

SYSTEMATIC SEARCH OF OPTIMAL SPACE SYSTEM MISSIONS DESIGN USING SET-BASED CONCURRENT ENGINEERING BASED ON MODELS

GÉRALD GARCIA ⁽¹⁾, SÉBASTIEN MADELENAT⁽²⁾, BENOIT LANGLOIS⁽³⁾, LUC
DELAMOTTE⁽³⁾, MARCEL VERHOEF ⁽⁴⁾, ANA RUGINA ⁽⁴⁾

(1) Thales Alenia Space (2) Thales Research & Technology (3) Thales Global Services (4) ESA



TABLE OF CONTENTS

1 SBCE Introduction

2 OSIP study

3 Model based SBCE

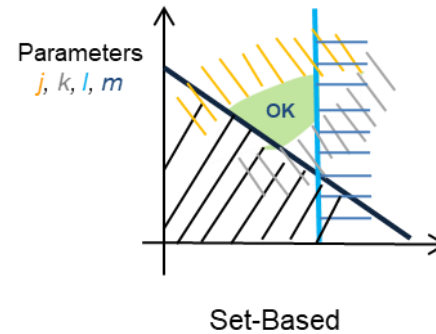
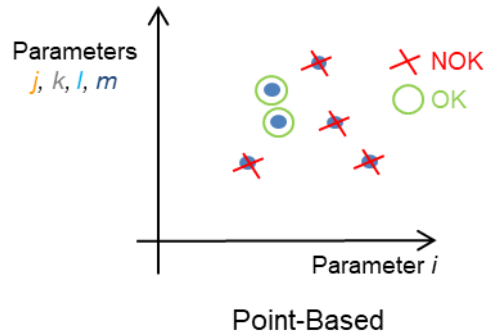
4 Model exploitation

5 Conclusion

FROM POINT BASED TO SET BASED

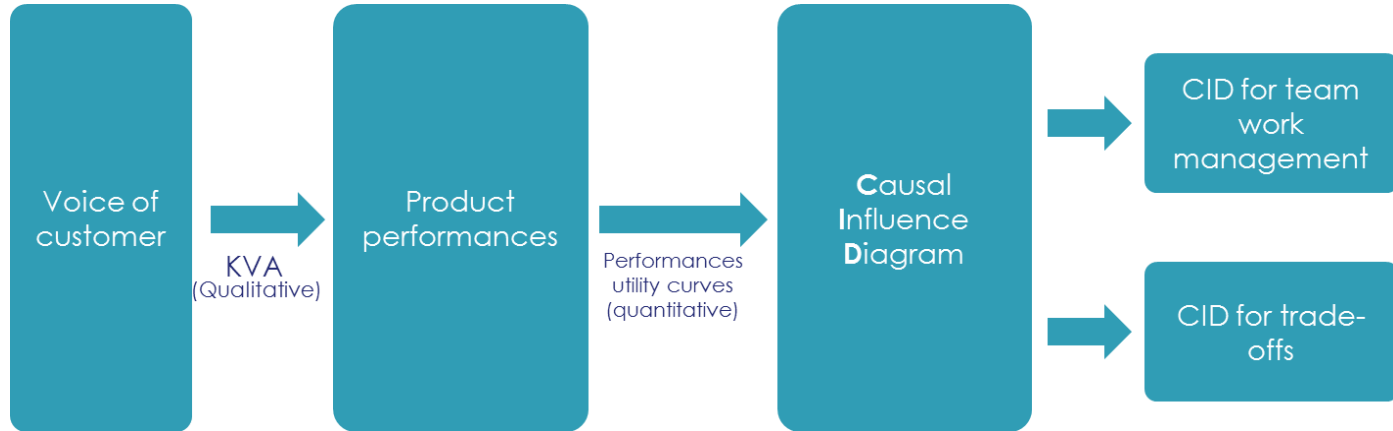
/// Doodle is using set based concept to define best meeting dates

/// Applying the same principles to engineering process



SET BASED CONCURRENT ENGINEERING

/// Overall process :



/// One important artefact : the Causal Influence Diagram

/// CID displays the relationship of dependency between :

- ! KVA : Key Value Attributes => expected system attributes from the customer perspective (for example image quality)
- ! Dependent Variables => Key Specifications translation of KVA into engineering parameters : what the system has to do (e.g. required deltaV)
- ! Independent Variables => Design Variables that express the design decisions made by the engineering team (e.g. altitude)

OBJECTIVES OF THE OSIP STUDY

Demonstrate the interest
of SBCE for space
mission design



- /// Adapt SBCE to space systems and applications
- /// Demonstrate this on representative use-cases

Propose a model-based
approach to scale-up
SBCE to complex space
system design



- /// Define a model-based approach
- /// Prototype a modeler and use it on use-cases
- /// Explore usages of this modeler
- /// Integration into current engineering environment

OSIP Study from January 2021 for 12 months (TO : M. Verhoef)

