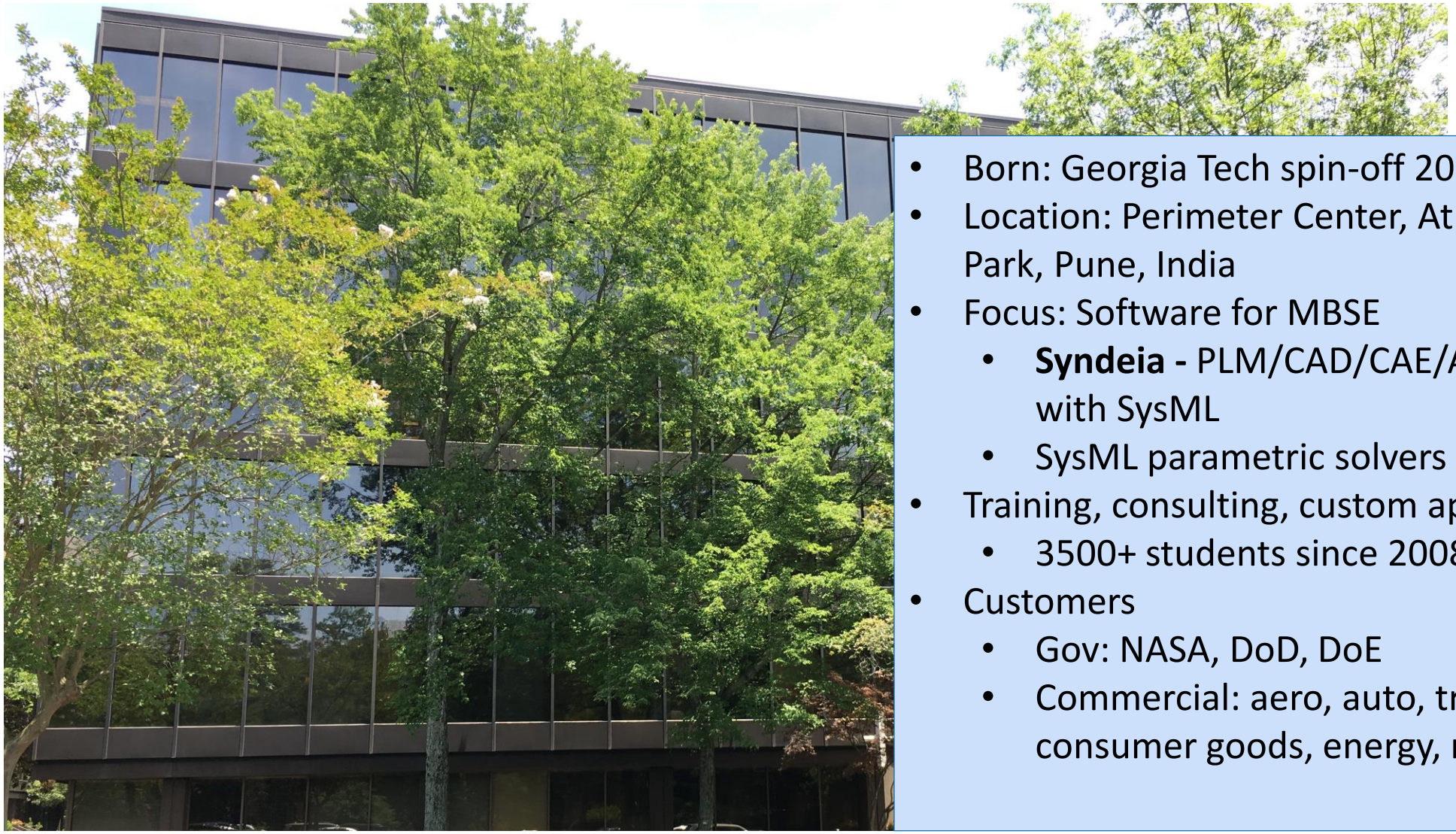
Introduction to SysML
Part 1.0: Course Content and Purpose; MBSE and SysML

With tutorial exercises using Magicdraw

Course Content

- SysML – a graphical modeling language for describing systems
- Course Purpose
  - to introduce new users to SysML language terminology and notation
  - to introduce the concepts of Model-based Systems Engineering (MBSE) and how MBSE and SysML may be deployed as part of the overall system development and engineering process
- Course instructor – Dr. Dirk Zwemer (dirk.zwemer@intercax.com)
- Course instructor – Dr. Manas Bajaj (manas.bajaj@intercax.com)



- Born: Georgia Tech spin-off 2008
- Location: Perimeter Center, Atlanta; Pune IT Park, Pune, India
- Focus: Software for MBSE
  - **Syndeia -** PLM/CAD/CAE/ALM Integration with SysML
  - SysML parametric solvers
- Training, consulting, custom apps
  - 3500+ students since 2008
- Customers
  - Gov: NASA, DoD, DoE
  - Commercial: aero, auto, transportation, consumer goods, energy, mfg., healthcare

Instructors

Dirk Zwemer, PhD is President and CEO of Intercax (*www.intercax.com*). Dr. Zwemer has over thirty years experience in the electronics industry with Bell Labs, Exxon, ITT, SRI Consulting and other organizations. He is the author of three patents and multiple technical papers, trade journal articles, and market research reports. . He received a BS in Chemistry from MIT, a PhD in Chemical Physics from UC Berkeley and an MBA from Santa Clara University.. Dr. Zwemer provides strategic consulting for customers and shows how to apply SysML in a wide variety of domains. He is a certified systems modeling professional (OCSMP Level 4 — Model Builder Advanced).

Manas Bajaj, PhD is the Co-Founder and Chief Systems Officer of Intercax (*www.intercax.com*). Intercax creates innovative software and services for enabling next-generation model-based systems engineering at organizations developing complex systems. Manas earned his PhD (2008) and MS (2003) in Mechanical Engineering from the Georgia Institute of Technology, and his B.Tech. (2001) in Ocean Engineering and Naval Architecture from the Indian Institute of Technology (IIT), Kharagpur, India. He has been actively involved in the development, implementation, and deployment of the OMG SysML standard and the STEP AP210 standard for electronics, and is a Content Developer for the OMG Certified Systems Modeling Professional (OCSMP) program.

