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



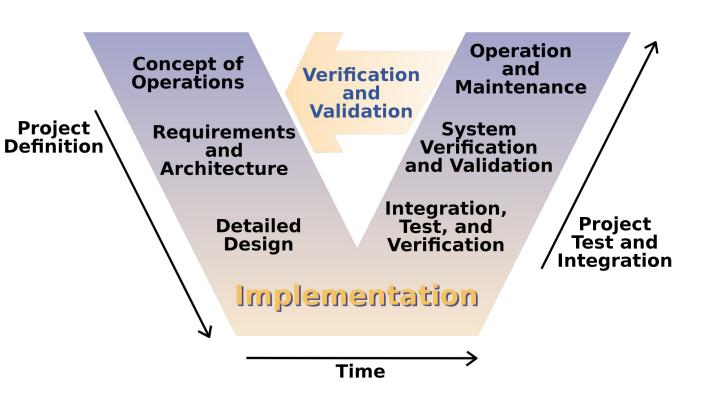
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Engineering

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?

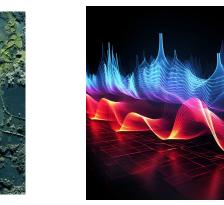
- Simulation of aspects of human intelligence in machines
- Enables: •
 - Visual perception Ο
 - Speech recognition Ο
 - Text analysis Ο
- Provides:
 - Image creation 0
 - Speech synthesis Ο
 - Text generation Ο





	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	First A	Attempts			





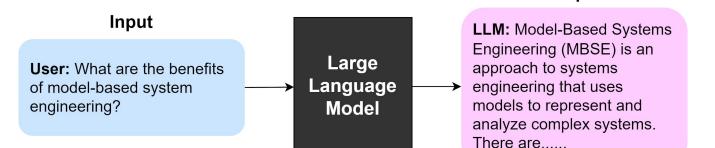




Large Language Models (LLMs)

What are LLMs?

- LLMs are Als 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, OpenAl, 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	

*Interview programming questions



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Output

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."

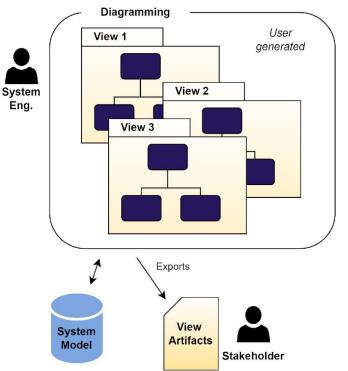
Clear specification of goals and comprehensive validation of solutions will become increasingly important.

