



**34<sup>th</sup>** Annual **INCOSE**  
international symposium

hybrid event

Dublin, Ireland  
July 2 - 6, 2024



William Barnum, Dr. William Fisher, Dr. Mark Winstead, & Dr. Stephen Walsh  
The MITRE Corporation

# A Classical Modernization of the V-Model

Copyright © 2024 by The MITRE Corporation. ALL RIGHTS RESERVED.

Approved for Public Release. Distribution Unlimited. Public Release Number 23-03688-8.

Permission granted to INCOSE to publish and use.

2-6 July 2024

[www.incose.org/symp2024](http://www.incose.org/symp2024) #INCOSEIS

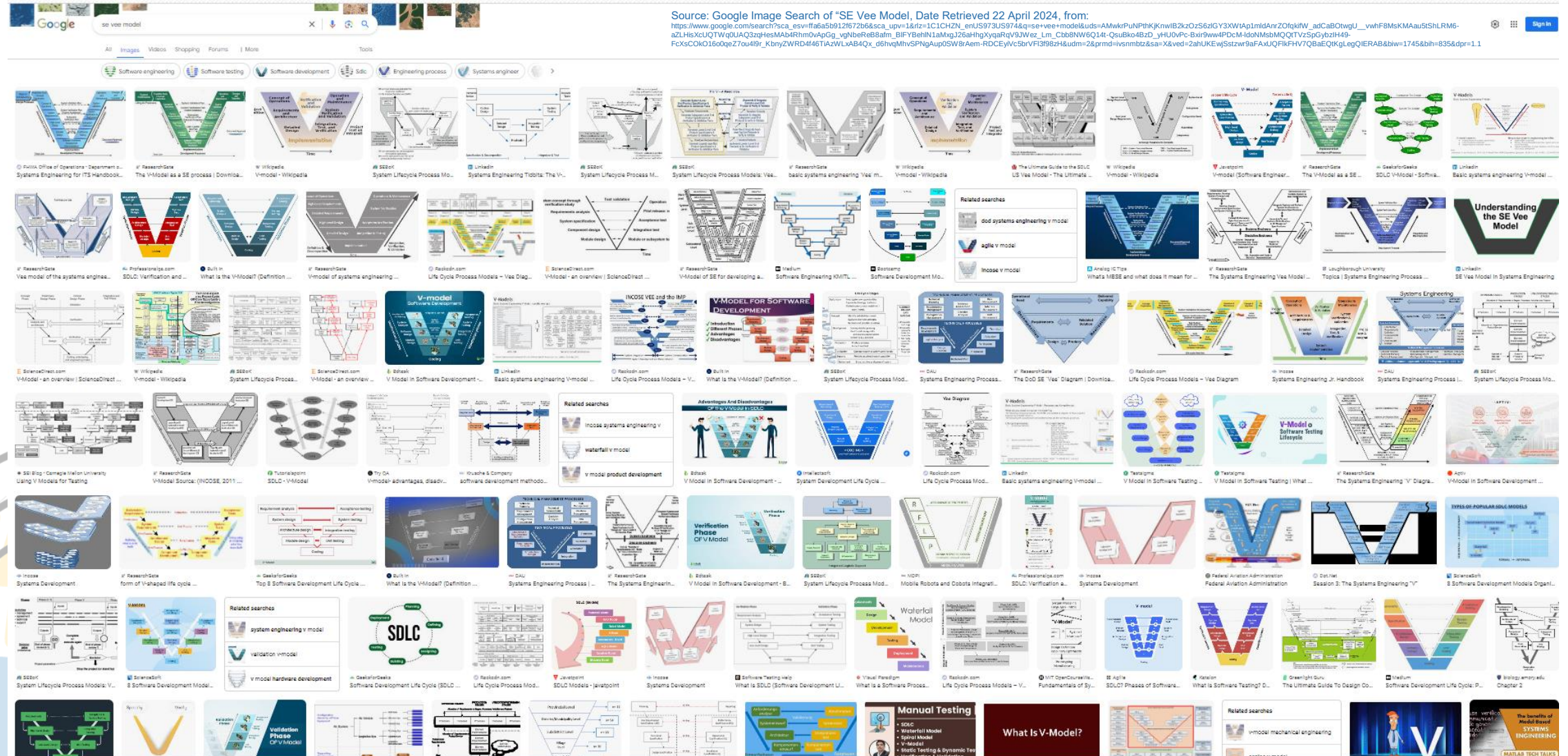
# History of the SE “Vee Model”

- The "Vee" model was meant to organize the basic systems engineering processes. Forms of it were around in the 1960s, though no clear citations.
  - First published in 1979 by Barry Boehm, but he cites it as in personal communications from J.B Munson in 1977
- Original intent was a logical model, not time nor maturity sequence
  - Not intended as a development process description
  - Meant to capture the multi-level nature of systems, with refinement to system elements as you go down (left side) and integration of elements to composite elements, subsystems, and then system(s) (right side)

Ref: Weilkiens, T., Lamm, J. G., Roth, S., & Walker, M. (2016).

