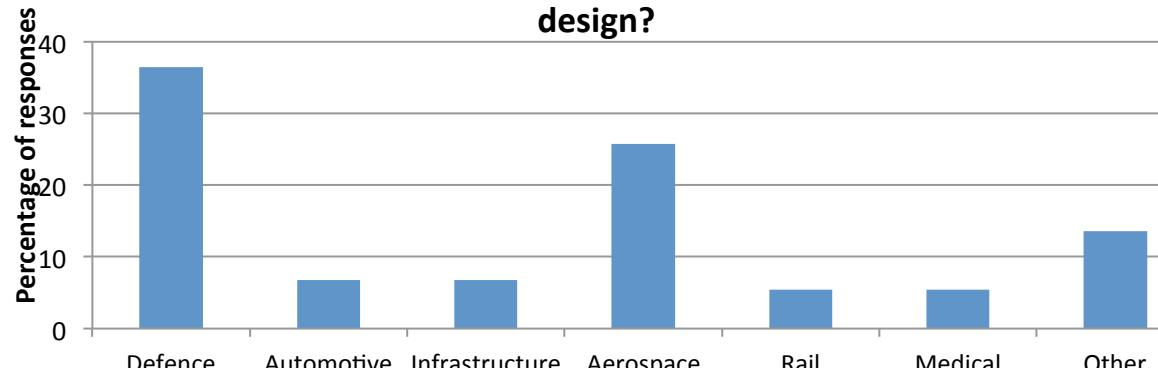
In which region(s) have you performed conceptual design?



What roles have you performed in conceptual design?



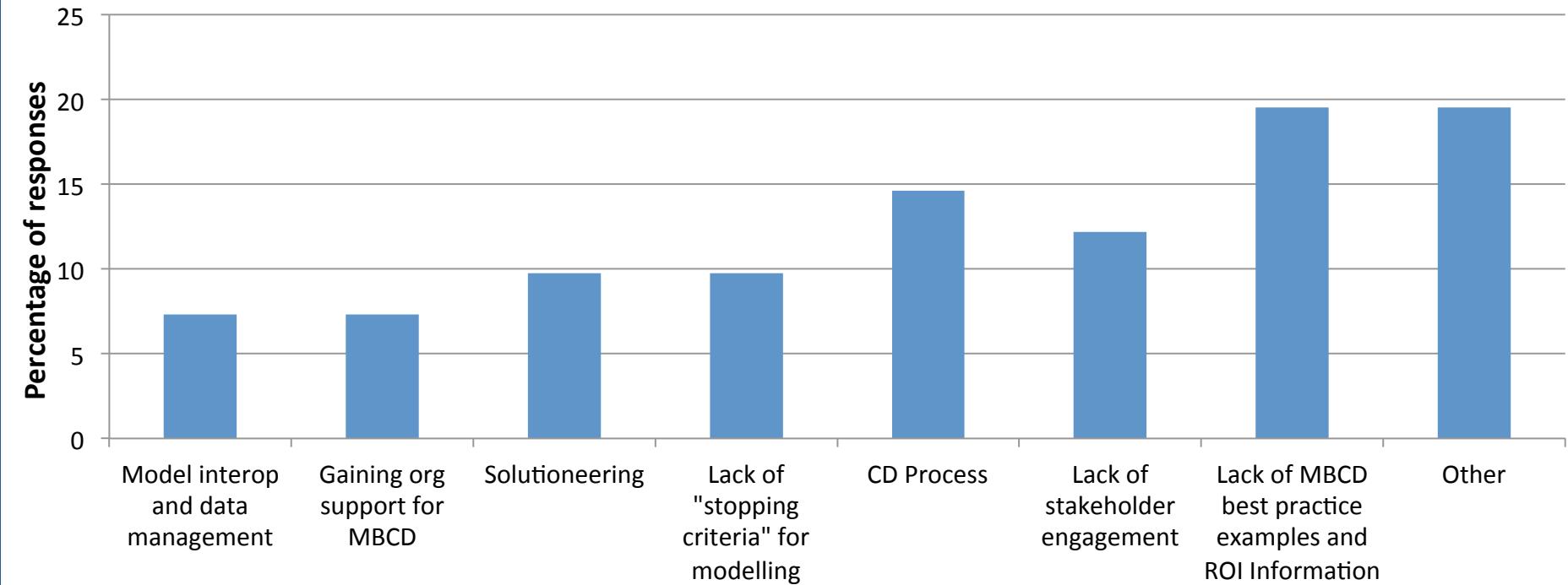
In which industry(ies) have you performed conceptual design?