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



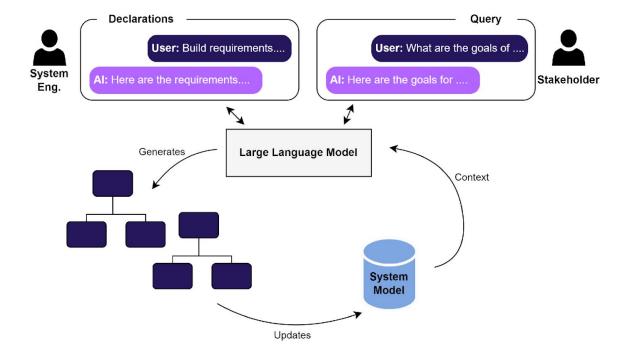
Declarative Modelling

Current Modeling Methods



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

Davinci's Al 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

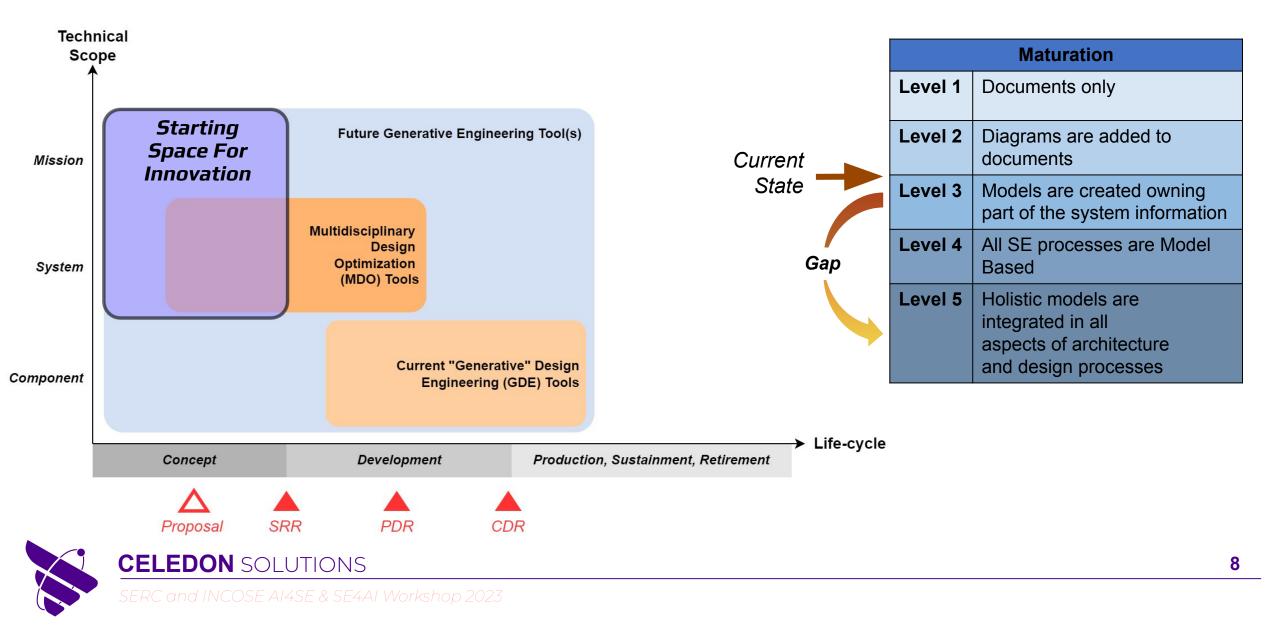
Bad at:

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

** GPT-4
Create comprehensive engineering requirements for a lawn mower.
Comprehensive Engineering Requirements for a Lawn Mower
1. Overview
The engineering requirements aim to guide the development and assessment of a lawn mower that is safe, efficient, durable, and user-friendly, catering to a range of users, from
residential consumers to professional landscapers.
2. Functional Requirements
2.1 Mowing Capability
Cutting Width: Define a range of cutting widths suitable for different applications.
• Cutting Height: Allow adjustment of cutting height from [x] mm to [y] mm.
• Terrain Adaptability: Ensure optimal performance across various terrains (e.g., flat, sloped).
2.2 Power Source
Energy Efficiency: Employ energy-efficient motors and/or engines.
• Emission Controls: Comply with relevant emissions standards for gas-powered models.
Battery Life: For electric models, ensure a minimum operational time per charge.
3. Safety Requirements
3.1 Operator Safety
Shielding: Ensure moving and heated parts are properly shielded.
• Emergency Stop: Feature an easily accessible emergency stop button.
 Safety Sensors: Implement sensors to halt operations in unsafe conditions (e.g., lifted, tipped).
3.2 Product Safety
Compliance: Adhere to relevant safety standards and certifications.
• Testing: Conduct rigorous safety testing under varied environmental conditions.

