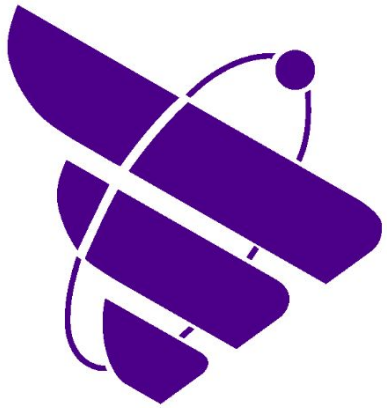
Demonstration of How to Use AI-Based Tools for Systems Engineers



CELEDON
SOLUTIONS

Presented by: Christopher Helmerich

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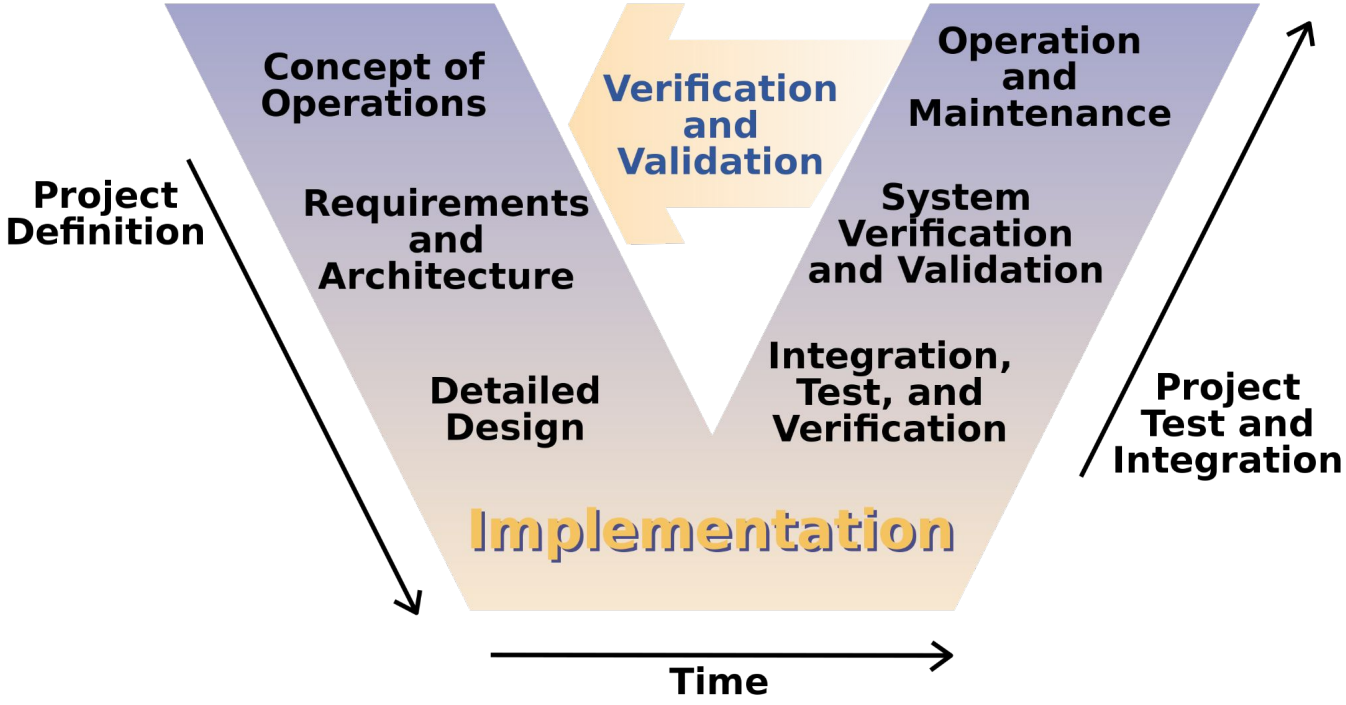
Engineering

What is engineering?