2014 Conceptual Design Issues



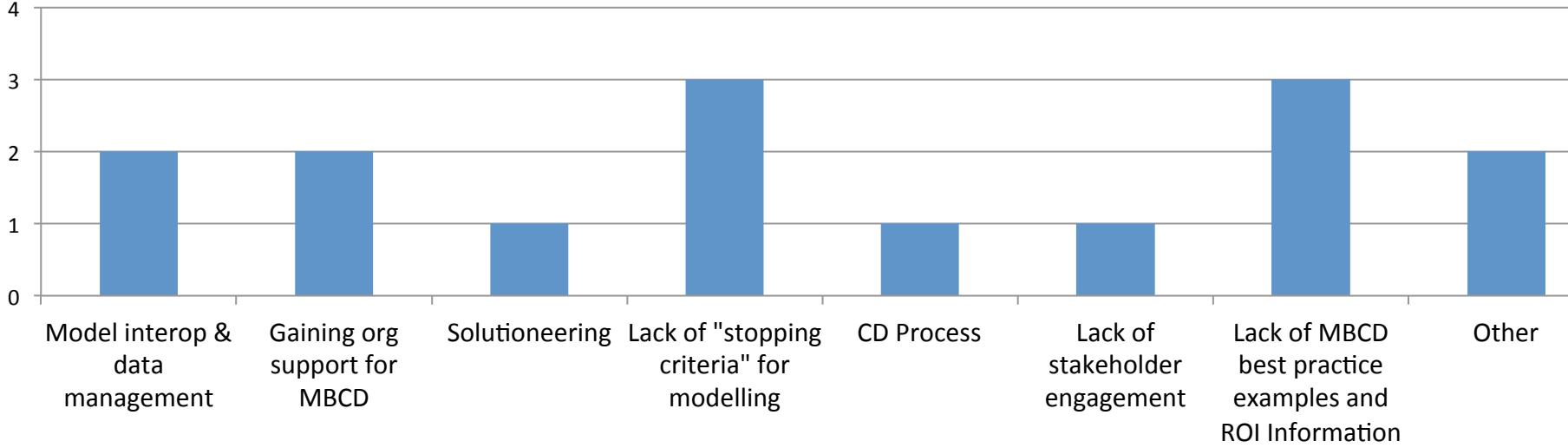
Issues by theme following workshop review (2014)



2014 Issues exacerbated by MBSE



Issues where MBSE made the issue worse



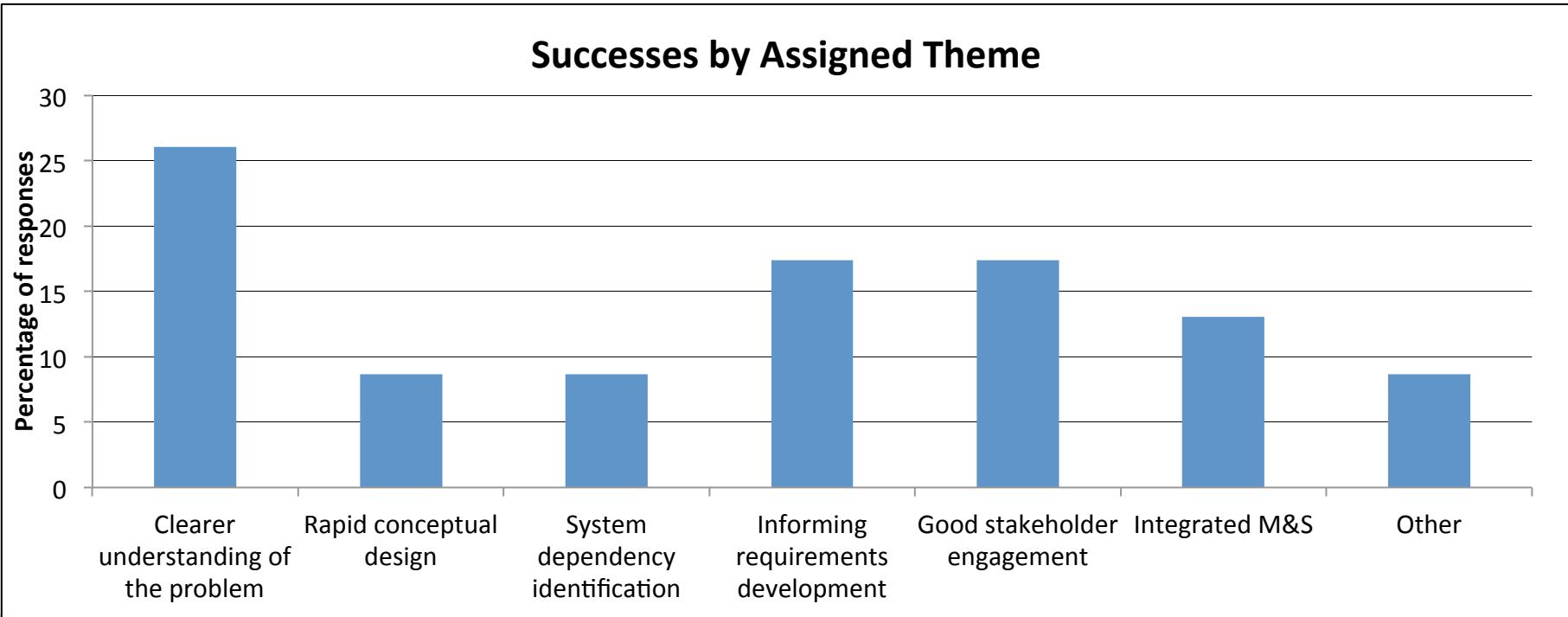
- Underlying causes for the “lack of stopping criteria for modelling” theme pointed to excessive MBSE during CD

- Shared models between acquirer and tenderer?