Course Organization

- Course is divided into 10 parts, with 5 live lecture sessions
- For each part, we will provide, after the related lecture session
  - A video lecture
  - A digital copy of the lecture slides
- For most parts, we also provide
  - Starter models for the hands-on exercises
  - Final models for the hands-on exercises
  - Video Demonstrations for the hands-on exercises
  - Digital files of step-by-step exercise instructions
- DO THE HANDS-ON EXERCISES

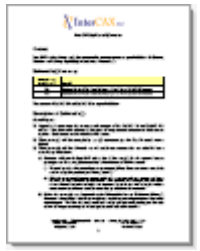
Course Organization

- Part 1 Introduction
- Part 2 Blocks and Block Definition Diagrams
- Part 3 Starting a Model – Packages and Use Cases
- Part 4 Requirements and Sequence Diagrams
- Part 5 Analysis - Parametric Diagrams
- Part 6 Activities and Activity Diagrams
- Part 7 Internal Block Diagrams
- Part 8 State Machines and Advanced Interactions
- Part 9 Interoperability
- Part 10 Deploying MBSE and Model Review

Course Content

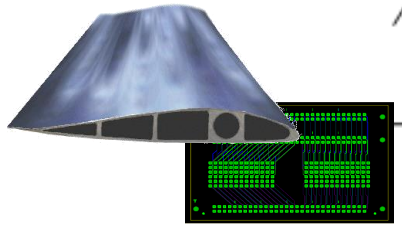
- SysML – a graphical modeling language for describing systems
- Course Purpose – to introduce new users to SysML language terminology and notation
- What the course is not
  - A complete survey of all SysML language concepts
  - Preparation for OCSMP exams
  - Training in a specific MBSE methodology
  - Training for a specific SysML tool