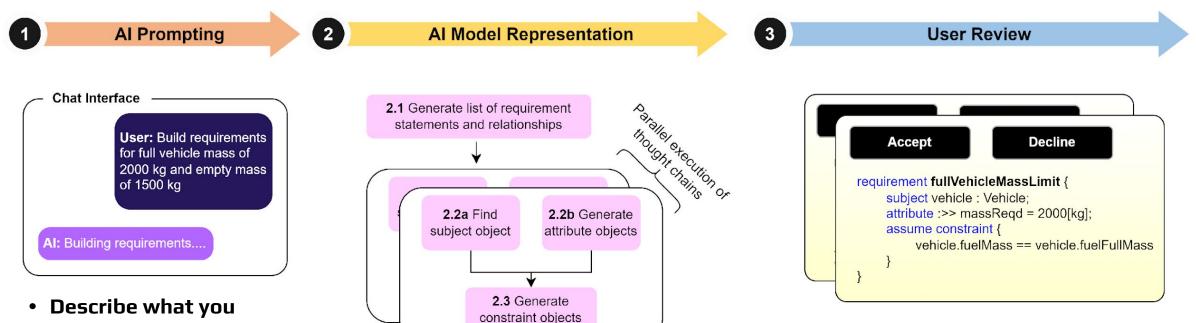


A New Modelling Paradigm



AI-Based Systems Engineering Tools (1/4)

AI-Based tools to speed up model creation.



AI generates connected model

objects (~12 model objects / min)

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

want in the model

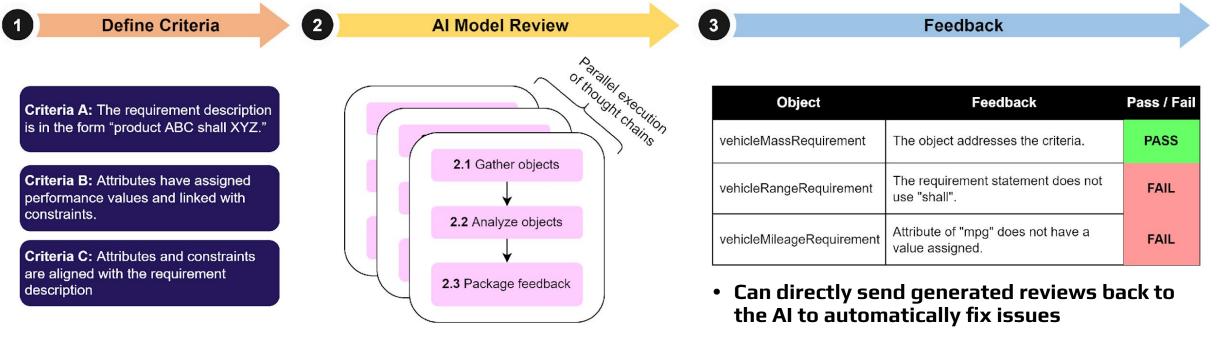
or provide entire

with natural language

technical documents

AI-Based Systems Engineering Tools (2/4)

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



 Describe the criteria of the review as content or model focused

• Al cross-reviews objects based on criteria (~30 objects / min)

10

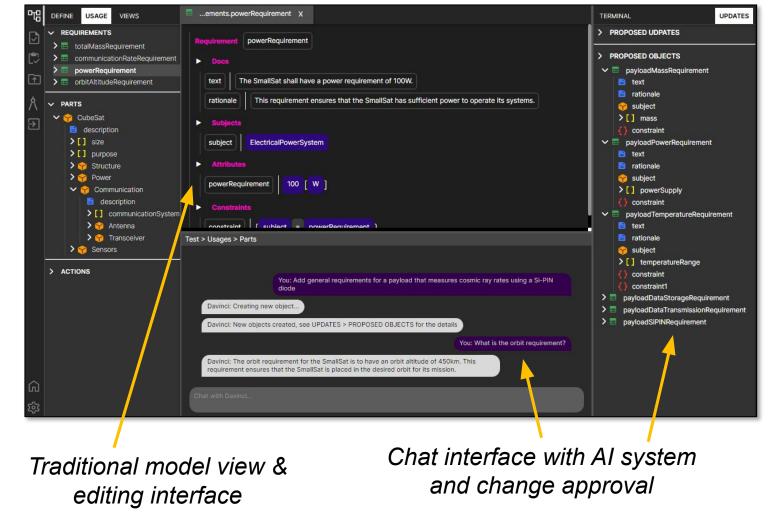
AI-Based Systems Engineering Tools (3/4)