2014 Survey Successes



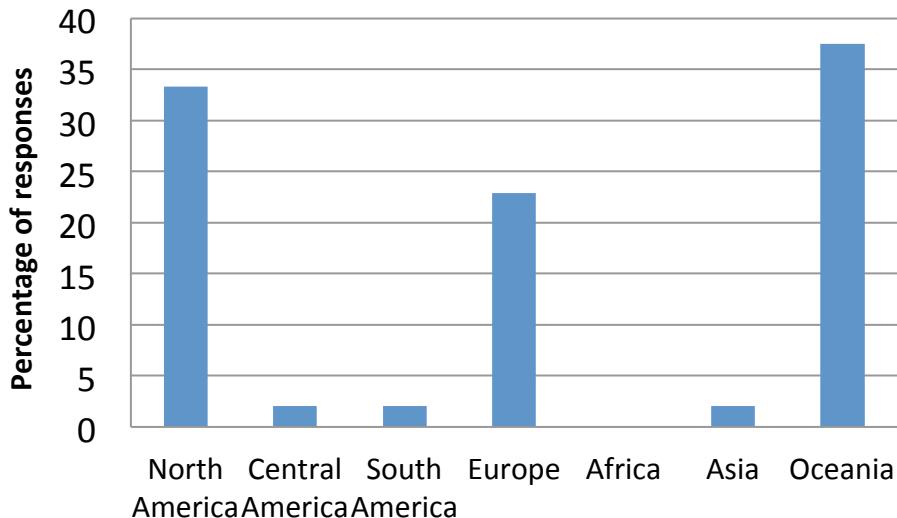
Successes by Assigned Theme



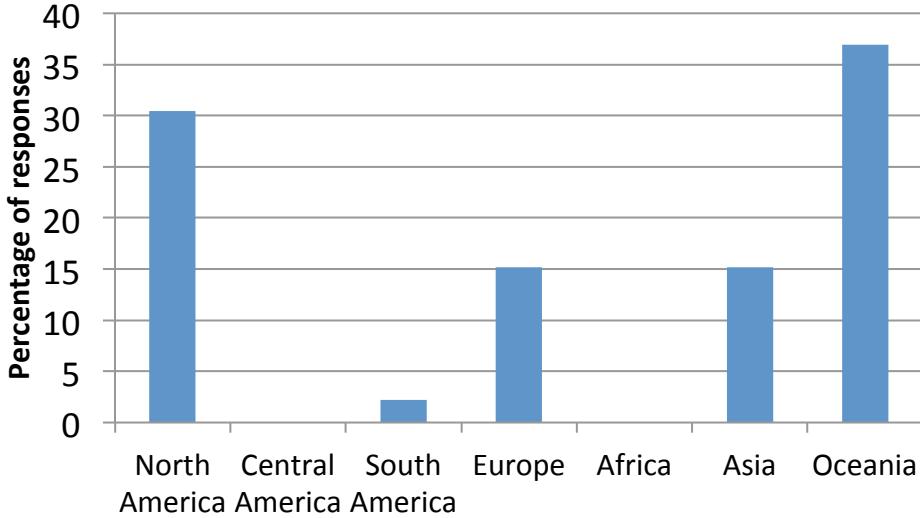
2015 Survey - Respondent Data (Regions compared to 2014)



In which region(s) have you performed conceptual design? (2015)



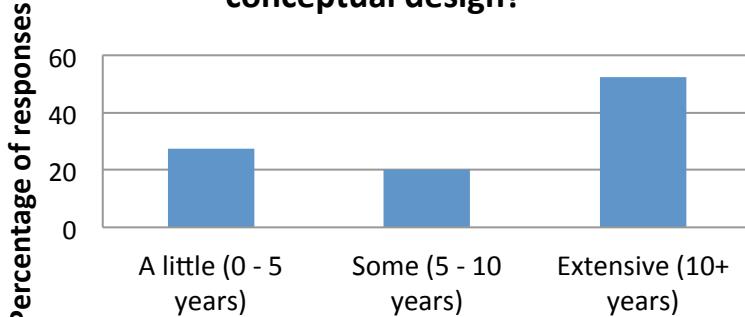
In which region(s) have you performed conceptual design? (2014)



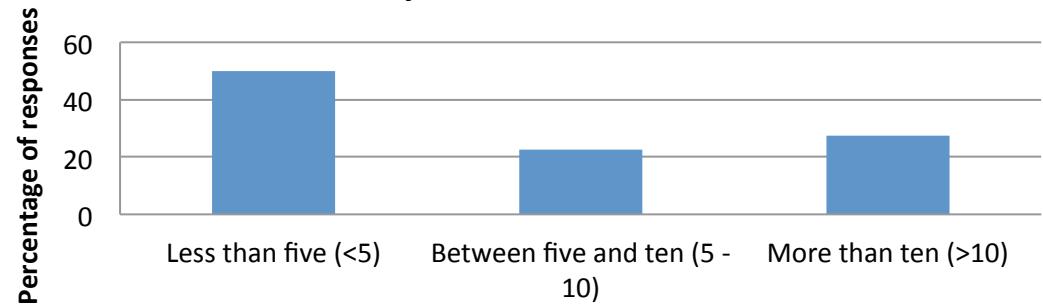
2015 Respondent Data



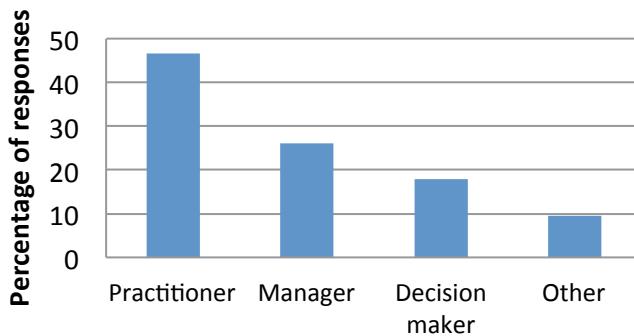
Do you have experience working in conceptual design?