- Identify a goal/problem
- Define requirements
- Conduct research
- Propose solutions
- Make models or prototypes
- Test and refine solutions
- Implement the final product or process
- Monitor, sustain, and modify



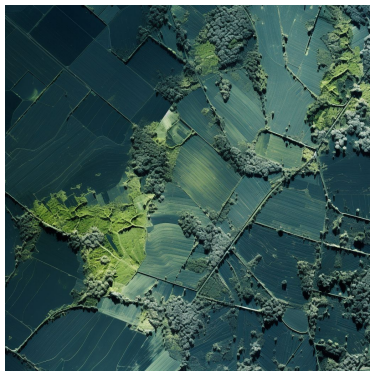
Artificial Intelligence (AI)

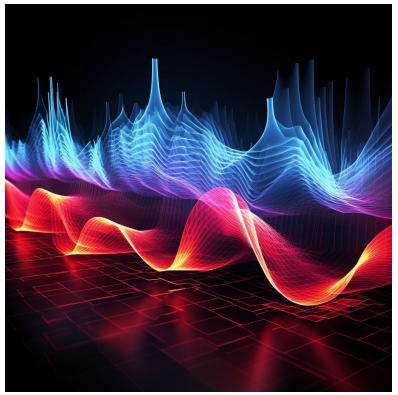
What is AI?

- Simulation of aspects of human intelligence in machines
- Enables:
  - Visual perception
  - Speech recognition
  - Text analysis
- Provides:
  - Image creation
  - Speech synthesis
  - Text generation

	Text	Images	Audio	Video	3D Objects
Classification	Sentiment Analysis	Medical, Agriculture, Satellite Imagery	Speech Recognition, Music ID	Activity Recognition	Medical, Autonomous Vehicles
Generation	ChatGPT, GitHub Copilot	DALLE 3, Midjourney	Siri, Meta Voicebox	Deep Dream, Video Colorization	CAD Optimization

Full Release **Rapid Development** **First Attempts**

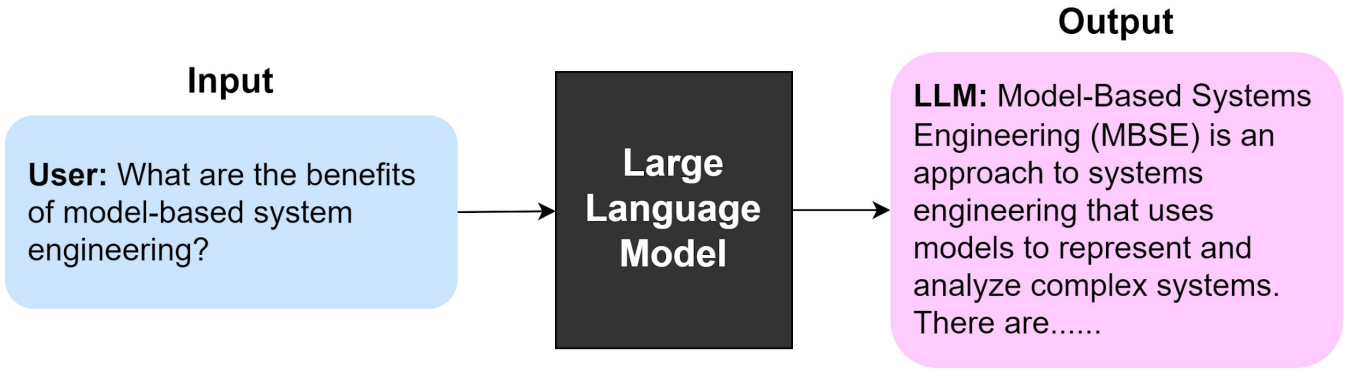




Large Language Models (LLMs)

What are LLMs?

- LLMs are AIs that generate output text from provided input text
- LLMs can answer questions, generate content, provide feedback, and write code
- LLMs are being integrated in many domains: Coding, Legal, Telemedicine, etc.
- Several available LLMs: GPT3.5, GPT4, Claude, LLaMA, BARD, PaLM, etc.



Adapted from: GPT-4 Technical Report, OpenAI, 2023

Test Evaluation	GPT-4 Score
SAT Evidence-Based Reading & Writing	710 / 800 (~93rd)
SAT Math	700 / 800 (~89th)
GRE Quantitative	163 / 170 (~80th)
GRE Verbal	169 / 170 (~99th)
AP Calculus BC	4 (71^{st} - 88^{th})
Leetcode* (easy)	76% (Human median = 67%)

**Interview programming questions*

The Coming Revolution in Engineering

Increasing reasoning and generation capabilities of AI implies a transition to higher level specification and validation by humans

