



Tool Vendor Perspective

MBSE in Telescope Modeling: European Extremely Large Telescope - World's Biggest Eye on the Sky

Saulius Pavalkis Ph.D., April 13, 2015
at 31st Space Symposium



- **Global User Support Manager** and former **Analyst** on the MagicDraw R&D team for over 10 years.
- **Major expertise area** is model-based requirements engineering, software and systems design.
- **Ph.D.** from Kaunas University of Technology (KTU) in model traceability area.
- **Multiple professional certificates:** OMG-Certified UML Professional, OMG-Certified Systems Modeling Professional, OMG-Certified Expert in BPM, and ITIL V3.
- **Multiple research and practical articles** in model-based design some of them are available in modeling community blog (blog.nomagic.com).
- **Researcher** at Kaunas University of Technology



140 M

120 M

100 M

80 M

60 M

40 M

20 M



Budget: €1,055M

Main mirror: 40m diameter

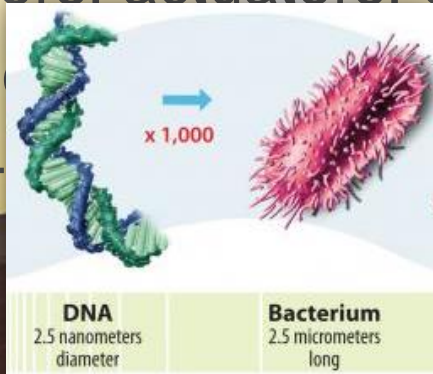
Height: 80m

Footprint: 100m

E-ELT Control System



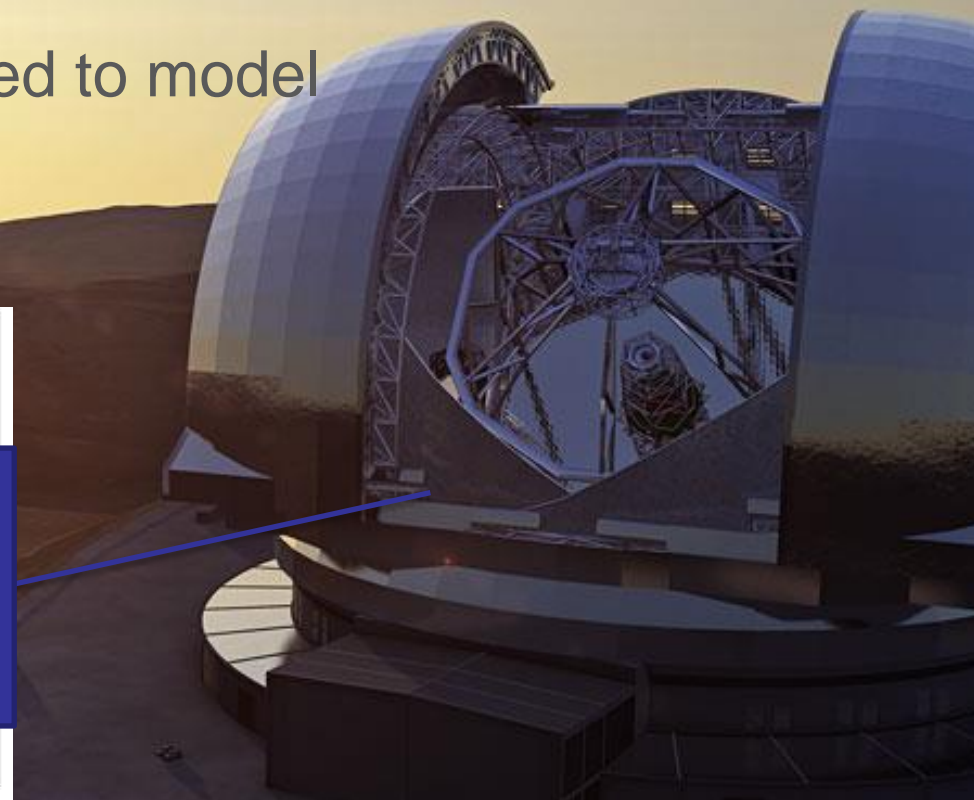
- The Control System (TSC) includes all hardware, software and communication infrastructure required to control the system
- Manages and coordinates system resources (subsystems, sensors, actuators, etc.)
- Magic was used to model E-ELT



DNA 2.5 nanometers diameter	Bacterium 2.5 micrometers long
<div><<block>> <<logical>> tel : Telescope</div>	
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am name	EELT_Control
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ication date	6/8/09 11:02 AM
Completion status	

1000 mirrors. The position of the segments must be coordinated to deliver a continuous surface with an error below 100nm



Complex Systems Design Challenges



- Geographical distribution
- Large amount of data
- Heterogeneity: different roles, domains, tasks and still everything needs to be integrated
- High technical demands
- Custom work processes and adapting product to them

Team believed that SysML and MBSE
would contribute significantly to tackle
these challenges

What is MBSE?