DBSE – the Status Quo



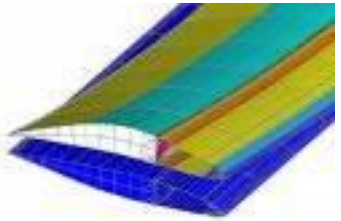
Project Management

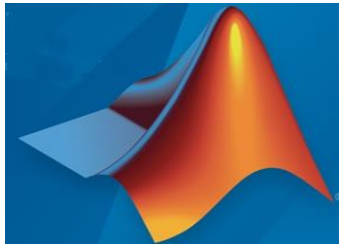
Requirements



CAD

Simulation/CAE



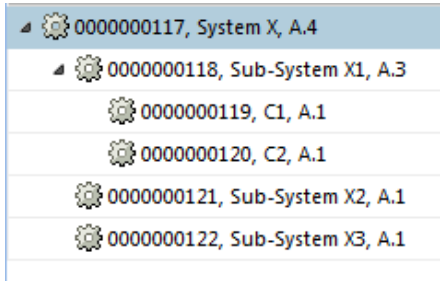


Optimization

Libraries / Databases

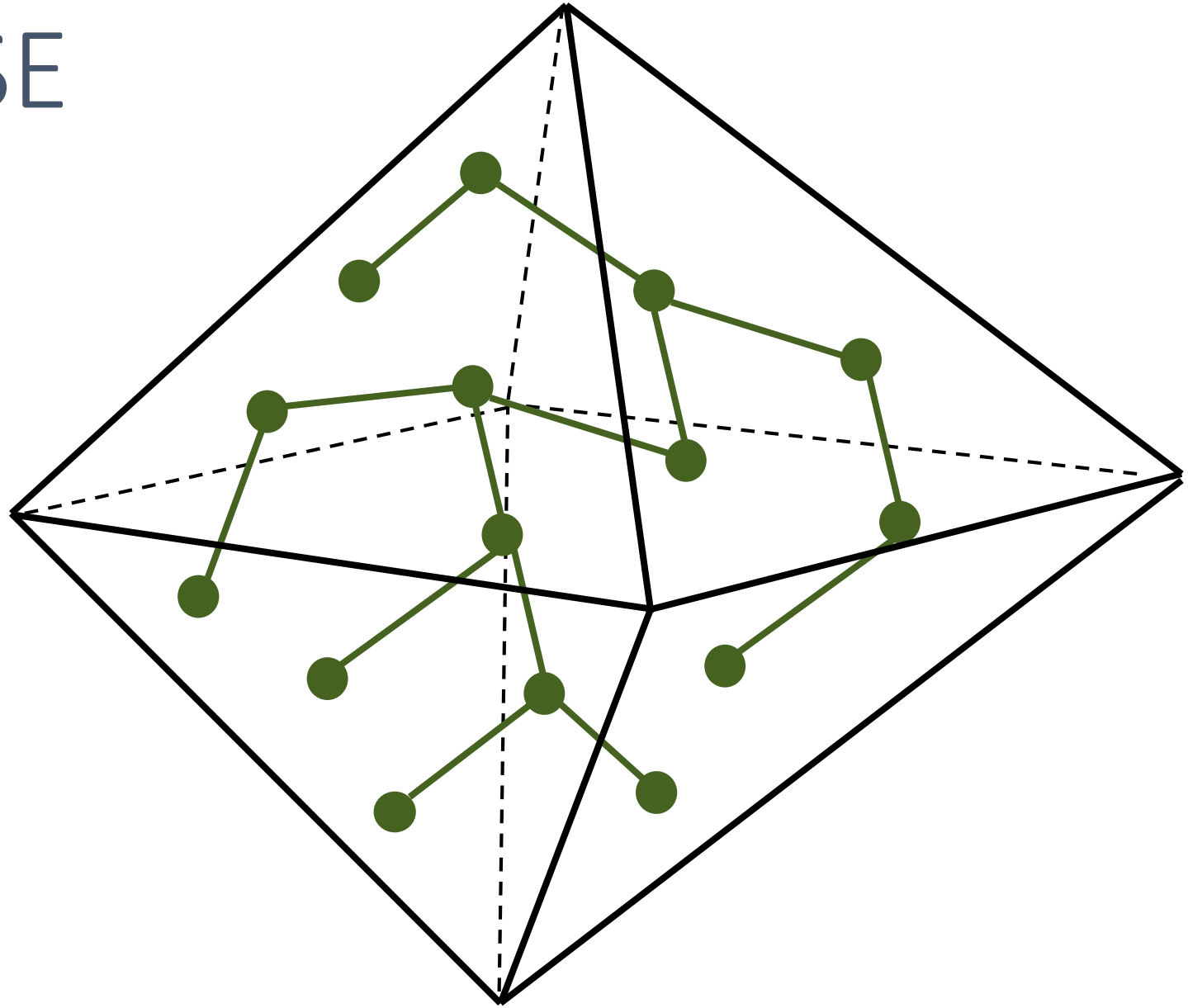
PLM System

Manufacturing, Supply Chain

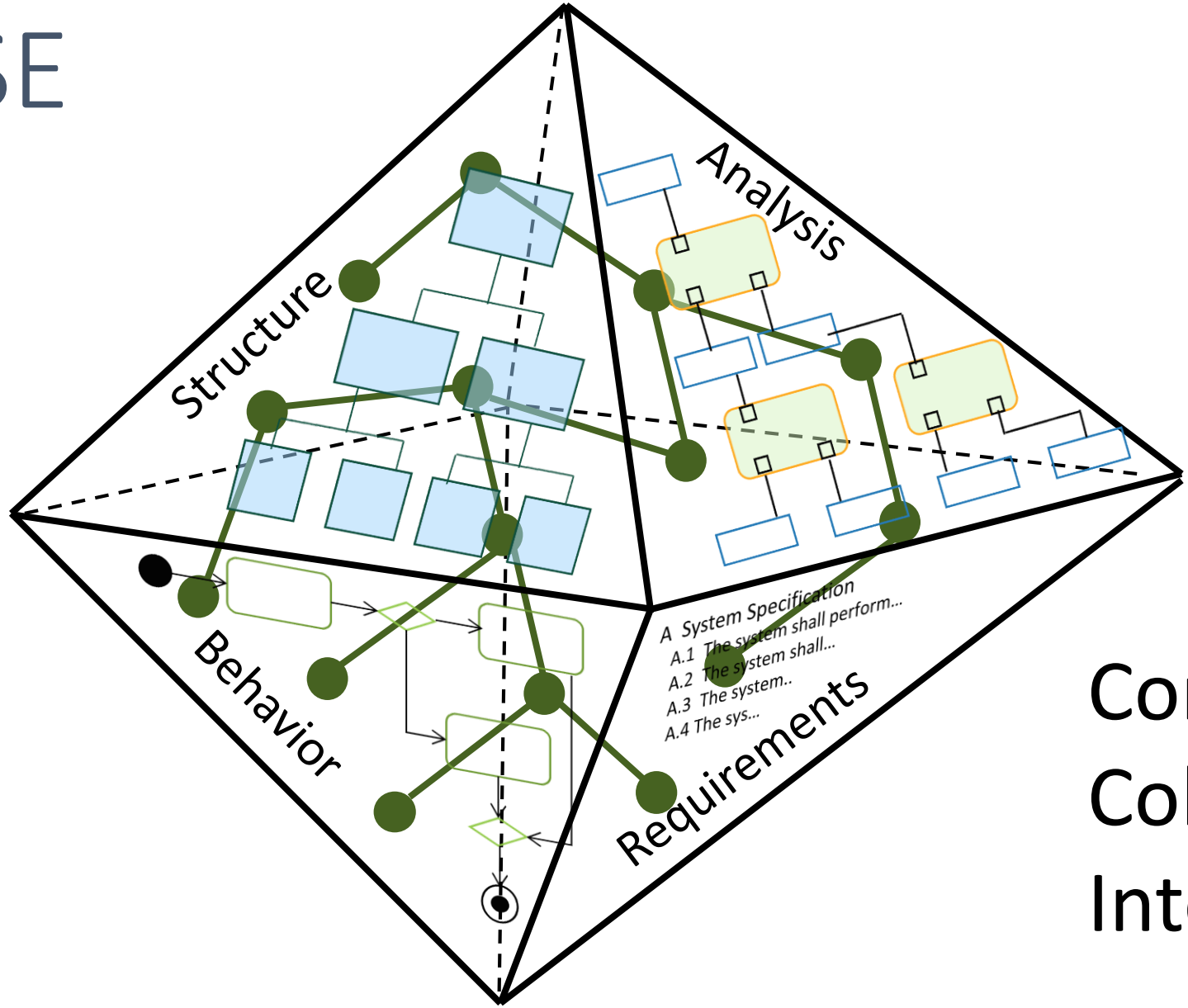


Reviews, Meetings, Administration

MBSE



MBSE



Consistency
Coherence
Integrity

Validation and Verification

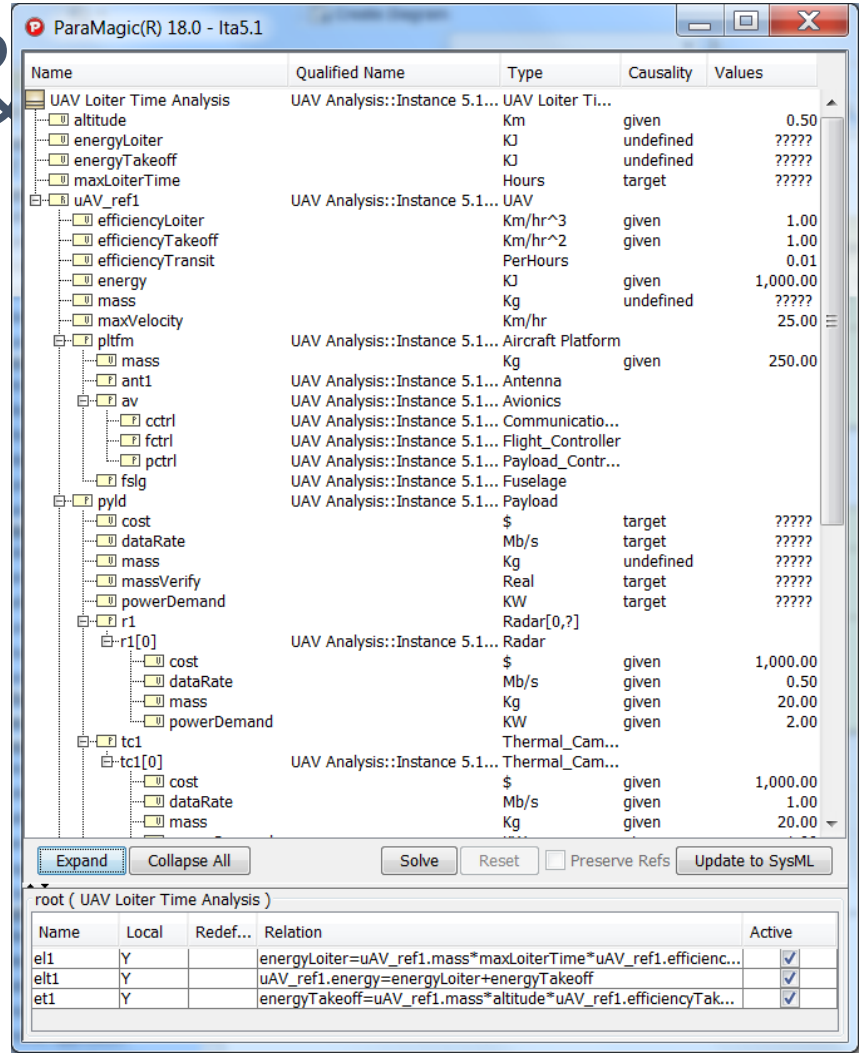
Validation – Is the system specification complete and consistent?
Verification – Will the system, as specified, meet requirements?