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

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Davinci Systems Modelling Tool - In development





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Al-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*

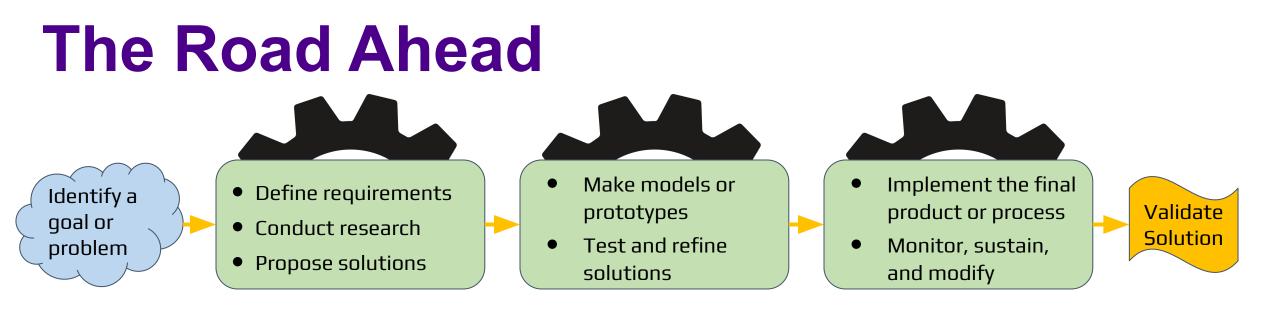
CELEDON SOLUTIONS

Davinci Systems Modelling Tool - In development ...ampleReviews.TestReview > Reviews ExampleReviews Result Summary Y TestReview Criteria: Requirement text must use shall statements Requirement review. totalMassRequirement The requirement for the SmallSat to have a total mass less than 150 kg FAIL is stated using 'must' which is not a 'shall' statement. It should be revised to use 'shall' to align with the criteria. Criteria communicationRateRequirement The requirement for the SmallSat to have a communication rate of 40 Mbps is stated using 'should' which is not a 'shall' statement. It should FAIL be revised to use 'shall' to align with the criteria. Requirement text must use shall statements powerRequirement The requirement for the SmallSat to have a power requirement of 100W is stated using 'should' which is not a 'shall' statement. It should FAIL be revised to use 'shall' to align with the criteria. Requirement text and rationale statements must orbitAltitudeRequirement The requirement for the SmallSat to have an orbit altitude of 450km is PASS be clear and aligned with stated using 'shall' which aligns with the criteria. each other. Criteria: Requirement text and rationale statements must be clear and aligned with each other. Requirement constraints must reference the subject totalMassRequirement The requirement text and rationale statements are clear and aligned PASS object and an attribute with each other. The requirement ensures that the SmallSat meets the object in its condition weight restrictions for its launch vehicle. tion totalMass The description of the total mass attribute is clear. PASS Add New Criteria communicationRateRequirement The requirement text and rationale statements are clear and aligned PASS with each other. The requirement ensures that the SmallSat can transmit data at a sufficient rate for its mission Packages to PASS communicationRate The description of the communication rate attribute is clear. Review powerRequirement The requirement text and rationale statements are clear and aligned PASS with each other. The requirement ensures that the SmallSat has sufficient power to operate its systems Test.Usages.Requirements PASS powerRequirement The description of the power requirement attribute is clear. **Run Review** orbitAltitudeRequirement The requirement text and rationale statements are clear and aligned with each other. The requirement ensures that the SmallSat is placed PASS in the desired orbit for its mission.

Provided review criteria

Al content review with summaries and evaluations





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."