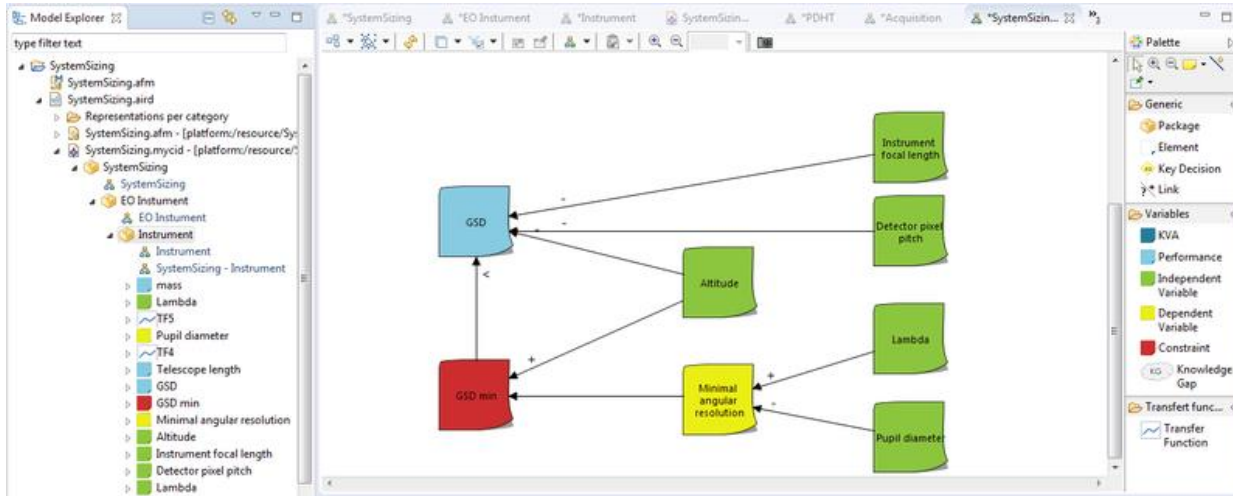
MODEL BASED SUPPORT TO SBCE

/// Develop a model-based approach for the Causal Influence Diagram

/// Permit to author quickly design CID using several views and keeping all the model consistent

/// Provide « packaging » capability to split the CID in manageable/reusable parts

/// Rely on Eclipse MBSE open source stack (Kitalpha, used also for Capella)



EXPLORATION OF THE MODEL

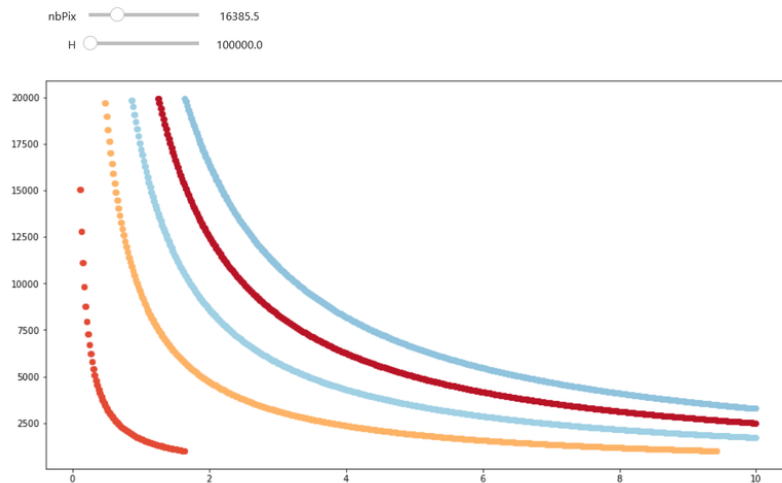
/// CID model open the door to a computer aided exploration of results

/// We explore in this study the capability of solvers to reduce the domain of design variables according to given constraints :

I For example : What is the range of altitude possible with a GSD of 50cm and a maximum dry mass of 500kg ?

/// The solver is synthetised from the CID informations and produce feasibility domains

/// The results are explored in the form of trade-of curves



CONCLUSION

/// This study is still on-going work to be concluded beginning next year

- / First prototype of the MyCID editor has been released
- / UC are in progress
- / First exploitation example are available
- / Integration with engineering environment (Capella, CDF tools, ...) will be studied

/// Moving from point based to set-based engineering is a must to cope with current space industry challenges (in particular reduction of lead time and cost while being more and more agile)

/// SBCE improves engineering activities organisation and management :

- / Based on what we have to learn to take the right decisions at the right time,
- / Structuring work of the team in an agile way
- / Improving knowledge capitalisation

/// The model based SBCE :

- / introduce new kinds of models in MBSE landscape complementary to others ones
- / It seems a promising approach for generalising the use of multi-criteria optimisation methodologies

THANKS FOR YOUR ATTENTION

ANY QUESTIONS ?