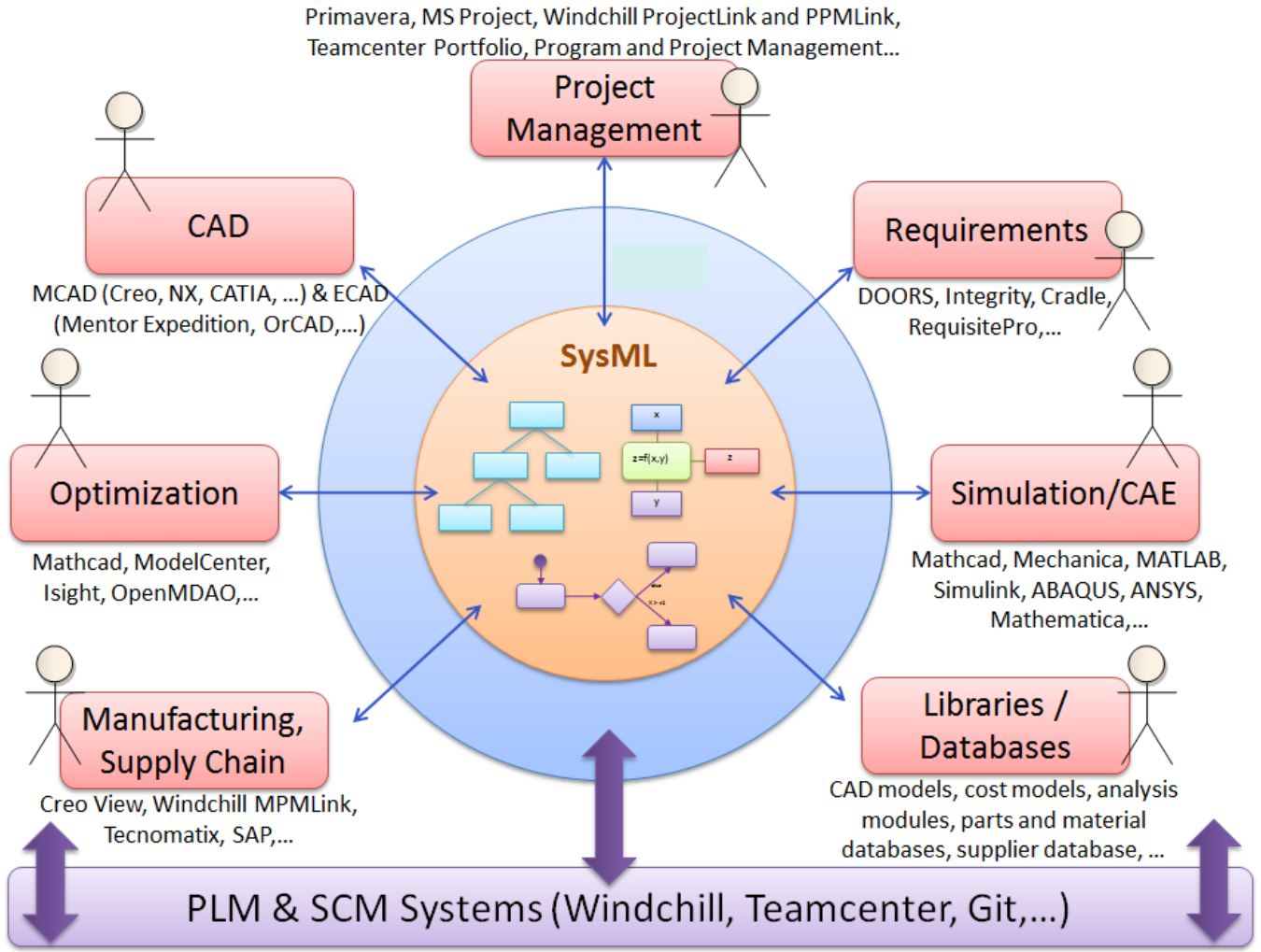
With MBSE

- Database organization and precise semantics of model elements allow for automated queries
- Models can be validated for completeness and consistency
- Model requirements can be verified by analysis of performance, reliability, cost, risk, …
- Trade studies, evaluation of variants and optimization can be supported.