Model-based systems engineering (MBSE) is the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases

(INCOSE-TP-2004-004-02, Version 2.03, September 2007).



INCOSE
strategic vision that SE is MBSE

3 Pillars of MBSE



- **Language** – de facto modeling language is SysML from OMG.
- **Method** – without method language can be used in different ways, including incorrect methods. Used methods: State Analysis and OOSEM.
- **Tool** – model is a collection of complex data which can be edited, augmented, queried and reported upon using a suitable tool.



OOSEM



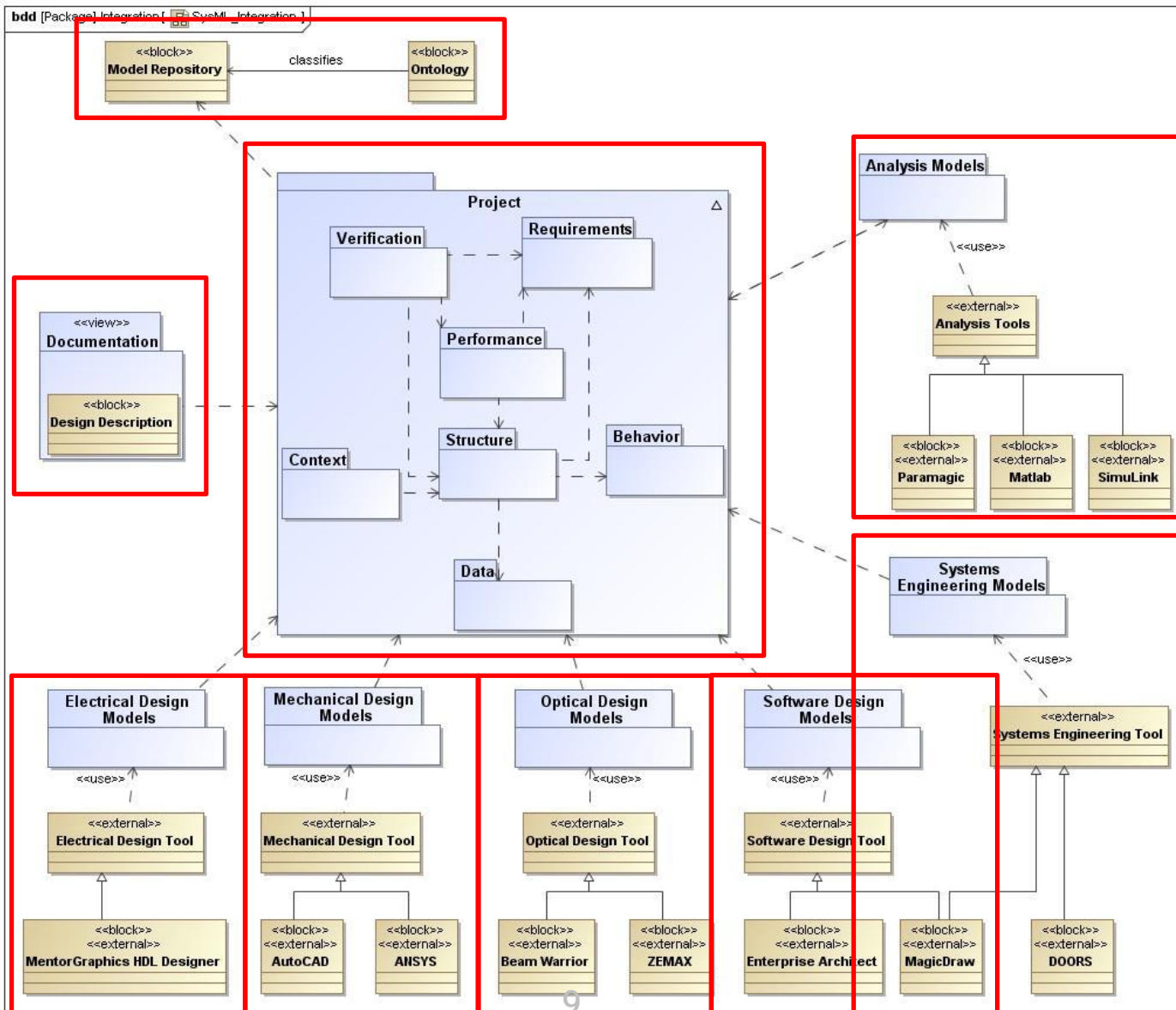
We were chosen as the vendor most suitable for such complex projects