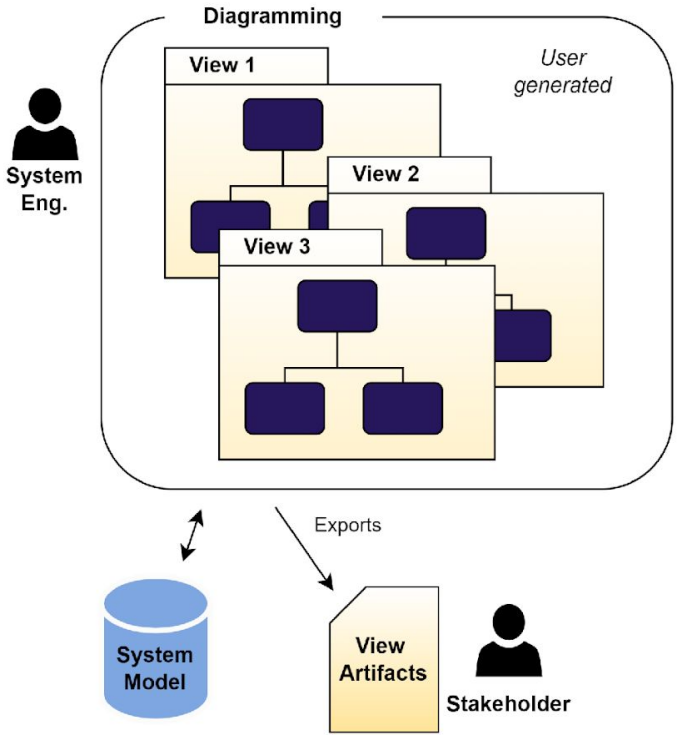
"You will tell it what to build, not how to build it."

Clear specification of goals and comprehensive validation of solutions will become increasingly important.

"The AI will ask you questions when making critical design choices"

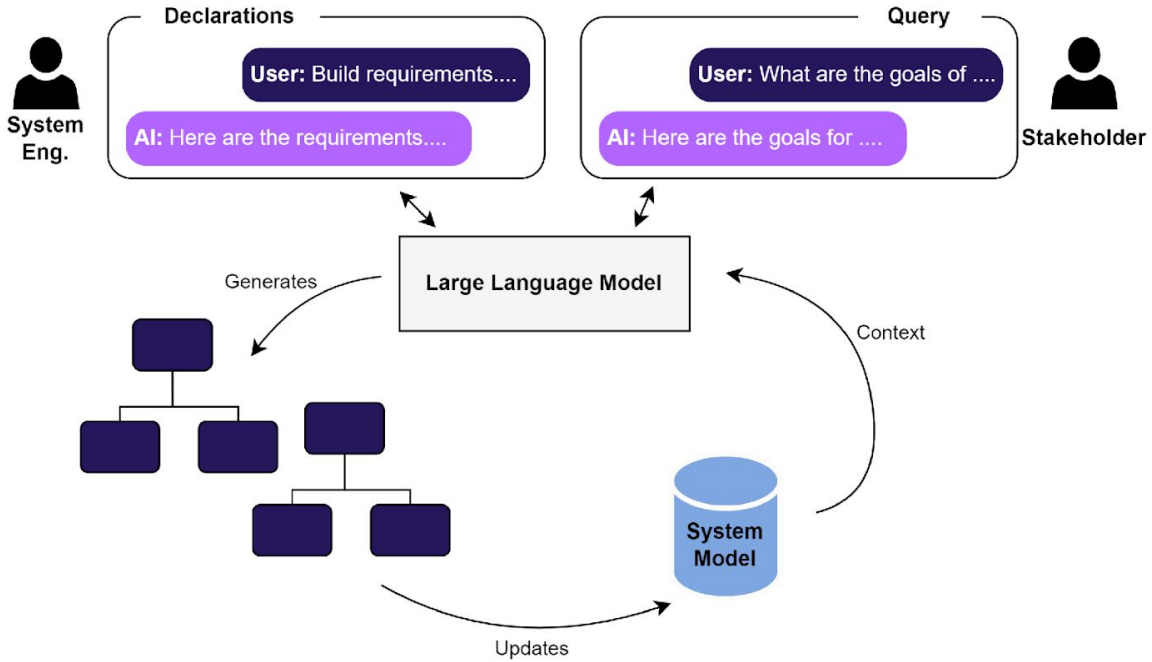
Declarative Modelling

Current Modeling Methods



- Manual methods focused on building diagrams using unintuitive applications
- Formally structured views and viewpoints

Davinci's AI Modeling Approach



- Automated method focused on declaring relations and objects in natural language with AI modeling them in SysML 2.0 textual syntax
- Dynamic query of information using the AI