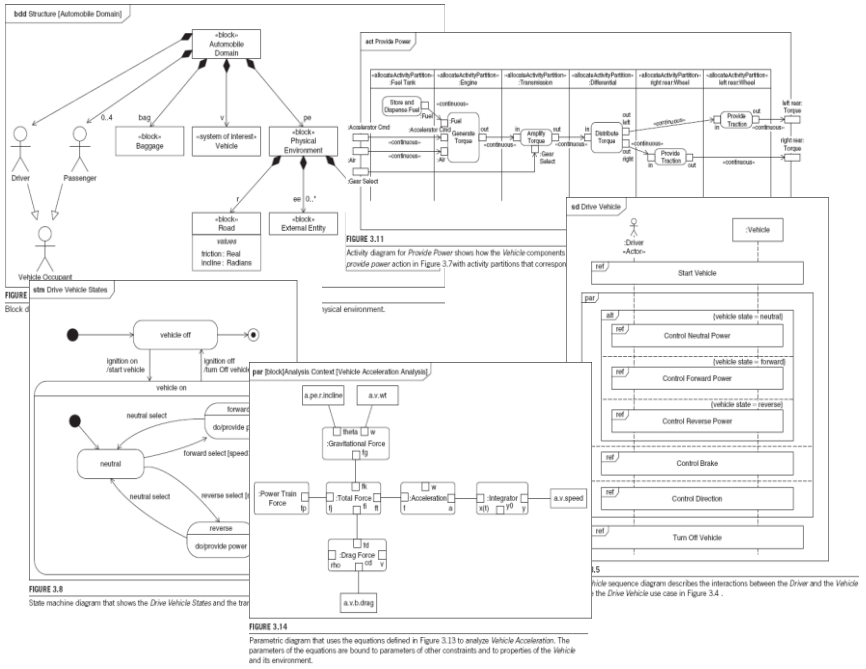
Model Execution

&





How to Implement MBSE

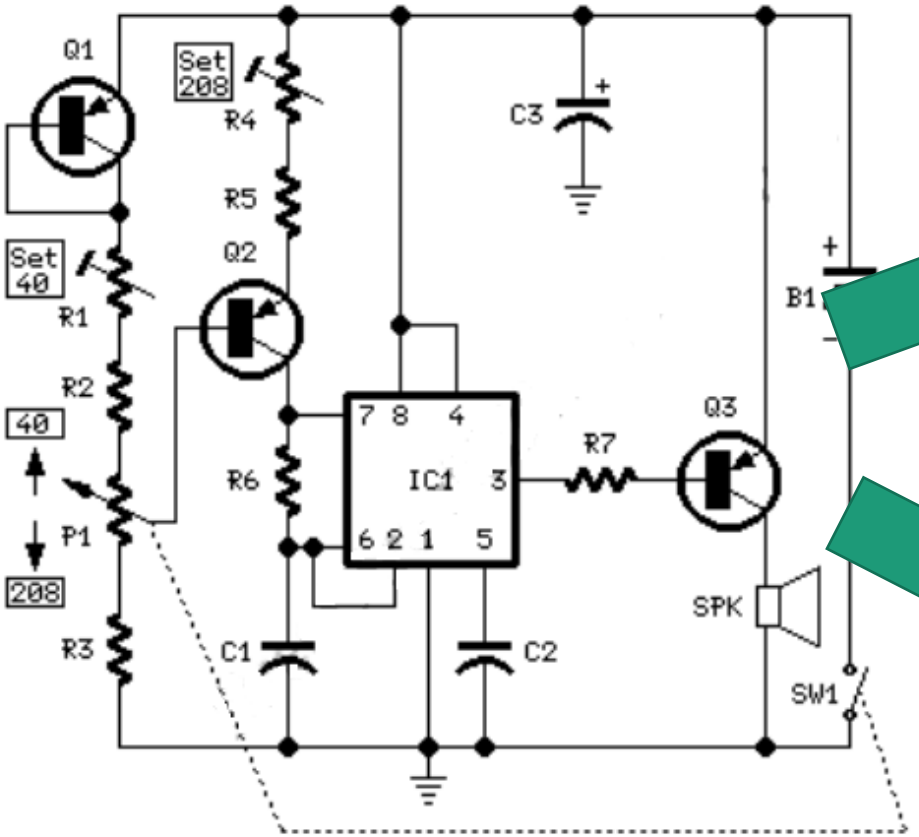


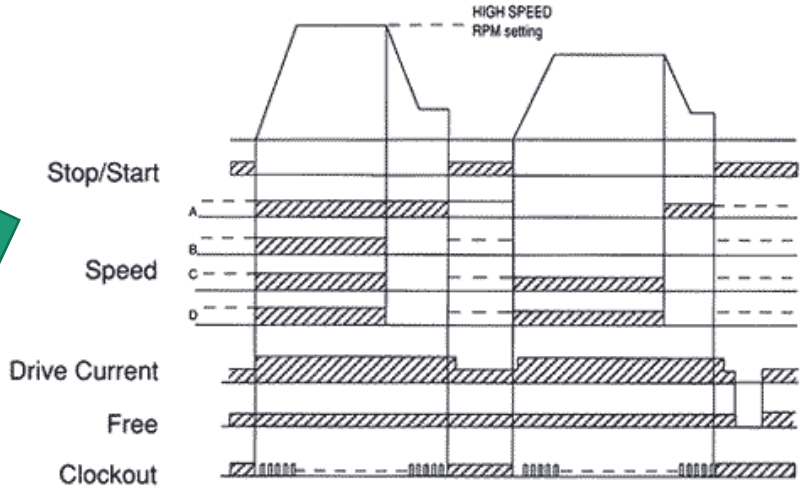
Intuitive

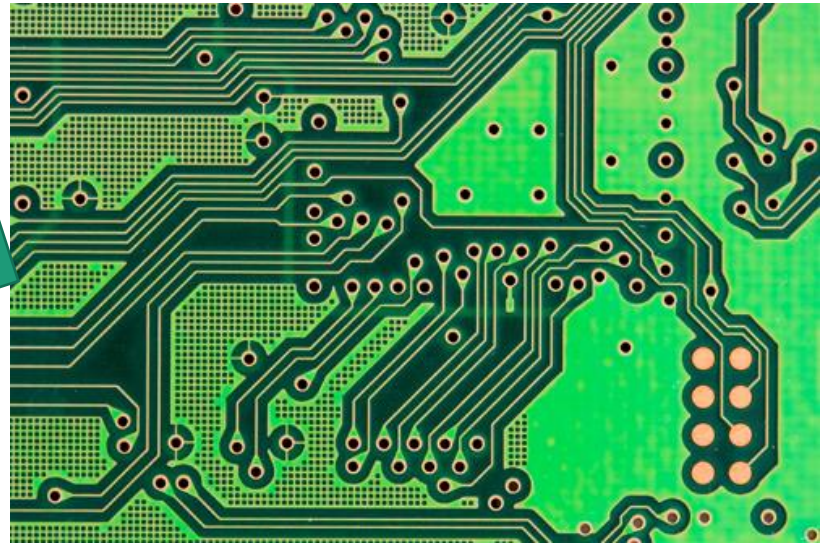
A Graphical Modeling Language

Analytical

How to Implement MBSE





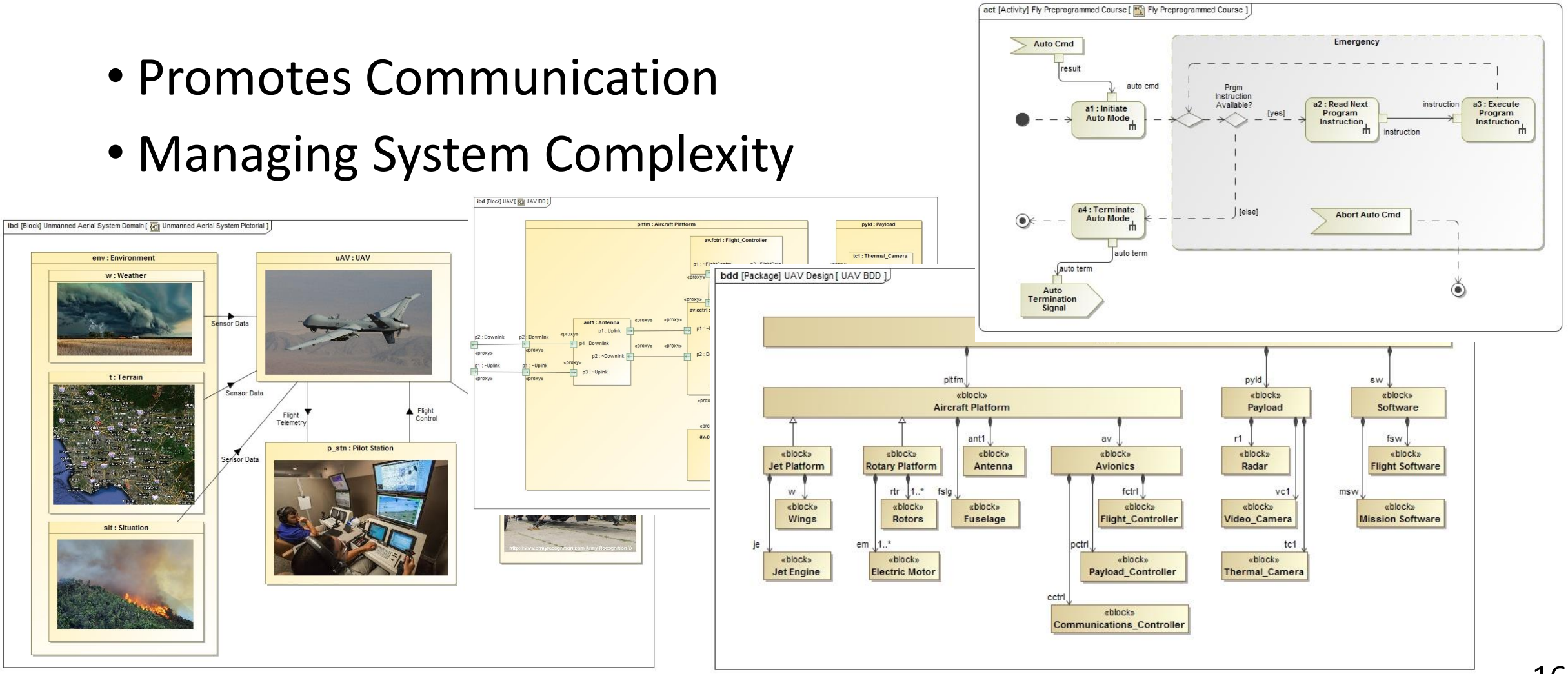


The Origins of SysML

- SysML Timeline
  - UML (Unified Modeling Language) c. 2000
  - UML for Systems Engineering RFP by OMG, INCOSE and ISO 10303 AP233
  - SysML 1.0 release Sept 2007
  - Multiple vendor support
  - OCSMP certification 2010
  - Gradual adoption, inflection point mid-2011
  - Academic and professional education opportunities, books
  - Multiple meeting presentations, success stories
  - SysML 1.5 release May 2017, SysML 2.0 RFP release January 2018