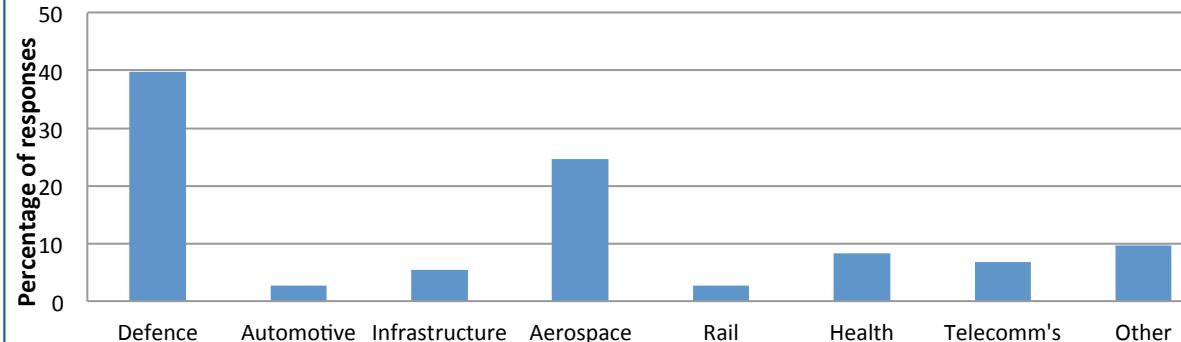
Approximately how many conceptual design projects have you been involved in?



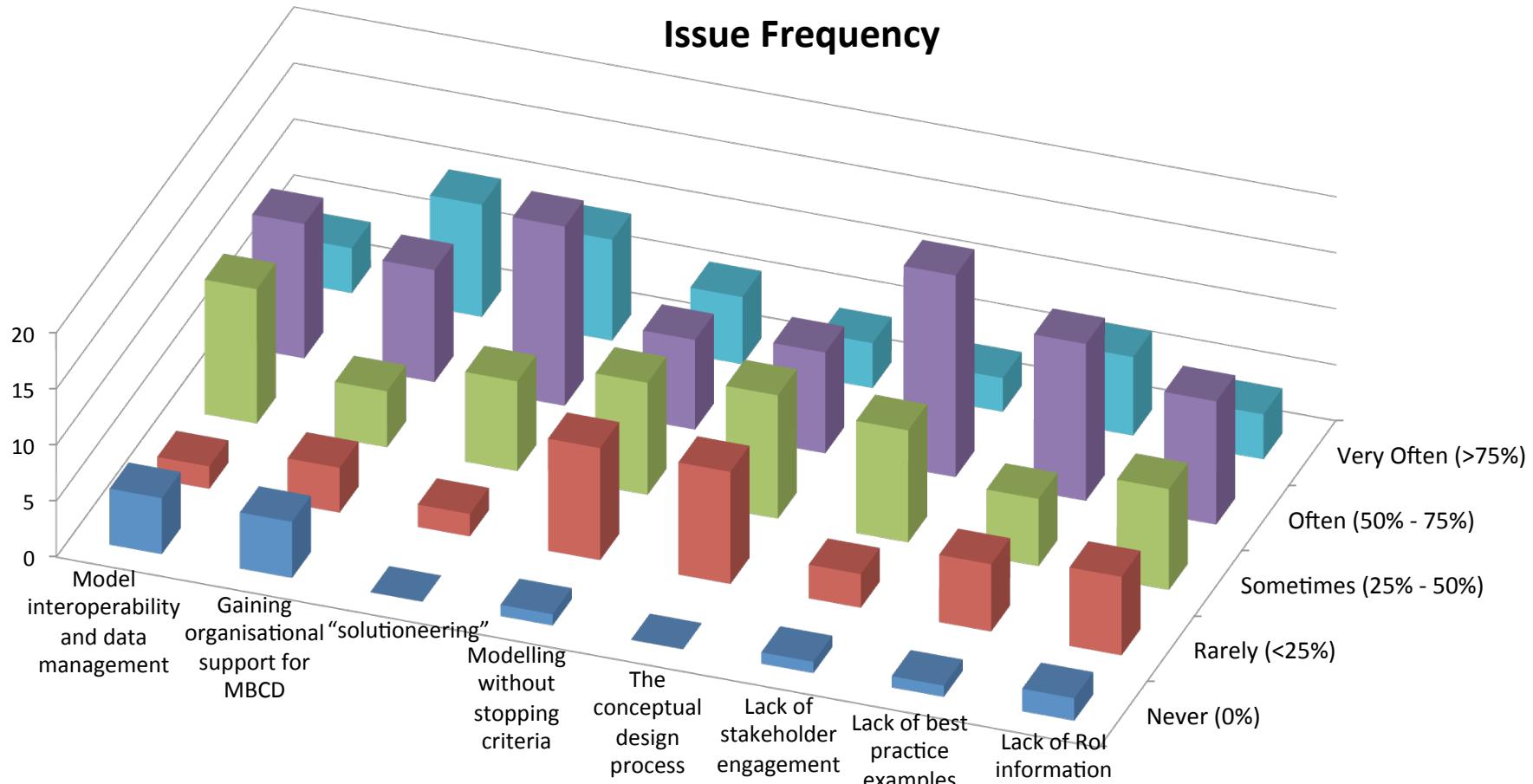
What roles have you performed in conceptual design?