MBSE Was Used For



- Define infrastructure (e.g. network)
- Define interfaces to sub-systems
- Provide a cost estimate, power consumption
- Define common standards based on catalogs and design conventions
- Define requirements for subsystems (e.g. data rates, data volume, latency)

MBSE Integrating and Addressing Multiple Aspects of the System

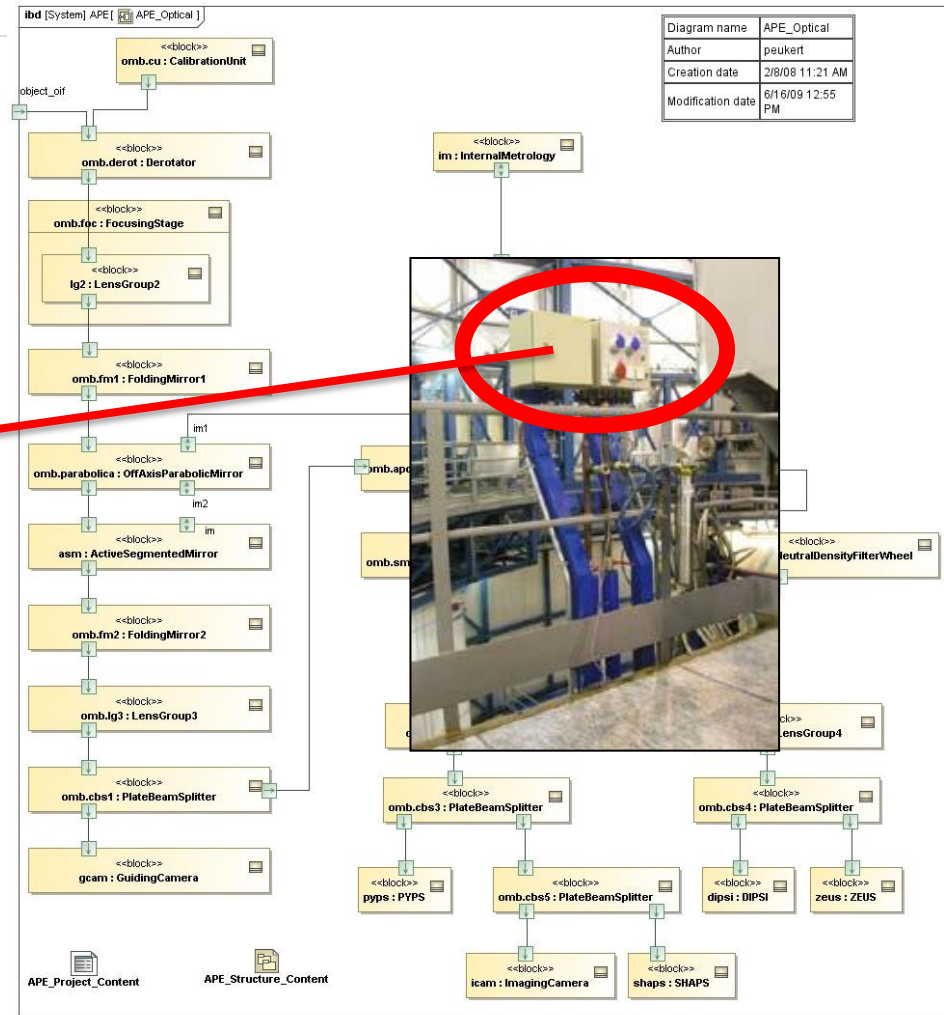
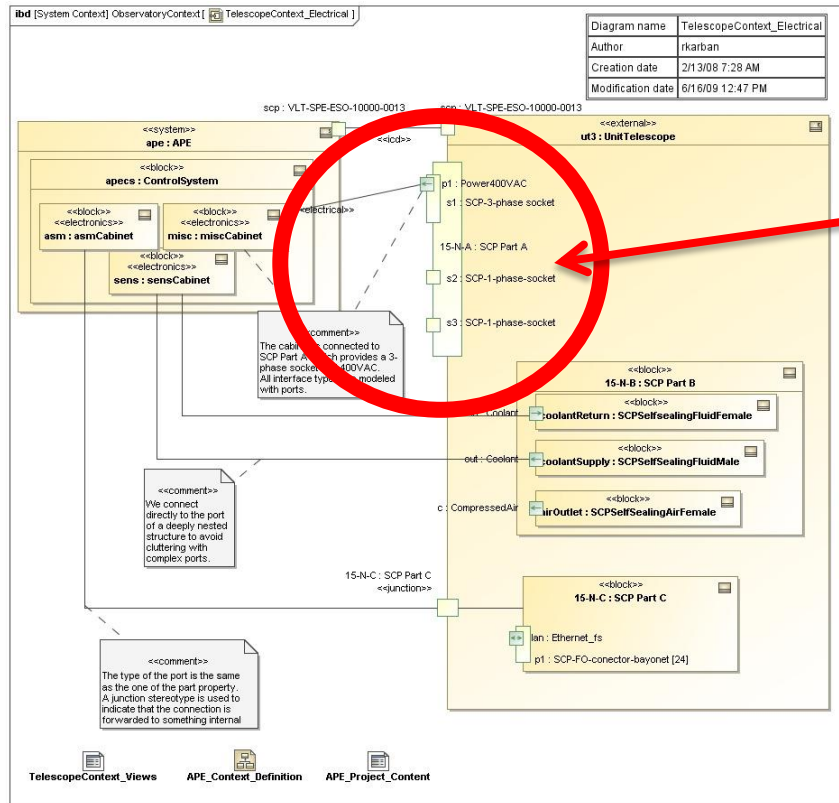