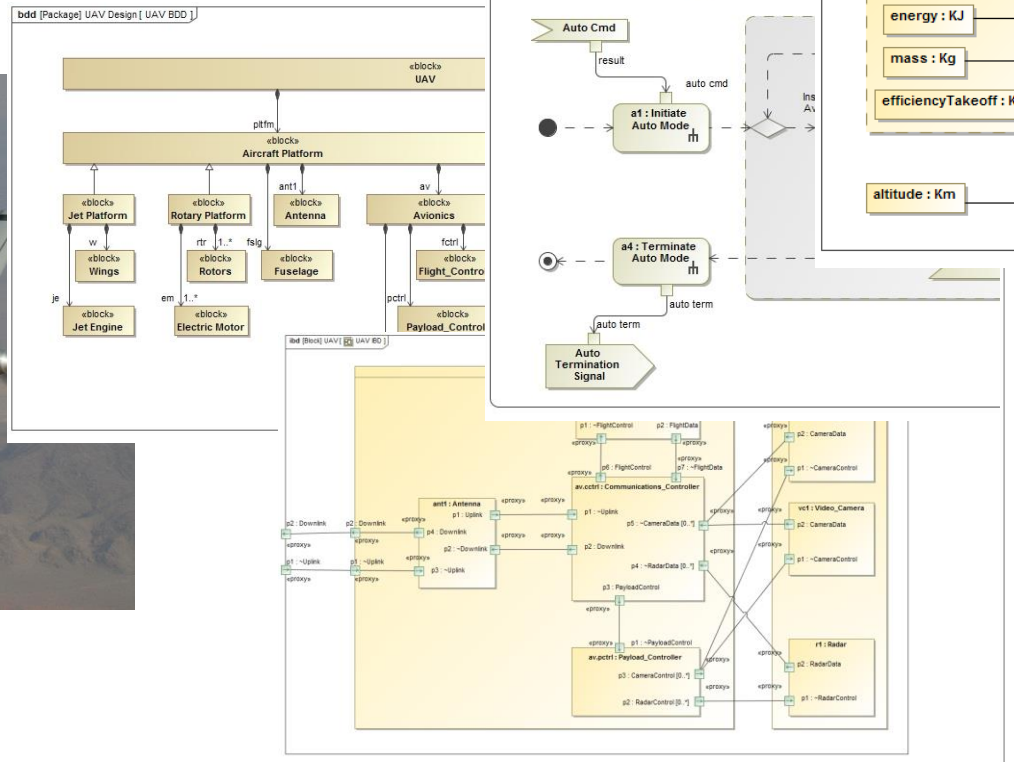
Reasons for SysML Success

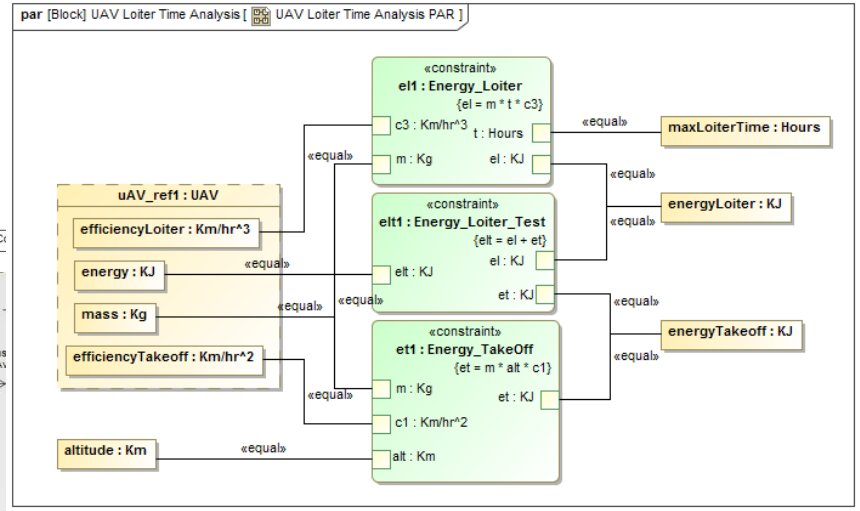
- Promotes Communication
- Managing System Complexity

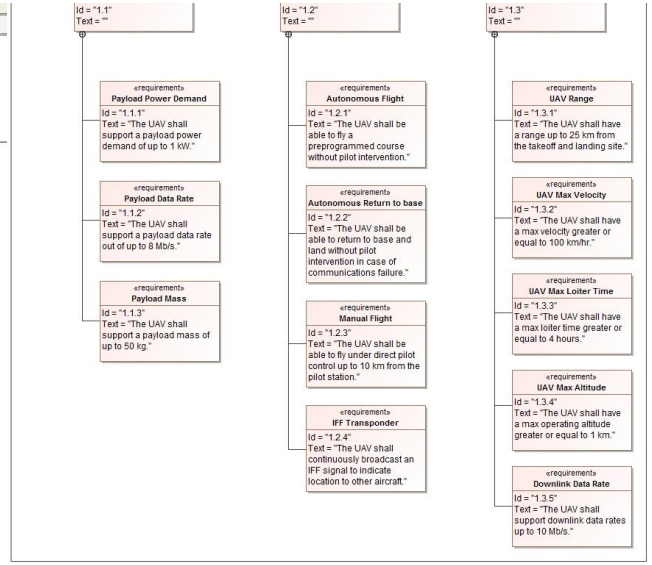


Reasons for SysML Success

- Knowledge Capture and Reuse







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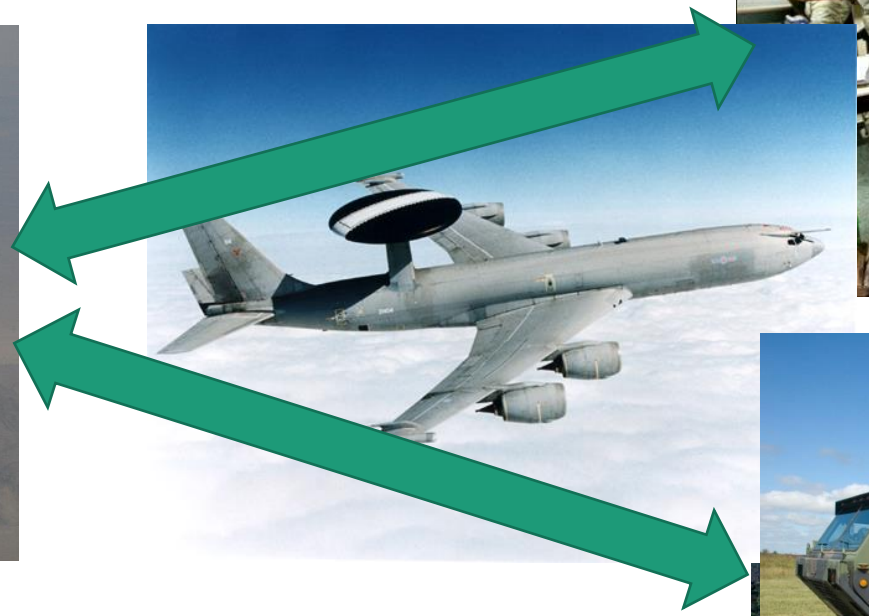


Benefits of SysML and MBSE

"documents kept consistent and up-to date"

"earlier detection of inconsistencies"

"accurate, efficient consistent communication"

"reuse of intellectual property"