In which industry(ies) have you performed conceptual design?

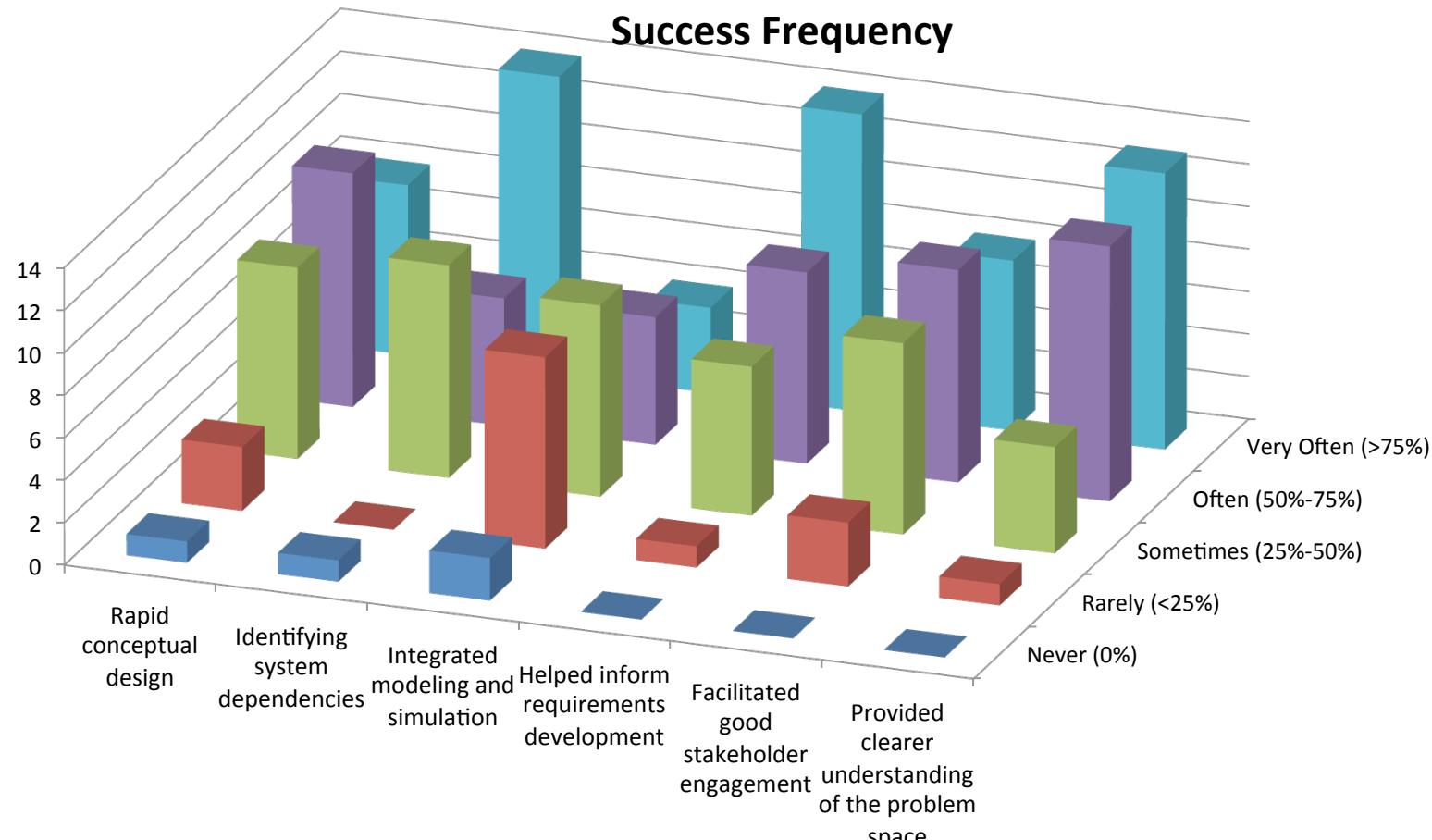


2015 Conceptual Design Issues



I have experienced issues with model interoperability and data management.	I have experienced issues with gaining organizational support for MBCD.	I have experienced stakeholders "solutioneering" (i.e. specifying a solution without understanding the problem).	I have experienced modeling without stopping criteria.	I have experienced issues with the Conceptual Design process that was used.	I have experienced a lack of stakeholder engagement	I have experienced issues due to a lack of MBCD best practice examples	I have experienced issues due to a lack of return on investment information on MBCD
difficult to transfer data e.g. reqts held in two tools	Models were used early in project and discarded. Then new models created later in project - resulted in mistrust	Once the candidate designs start to emerge often a preferred solution starts to run away with itself because people can visualize this easier than a concept. It is hard to put the brakes on a collective runaway desire to see something tangible.	modeling and software never stops	MBSE and other concept design run in parallel and not coordinated.	Preference to use Visio and Excel which many can use over MBSE tools which only a few can use	Hard to find definitions of good practice	Too hard to measure accurately as you would need to do the same project without using MDE.
Tend to work with one MBSE tool, so not a big issue	I am the decision maker	Including MBCD WG	I have not needed to look for this	We have done lots of R&D into improving our processes	Once they understand they get it	Eclipse documentation is the worst	I have not been looking for this problem
This has particularly been a problem when Systems Engineering in this phase is hard enough. MBSE/MBCD is a step too far. (or to another organisation within the same lifecycle stage)	For some, the step to Systems Engineering in this phase is hard enough. MBSE/MBCD is a step too far.	That's somewhat the idea in a MOTS space...although MOTS is never "MOTS".	Modeling for modeling's sake- acknowledge elicitation risk	Normally due to risk	They think MBCD is a "silver bullet"	We have had to develop these examples within our organisation over time, rather than having access to publicly available examples	The value of MBCD work is sometimes questioned - ROI information would help give the client confidence in the value of MBCD
This would have occurred more often if model interfacing processes weren't developed for specific easier interactions	Widespread and high-ranking support has been difficult to get (case-by-case individual support has been	That's why MBSE was used- to better understand the need	the stopping criteria often is money. When you run out - stop. This is a terrible reason to stop.	Often starting with the solution, then being asked to "backfill" or retroactively build the conceptual design.	Mgmt support critical (PM, or Line mgr)	We are sorely lacking in this area. Especially since a lot of the examples we have are classified.	The return on investment is sometimes low on the existing project, but for the product line as a whole, it always returns investment. you have PMs that say they do not want to pay for the next programs savings. They get no reward for just meeting their profit goals and helping the next program significantly reduce their development costs