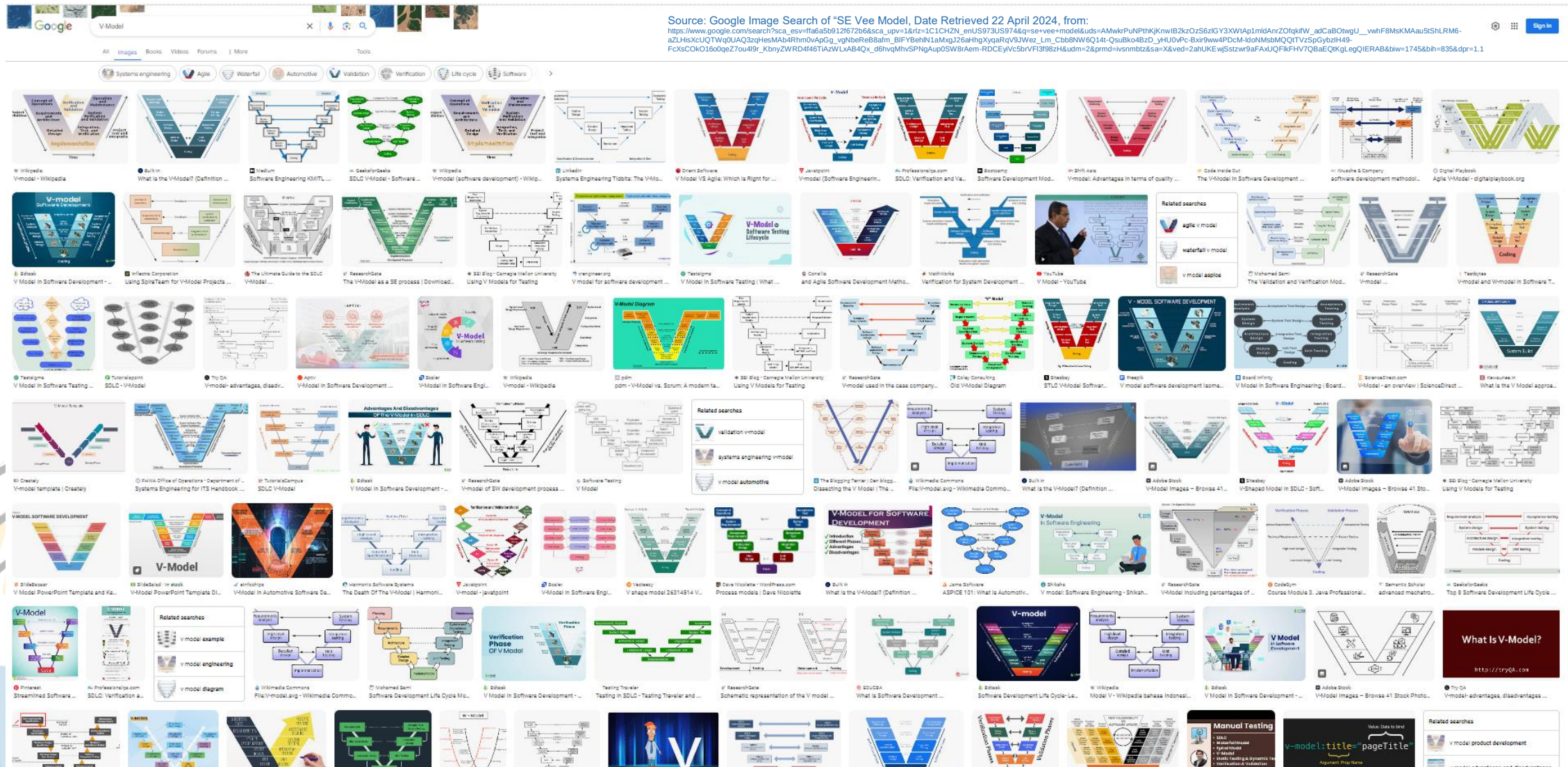


# Which “Vee Model”?





# How about the “V-Model”?



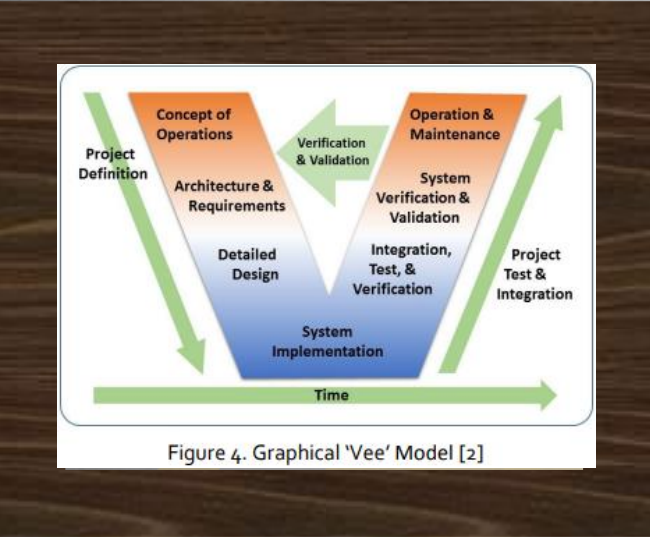
2-6 July 2024

[www.incose.org/symp2024](http://www.incose.org/symp2024) #INCOSSEIS



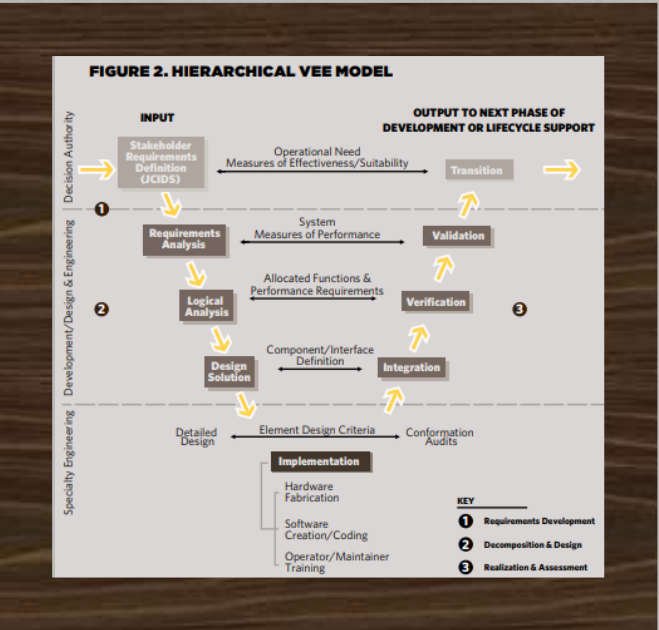