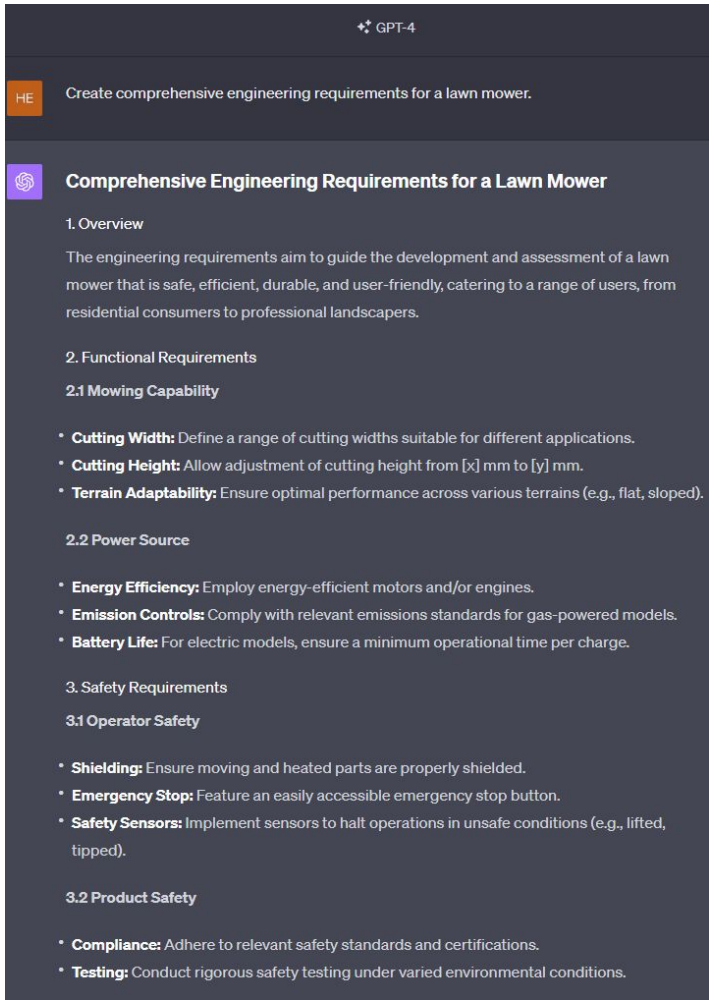
Baseline: Capabilities of ChatGPT Plus

Good at:

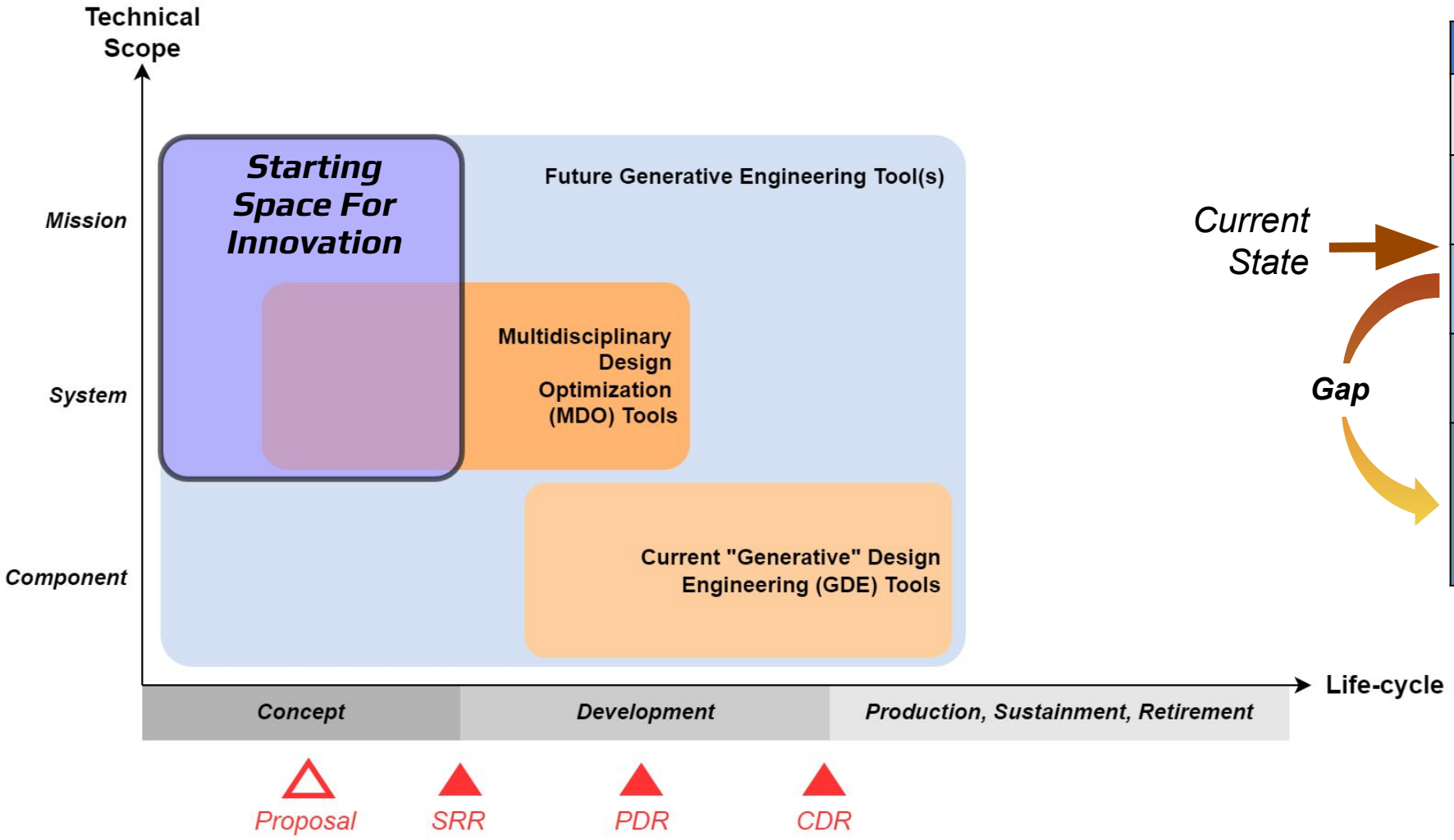
- Answering single step questions
- Summarizing information
- Generating paragraphs
- Understanding high-level scope in a complex system
- Understanding details in a simple system