Rely on .csv outputs etc to enable model interoperation	Not within my own organisation, but to the client organisation. Conceptual design (let alone model-based) is still done poorly, if at all.	All the time.	This is a management issue and is akin to creeping excellence in all forms of design.	Conceptual design phases tend to exhibit higher novelty than other design phases. There are process issues with or without MBCD.		This depends on the working environment. In large contracting companies industry there are often best practice examples available, less so in acquisition organisations, esp in Australia.	"How much more is this going to cost me?" gets asked a lot. Rely on the work by Eric Honour on ROI. Would be great to have more evidence for MBCD ROI

2015 MBCD Successes



2015 Success Comments

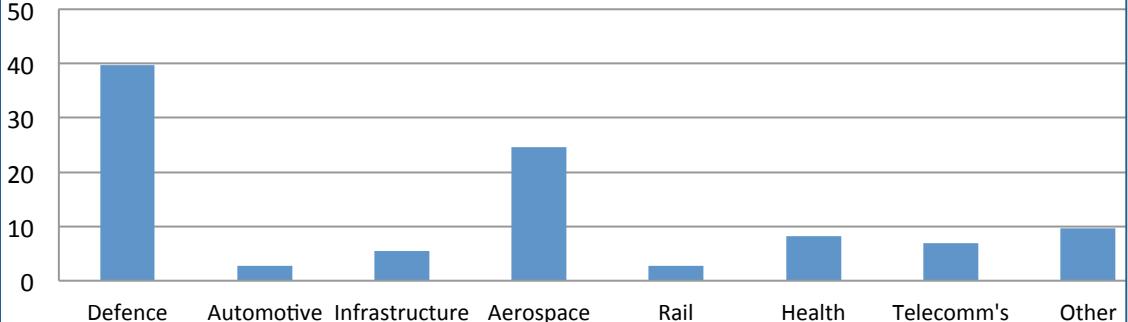


MBCD has facilitated rapid conceptual design	MBCD has assisted with identifying system dependencies	MBCD has enabled integrated modeling and simulation	MBCD has helped inform requirements development	MBCD has facilitated good stakeholder engagement	MBCD has provided clearer understanding of the problem space
Models can be built quickly	MBCD used explicitly to identify risks	Modeling and Simulation practices and tools not sufficient	Unless you mean "system shall" statements	MBCD diagrams structured to facilitate review by stakeholders	In certain situations it makes modellers/developers step back and design better
I would only "rapid" because you can get to a better quality conceptual design in the same time.	Was able to use the model in stakeholder workshops to investigate proposed changes to requirements. When we traversed from operational needs to the implications on system requirements the stakeholders sometimes changed their mind. This ability to show quickly how one change affects the upstream/downstream dependencies was very effective	Mostly web-based systems. No simulation.	So important!	Yes, they can see something visual quickly and provide feedback	In my experience, this is always the case
It is not always the case, but this has occurred often, particularly when building upon modelling work done previously on a similar project (or an earlier incarnation of the project)		only due to lack of interest by stakeholders... I'm sure MBCD can help here too.	Using the model tools, with integrated diagrams, allowed stakeholders to express their ideas and confirm that what they were saying was what was recorded. The integration with flow diagrams was very important in this, since stakeholders can relate easily to such diagrams.	It very much depends on the willingness of the stakeholder to learn and the graphical language used.	For stakeholders the model-based approach forced them to express their thoughts more precisely, which helped to gain agreement between stakeholder groups. Without this precision, vested interests were cautious to agreeing, for fear that what they thought they were agreeing to was perhaps not exactly what the proposer was saying.
Client emailed me afterwards to say that he didn't believe we could have achieved the quality specifications we had, within the time available, without using a model-based approach to organise the requirements and track their relationships.		This is a weakness of most tools.		See above comments.	
Lack of stopping and evaluation criteria makes this difficult to judge.				MBCD has enhanced stakeholder engagement but the representation of information can sometimes be a barrier for understanding for some stakeholders	
Most tools record a design they do not support the production of a design or set of designs.					