# A Stroll Through the Halls of Misperception & Complexity

*THERE'S ALWAYS TIME*



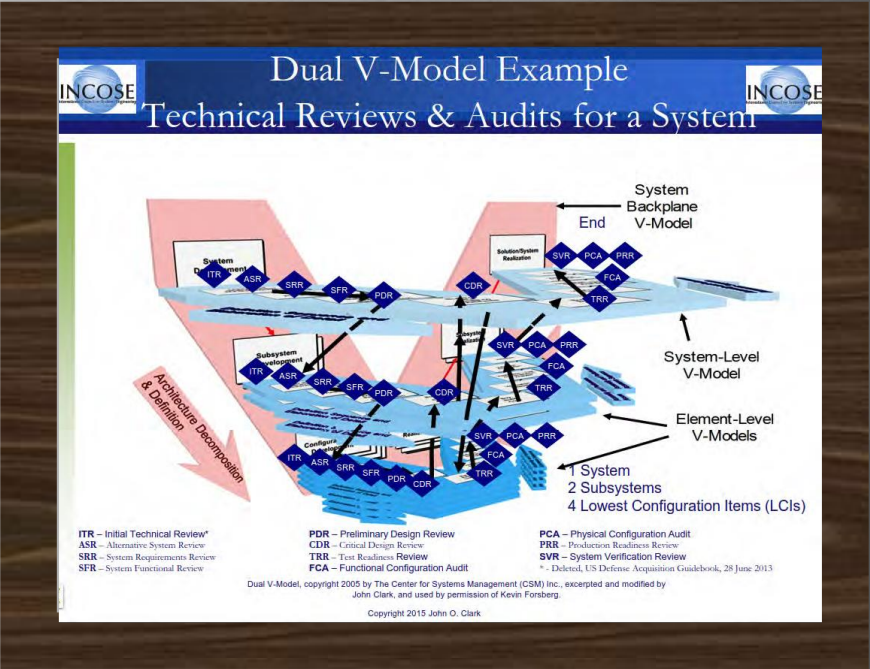
INCOSE (2015)  
INCOSE Systems Engineering Jr. Handbook 2015

*SE BY NUMBERS*



Redshaw (2010)

*SIMPLY SIMPLISTIC*



Clark (2015).