Credit: ESO
— No Magi

Multiple Internal Structures, Clear Interfaces



REUSABILITY



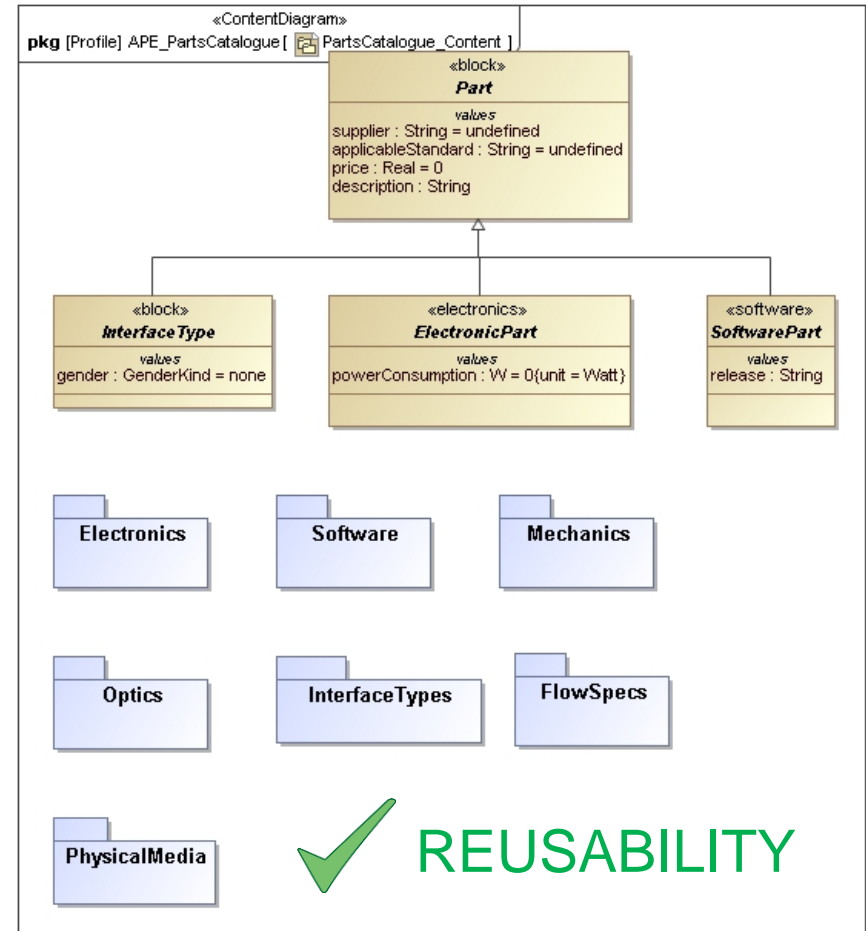
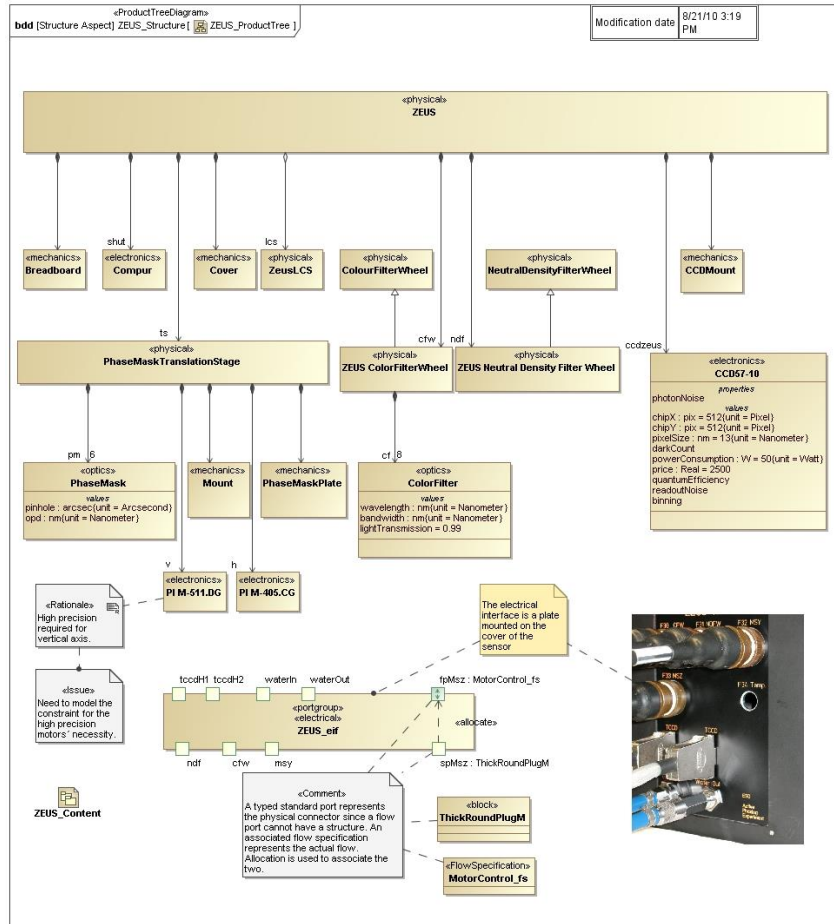
Electrical