Bad at:

- Step-by-step reasoning
- Complex problem solutions
- Generating 5+ page proposals/reports
- Parallel execution
- Running analysis
- Understanding details in a complex system



A New Modelling Paradigm

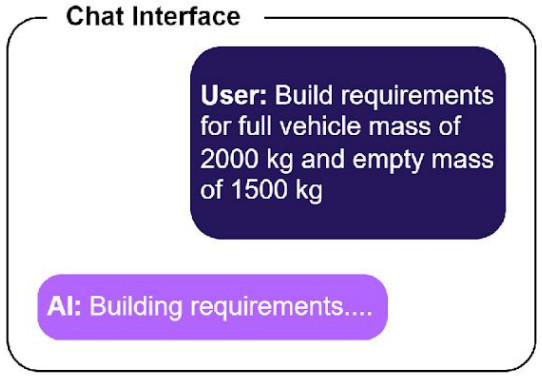


Maturation	
Level 1	Documents only
Level 2	Diagrams are added to documents
Level 3	Models are created owning part of the system information
Level 4	All SE processes are Model Based
Level 5	Holistic models are integrated in all aspects of architecture and design processes

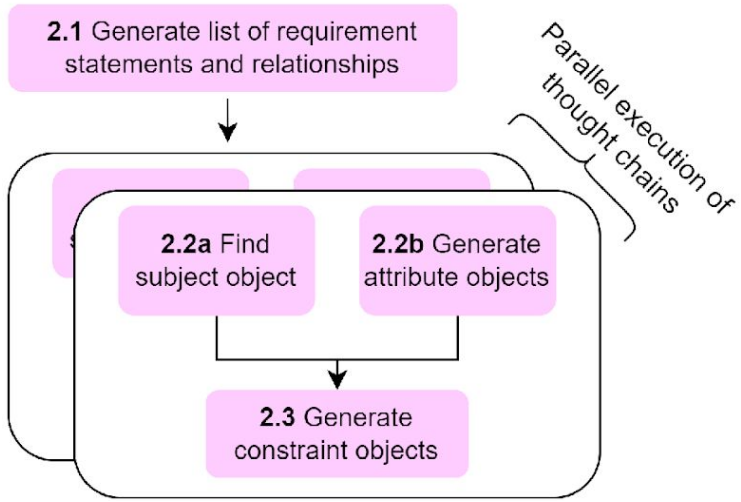
AI-Based Systems Engineering Tools (1/4)

AI-Based tools to speed up model creation.