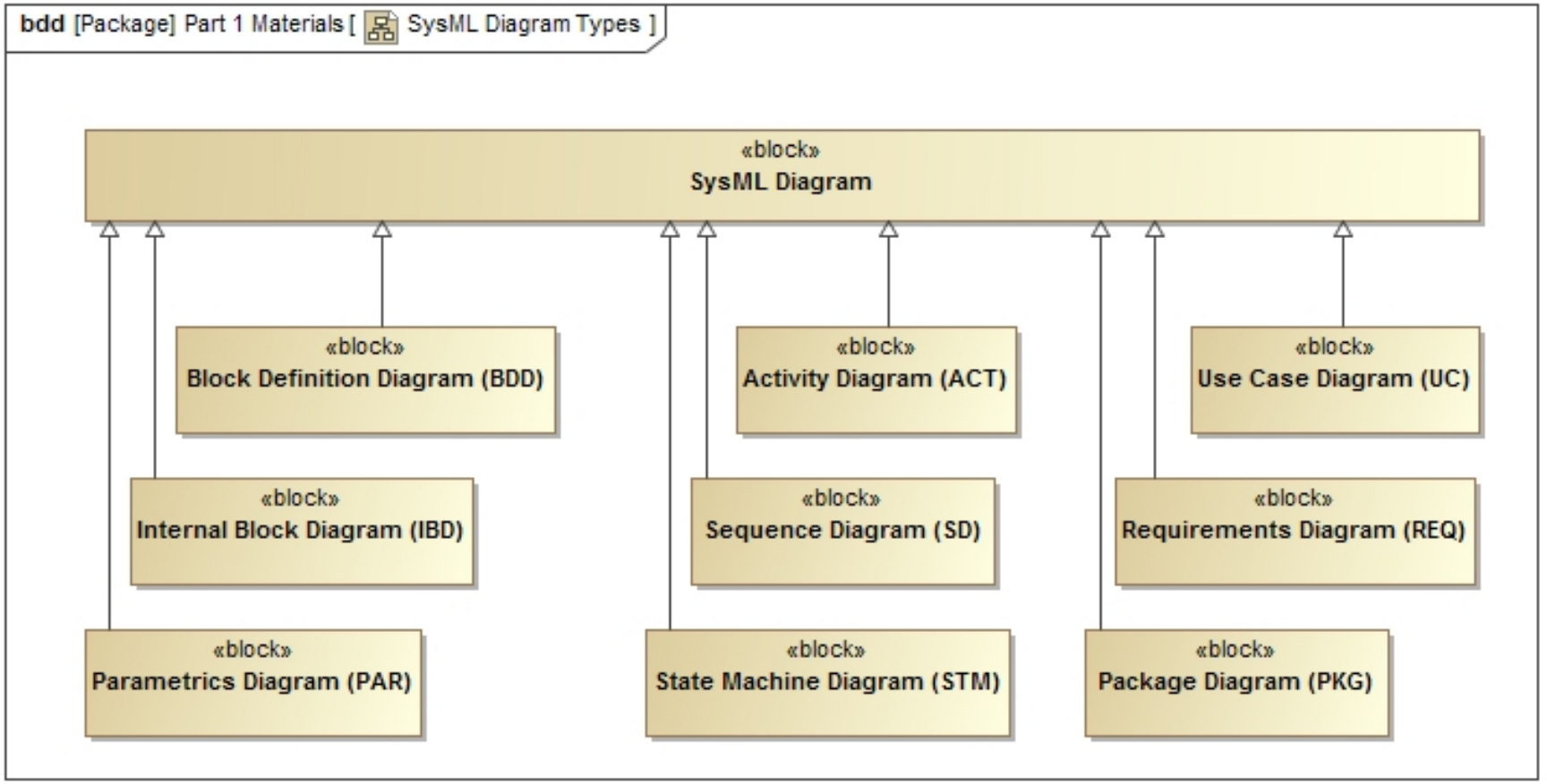
"more accurate budget and schedule forecasting"

"supports integration"

"ongoing reqts validation and design verification"

"attracts early career talent"