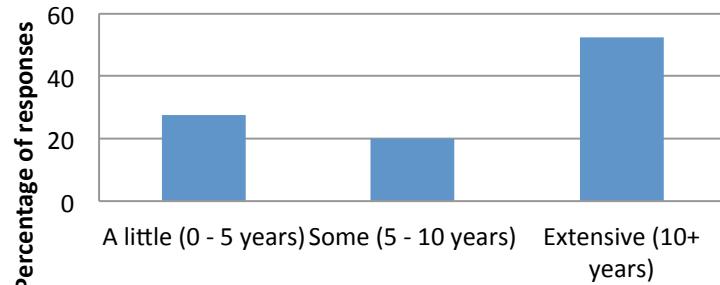
Comparing Respondent Data



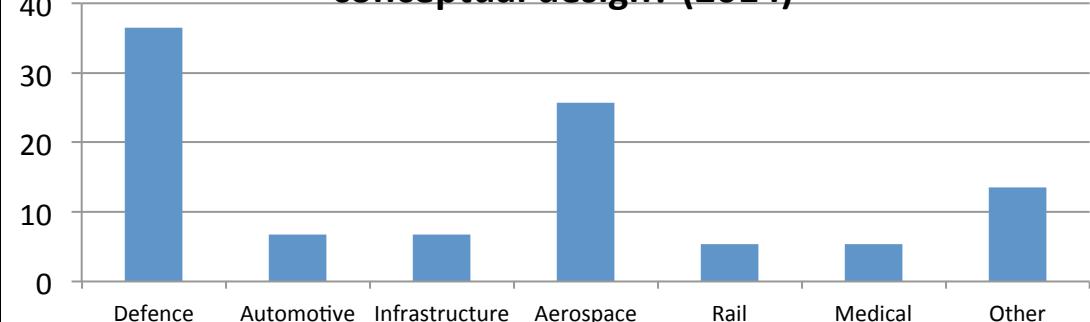
In which industry(ies) have you performed conceptual design? (2015)



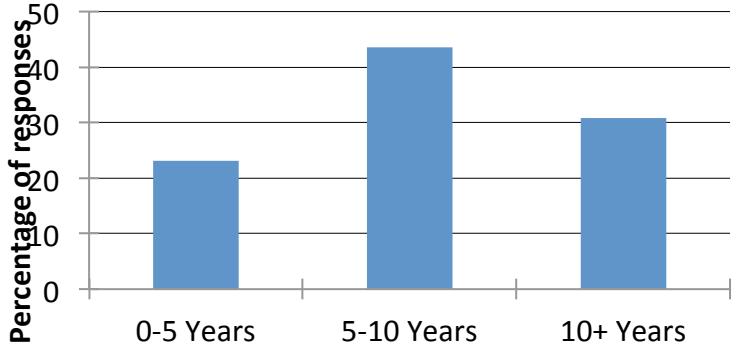
Do you have experience working in conceptual design? (2015)



In which industry(ies) have you performed conceptual design? (2014)



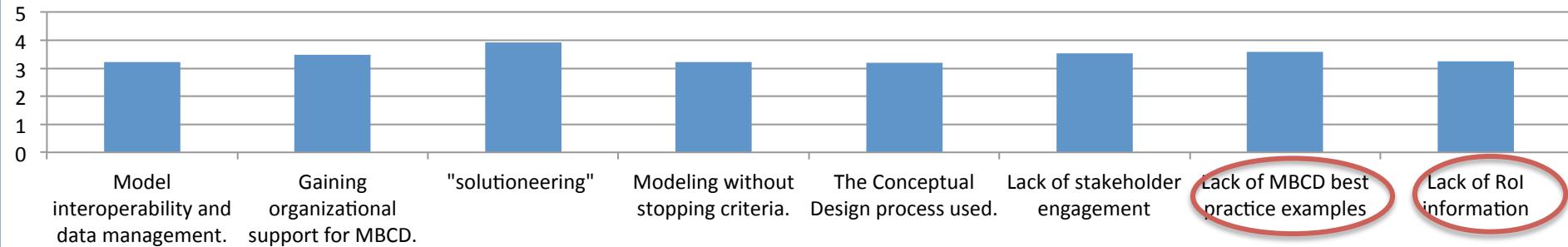
Respondent Experience? (2014)