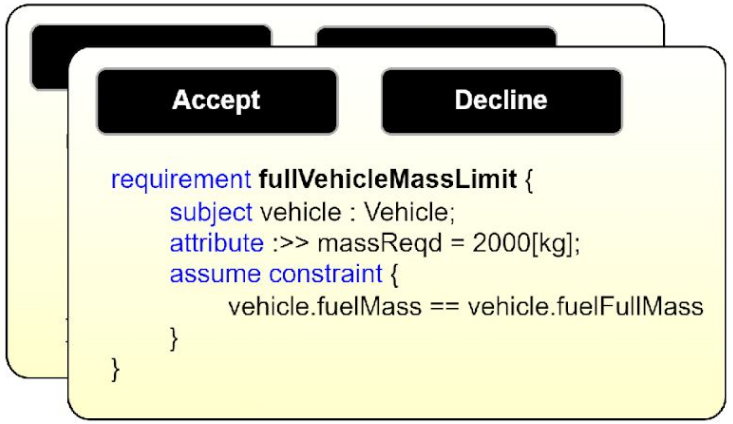
1 AI Prompting → 2 AI Model Representation → 3 User Review



- **Describe what you want in the model with natural language or provide entire technical documents**



- **AI generates connected model objects (~12 model objects / min)**



- **User selects objects to add into the model or requests more changes from the AI**

AI-Based Systems Engineering Tools (2/4)

Automated review of full models based on user criteria in a fraction of the time

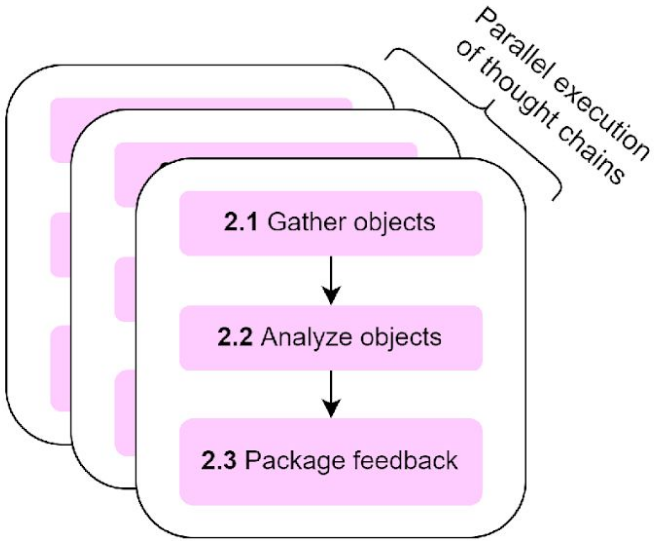
1 **Define Criteria** → 2 **AI Model Review** → 3 **Feedback**

Criteria A: The requirement description is in the form "product ABC shall XYZ."

Criteria B: Attributes have assigned performance values and linked with constraints.

Criteria C: Attributes and constraints are aligned with the requirement description

- **Describe the criteria of the review as content or model focused**



- **AI cross-reviews objects based on criteria (~30 objects / min)**

Object	Feedback	Pass / Fail
vehicleMassRequirement	The object addresses the criteria.	PASS
vehicleRangeRequirement	The requirement statement does not use "shall".	FAIL
vehicleMileageRequirement	Attribute of "mpg" does not have a value assigned.	FAIL