The Structure of SysML



SysML Diagram Header

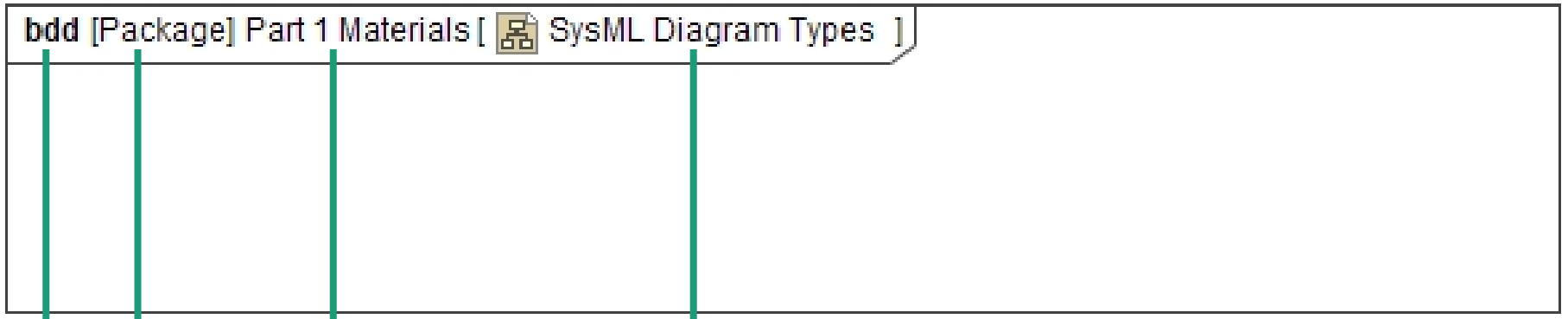


Diagram Type – what aspect of the model is being shown

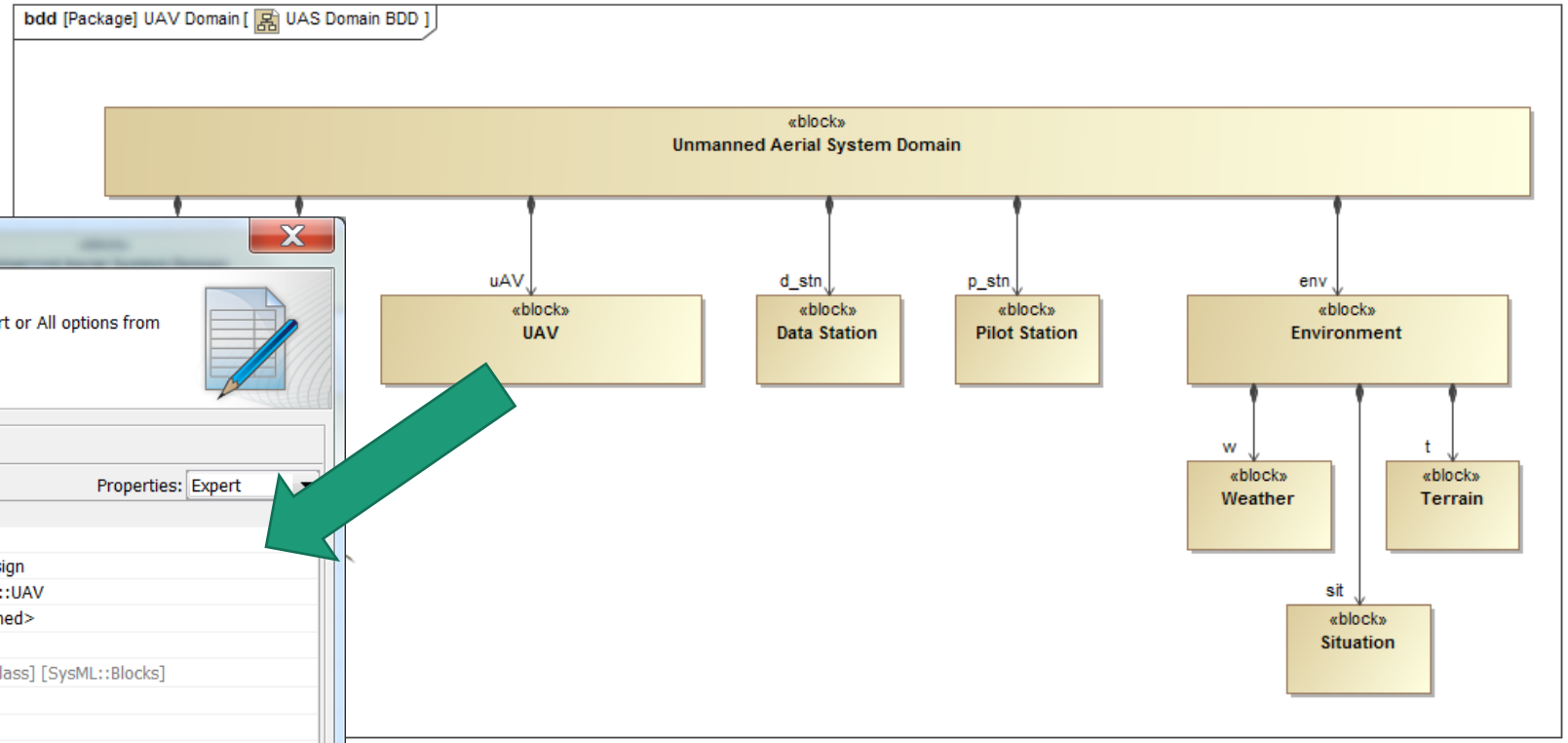
Owner Element Type

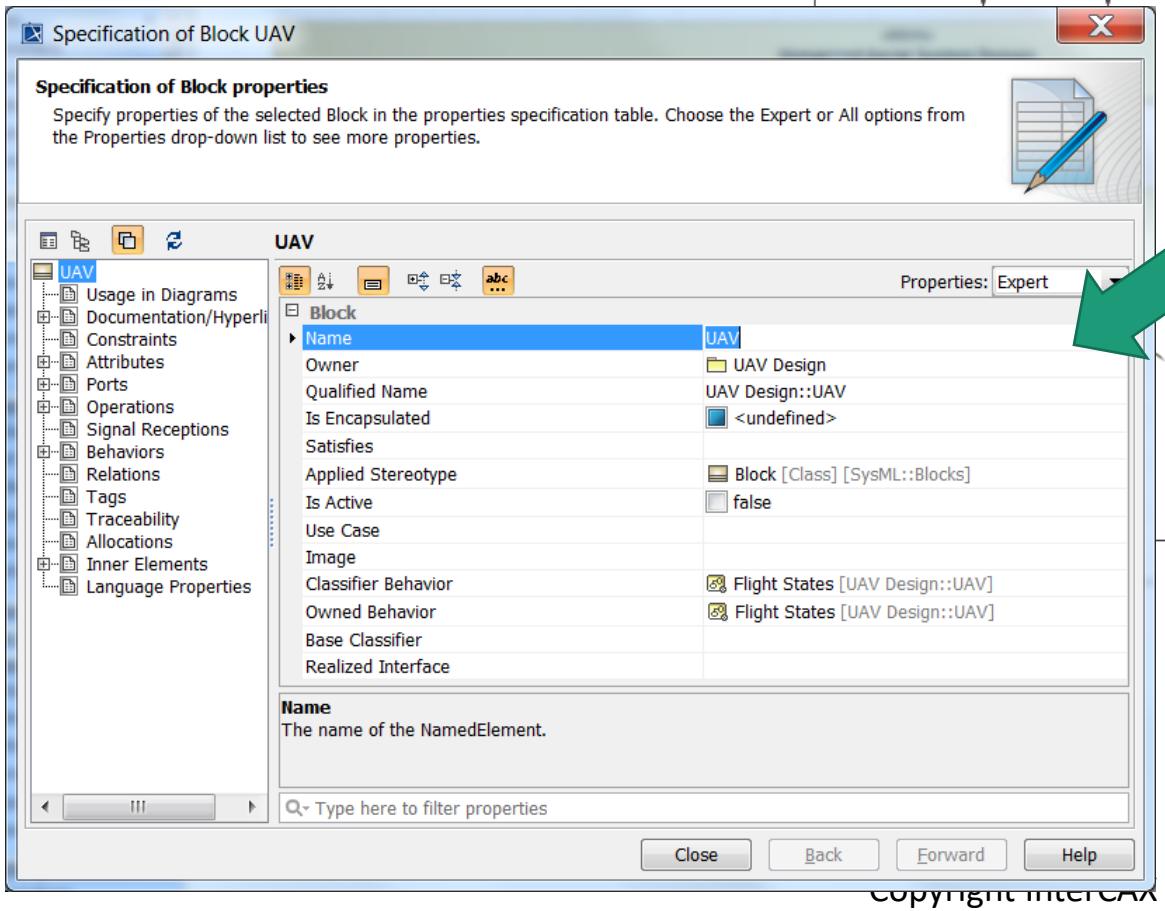
Owner Element Name

} What part of the model is being shown

Diagram Name

Drilling Down





Key Concepts

- The diagrams are not the model
- A diagram cannot show anything that is not in the model, but it need not show everything in the model
- Define once, use many times

More SysML Resources

- A Practical Guide to SysML, Third Edition: The Systems Modeling Language (The MK/OMG Press), Friedenthal, Moore, and Steiner (2014)
- SysML Distilled: A Brief Guide to the Systems Modeling Language, 1st edition (Addison Wesley Professional), Delligatti (2013)
- Systems Engineering with SysML/UML: Modeling, Analysis, Design (The MK/OMG Press), Wielkiens (2011)
- Software vendor tool documentation and websites
  - see especially Blogs and TechNotes at www.intercax.com, User Guide and Tutorials for ParaMagic (InterCAX LLC)
- http://www.omgsysml.org/– papers, vendor lists, committees and consortiums
- http://www.omg.org/spec/SysML/1.5/ - the official, complete SysML spec

Tool Familiarization

- Purpose – Provide a general orientation to the SysML Modeling Tool
- After completing this video (Part 1.0), go to
  - Video Part 1.1 Tool Familiarization
  - Starter Model Exercise 1.1 Tool Familiarization.mdzip
  - Exercise 1.1 Instructions.pdf

Recap

- At the end of the tool familiarization exercise, you should be able to
  - Start MagicDraw and open, save and close a project
  - Recognize terms for sections of the MagicDraw window: containment browser, diagram pane, diagram toolbar, floating toolbar, properties tab, specification window
  - Know the difference between an element and a symbol
  - Navigate between the containment browser and the diagram

Questions?

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