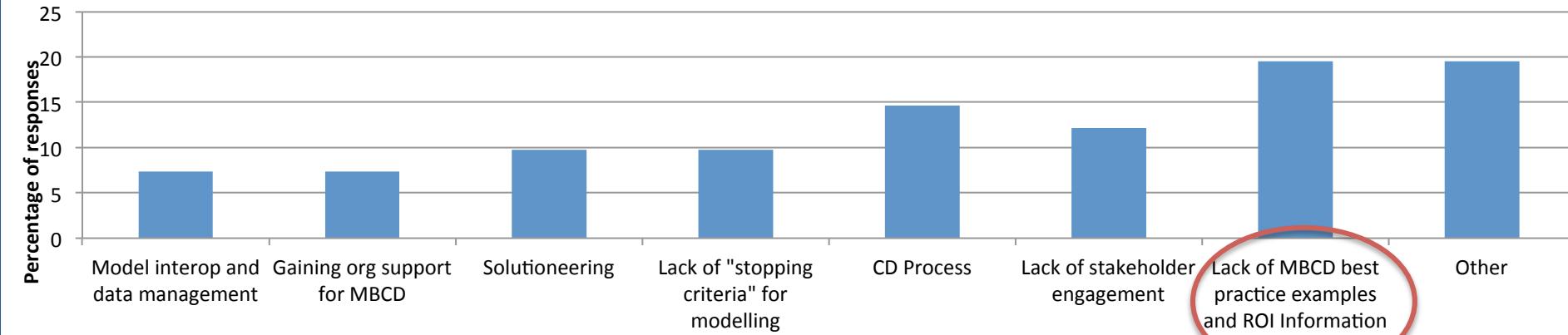
Comparing Issue Results



Issue Weighted Averages (2015)



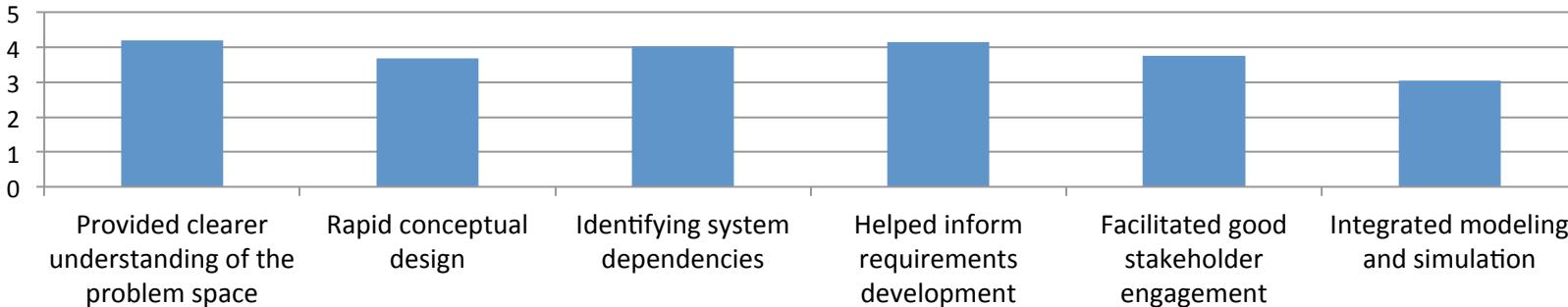
Issues by theme following workshop review (2014)



Comparing Success Results



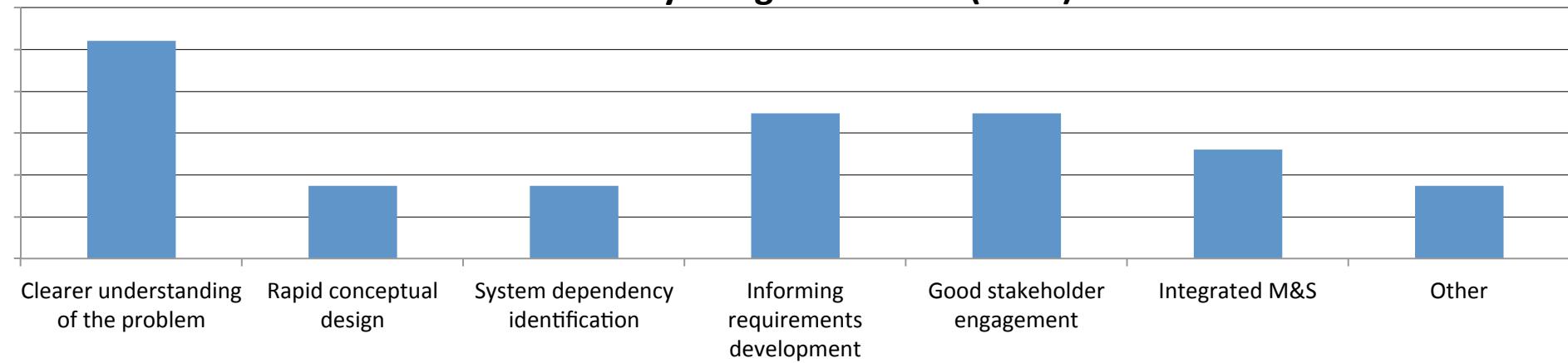
MBCD Success Weighted Averages (2015)



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Successes by Assigned Theme (2014)



Insights from the Surveys



- MBCD needs to be implemented via a methodology
 - WG activity to collect MBCD examples
- Stakeholder engagement is key
 - Need engaging tool graphics + SE “soft skills”
- MBCD can provide “clearer understanding of the problem” and “inform requirements development”
- Don’t model for the sake of modelling!
- Non-response bias concerns addressed

Activities and Challenges for the MBCD WG



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- MBCD case study collection activity
 - Leading issue in both surveys “Lack of best practice examples and ROI information”
 - Underlying cause of other issues
 - Lack of stakeholder engagement/the conceptual design process
 - Please let us know if you have a case study to share!
 - Distil these into a code of best practice as a subsequent activity
- Enhance MBCD strengths
 - Clearer understanding of the problem
 - Good stakeholder engagement
 - Informing requirements development

Acknowledgements



- INCOSE MBCD WG and steering committee for input and advice
- The people who gave their valuable time to complete the survey!