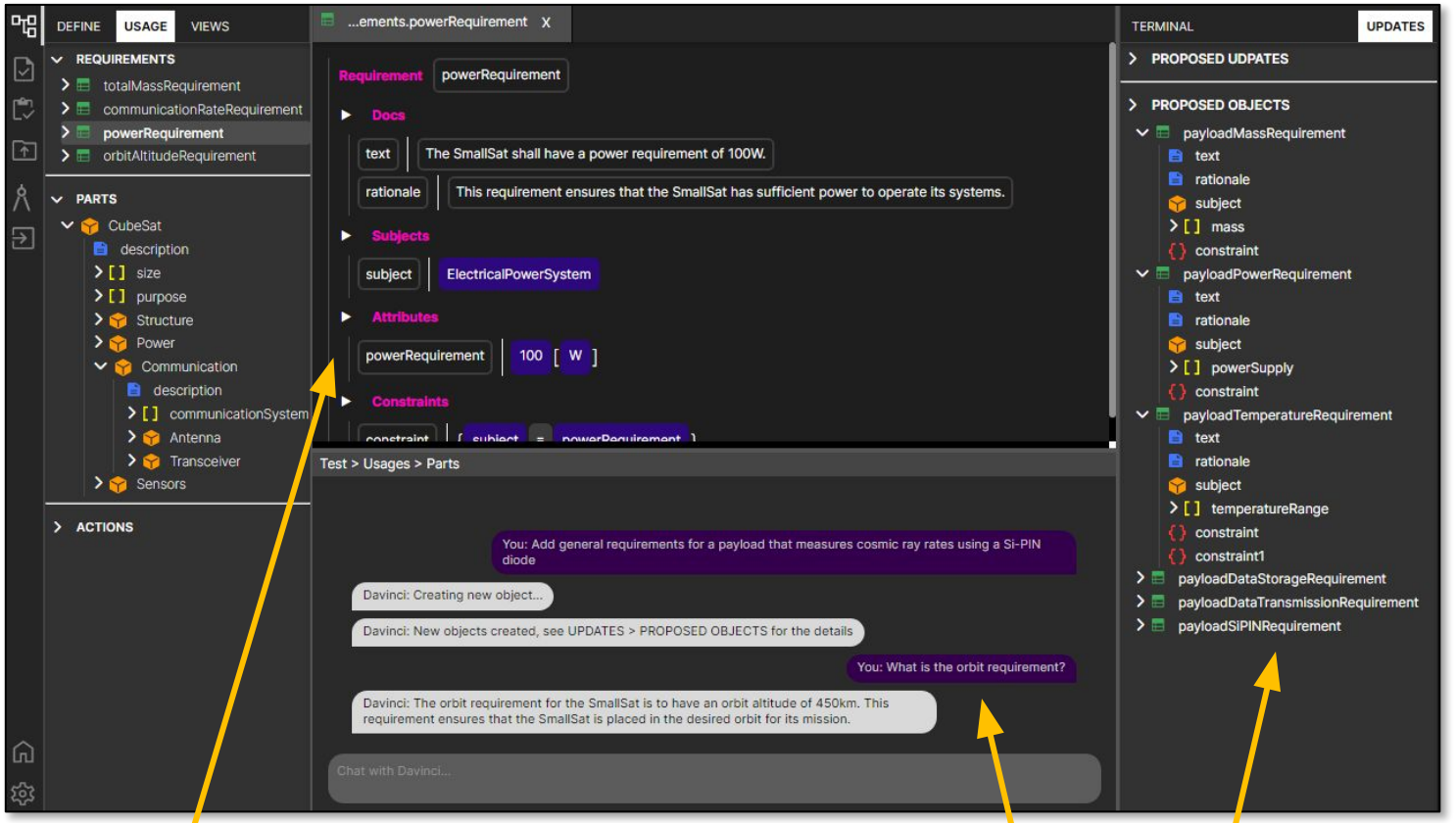
- **Can directly send generated reviews back to the AI to automatically fix issues**

AI-Based Systems Engineering Tools (3/4)

AI systems modeling solutions:

- Provides traditional MBSE capability paired with an LLM
- Automated modeling from natural language prompts
- Automated review and verification of system models
- Automated document to model representation