Optical

Credit: ESO

No Magic

Power Budgets and Cost Estimates from Model-Based Equipment Catalogs



Product Tree

Reusable part catalogs

Credit: ESO

No Magic

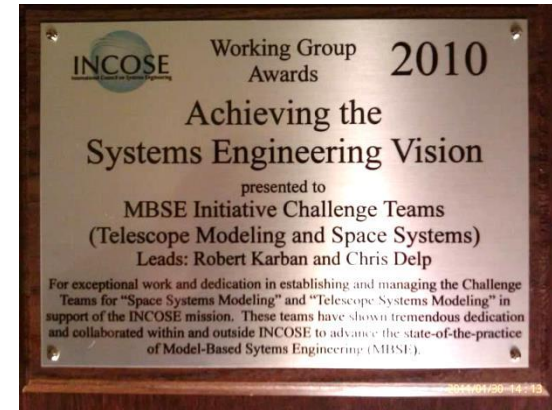


— No Magic

Results



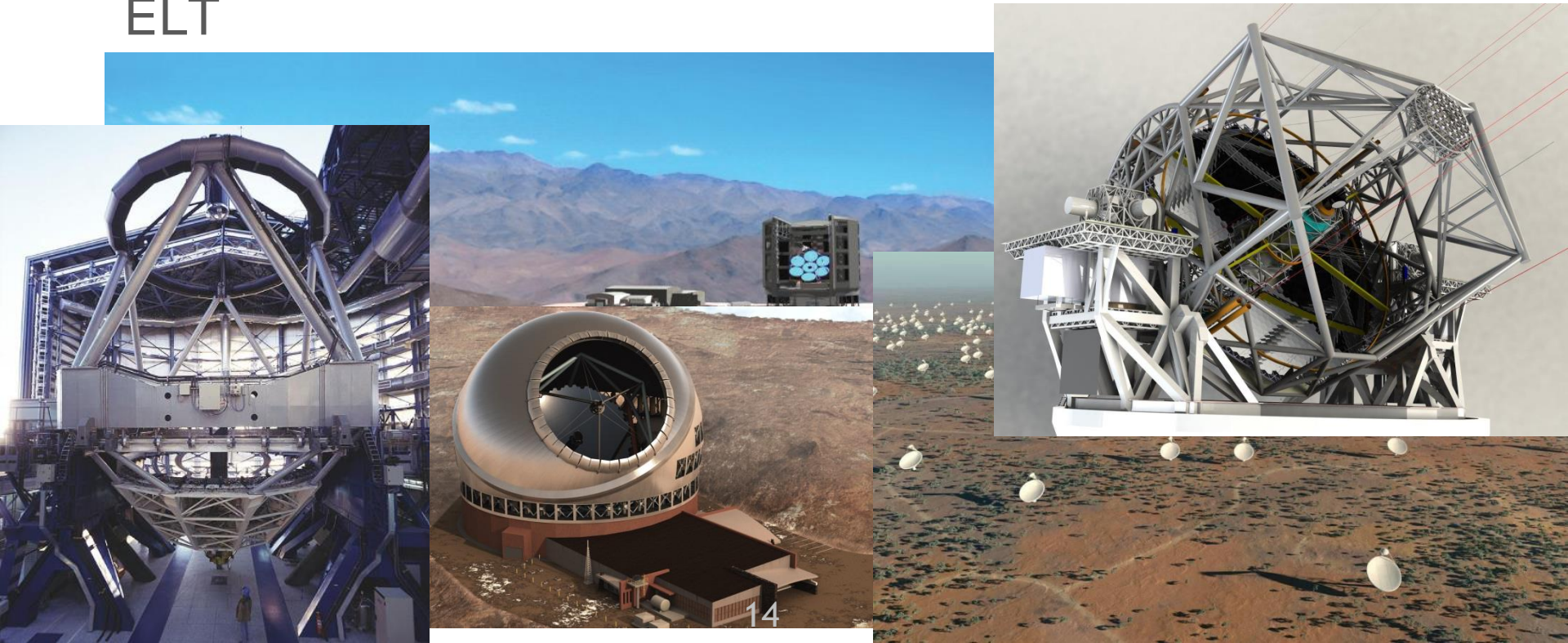
- Preliminary design were delivered
- Demonstrated that SysML is an effective means to support SE and handle complexity.
- Provided input (One of the most influential project for standard and tool development):
 - SysML RTF (SysML 1.3 were created updating interface modeling).
 - Tool vendor (400 official requests). Affected capabilities:
 - Standard support and usability
 - Requirements specification and interchange
 - Documentation generation
 - Model repository
 - Configuration and collaboration tools
 - Activity and state machine simulation
 - Validation and verification
 - Profiling and extendibility
- [Cookbook](#) for MBSE with SysML with guidelines where created
- In 2010, INCOSE presented an award to the Telescope Modeling Challenge Team for Achieving the Systems Engineering Vision 2020
- Inflicted impact on other telescope projects.



Other Telescope Projects Using MBSE



- The Giant Magellan Telescope
- JPL NASA Thirty-Meter Telescope
- The Square Kilometer Array
- European Southern Observatory's (ESO) projects: VLT, E-ELT



How to Start With MBSE?



Investment! MBSE is not silver bullet.



So how to build a Sustainable Modeling Culture:

1. Think big, start small, and evolve, i.e. pilot project.
2. Establish a Center of Excellence, i.e. dedicated core team, training.
3. Adopt best practices (e.g. Cookbook), tools (de facto No Magic, Inc. products), method, and language (de facto OMG SysML)



Thank You!

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