Davinci Systems Modelling Tool - In development



Traditional model view & editing interface

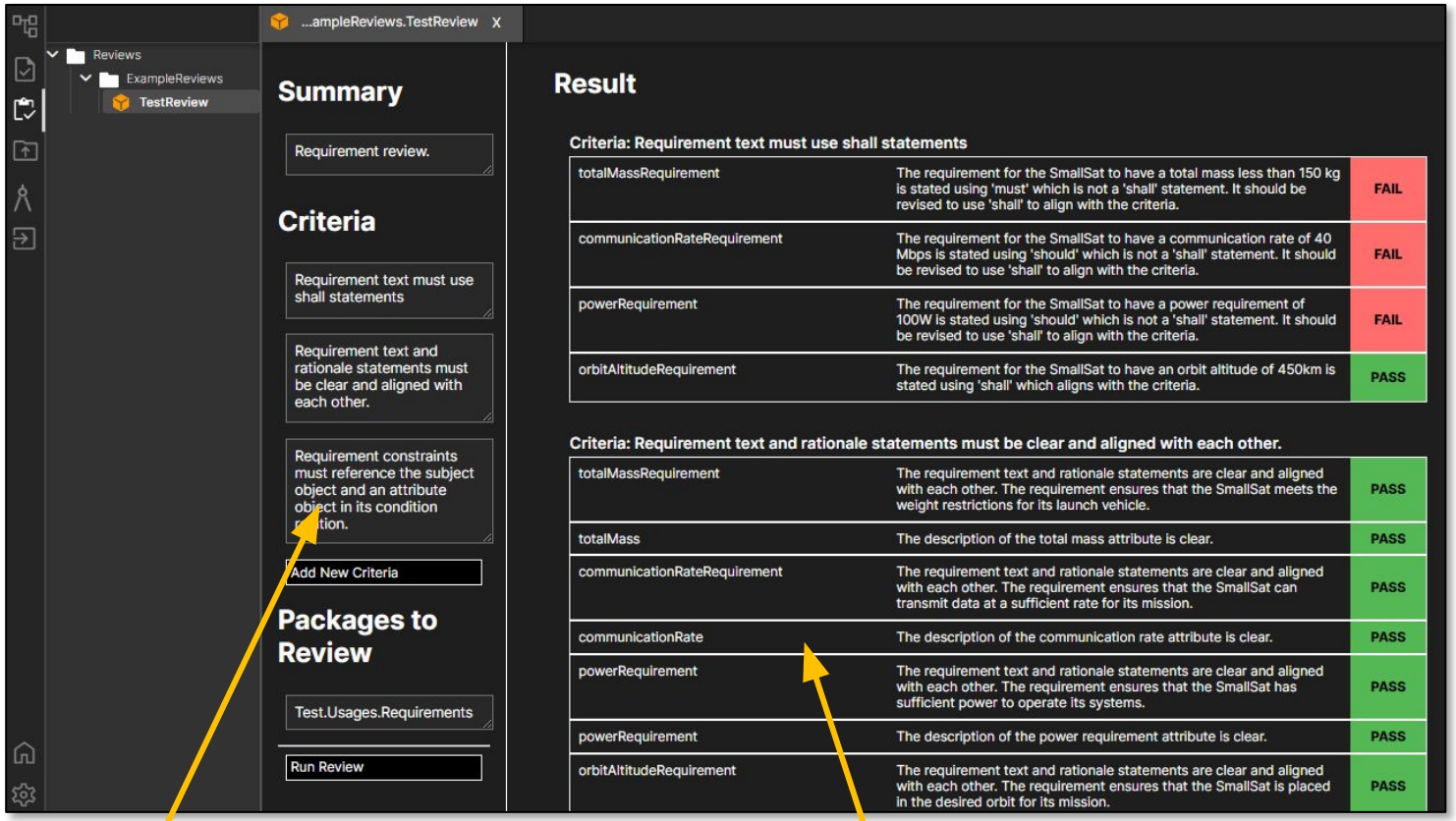
Chat interface with AI system and change approval

AI-Based Systems Engineering Tools (4/4)

Uses AI and MBSE:

- Chain of thought reasoning to execute steps when generating objects
- Generates and reviews multiple objects simultaneously with parallel LLM requests
- Vectorization methods to quickly gather model objects for LLM context
- Built upon the latest system modeling language: *SysML 2.0*

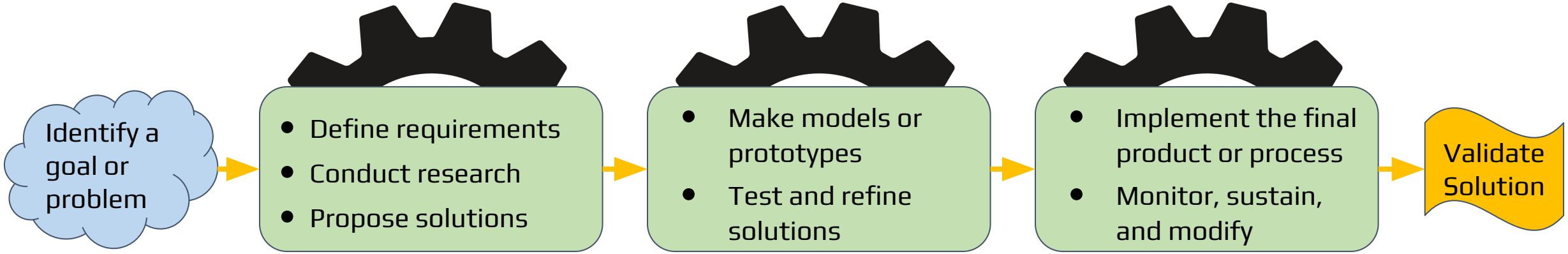
Davinci Systems Modelling Tool - In development



Provided review criteria

AI content review with summaries and evaluations

The Road Ahead



More and more subject matter experts will have to act as systems engineers

Systems engineering will become increasingly important in both the short term and long term even as its processes become automated

"The need for 'systems thinking' will grow."