# Classical Roman Engineering

The Colosseum



Photo by [Nick Fewings](#) on [Unsplash](#)

The Pantheon



Photo by [Mathew Schwartz](#) on [Unsplash](#)

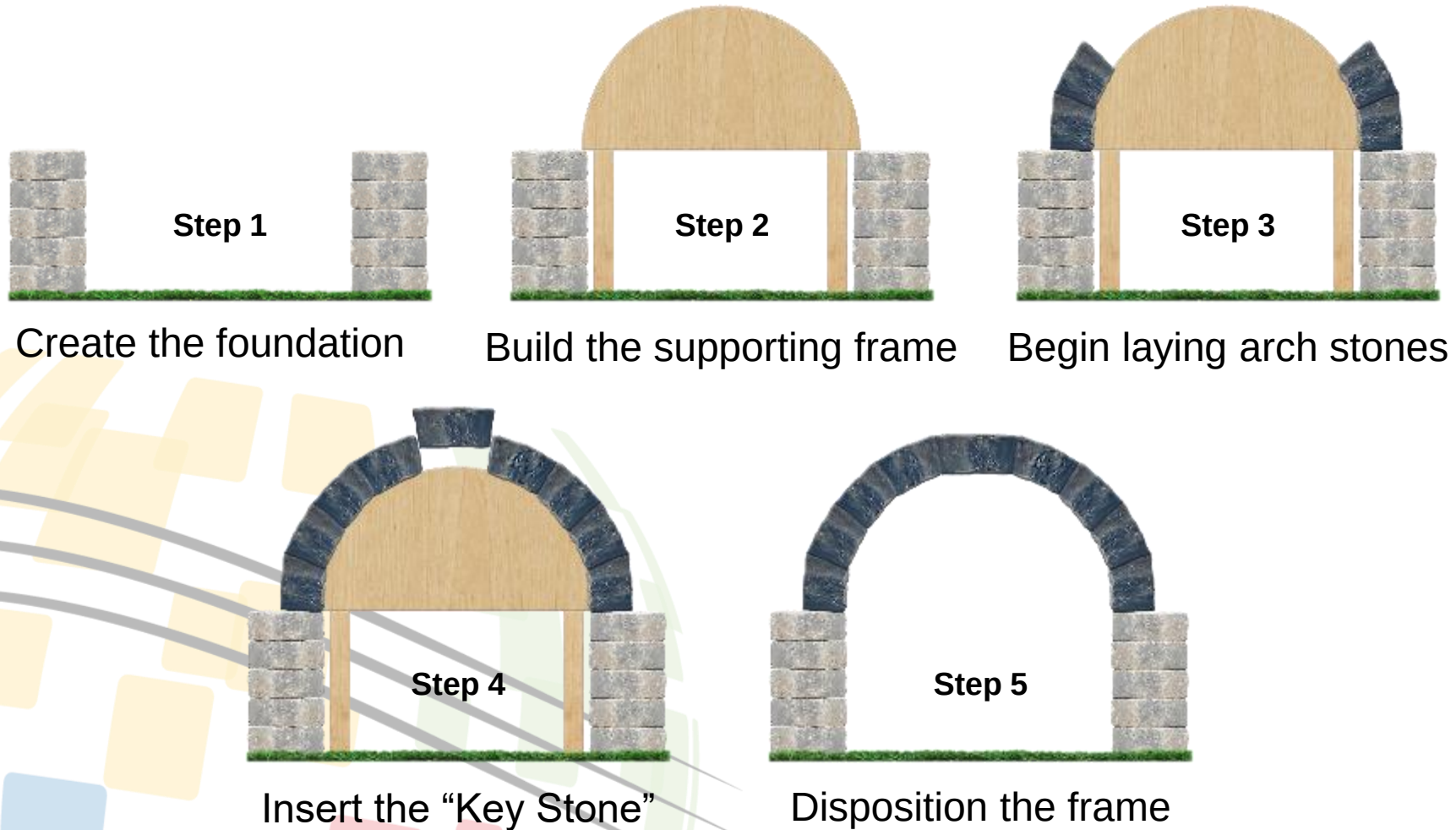
Pont Du Gard



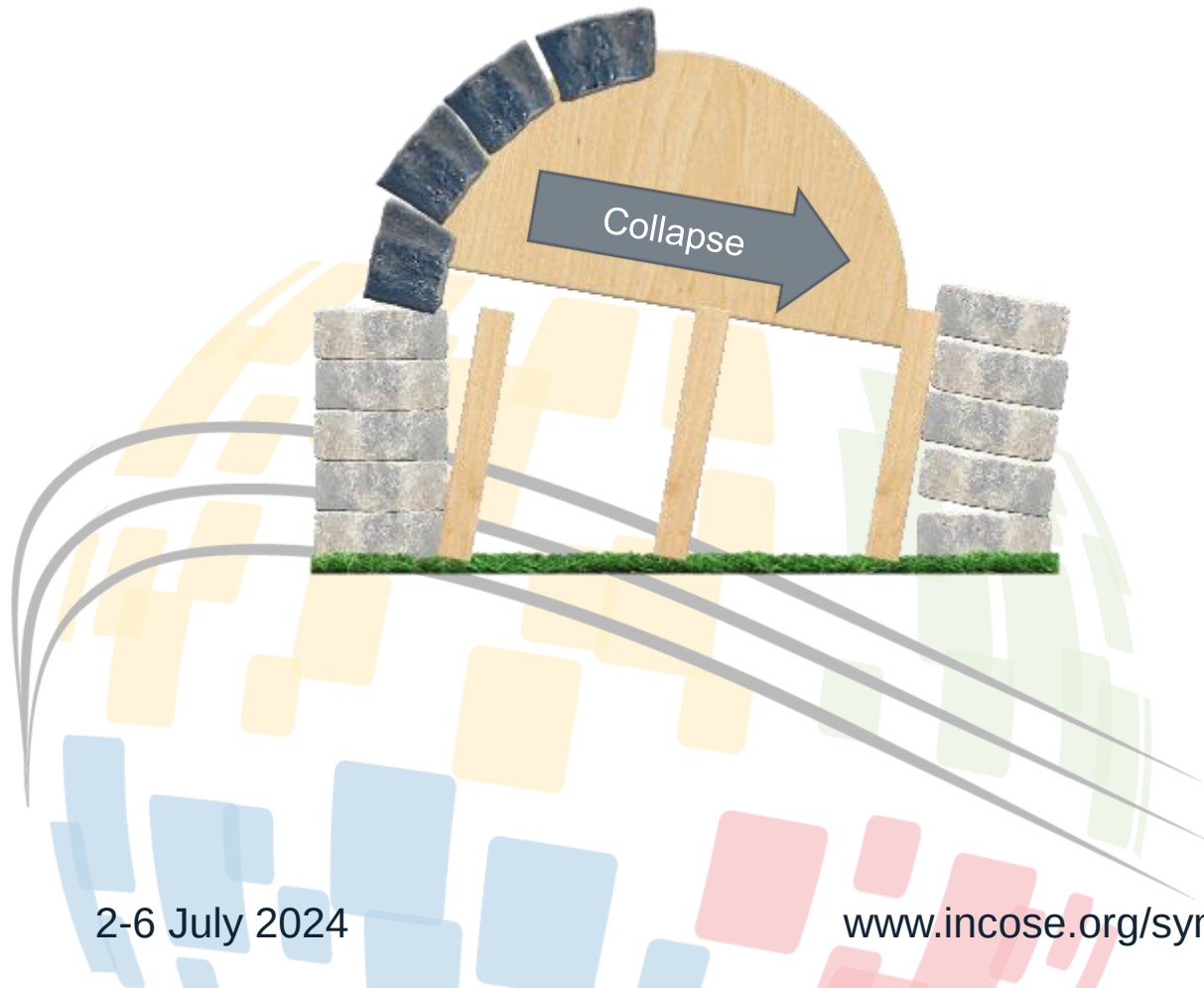
Photo by [Maria Bobrova](#) on [Unsplash](#)

**The Roman Arch is often deemed as the *most important architectural discovery in history.***

# Simple Steps to Build an Arch



# Challenges during construction





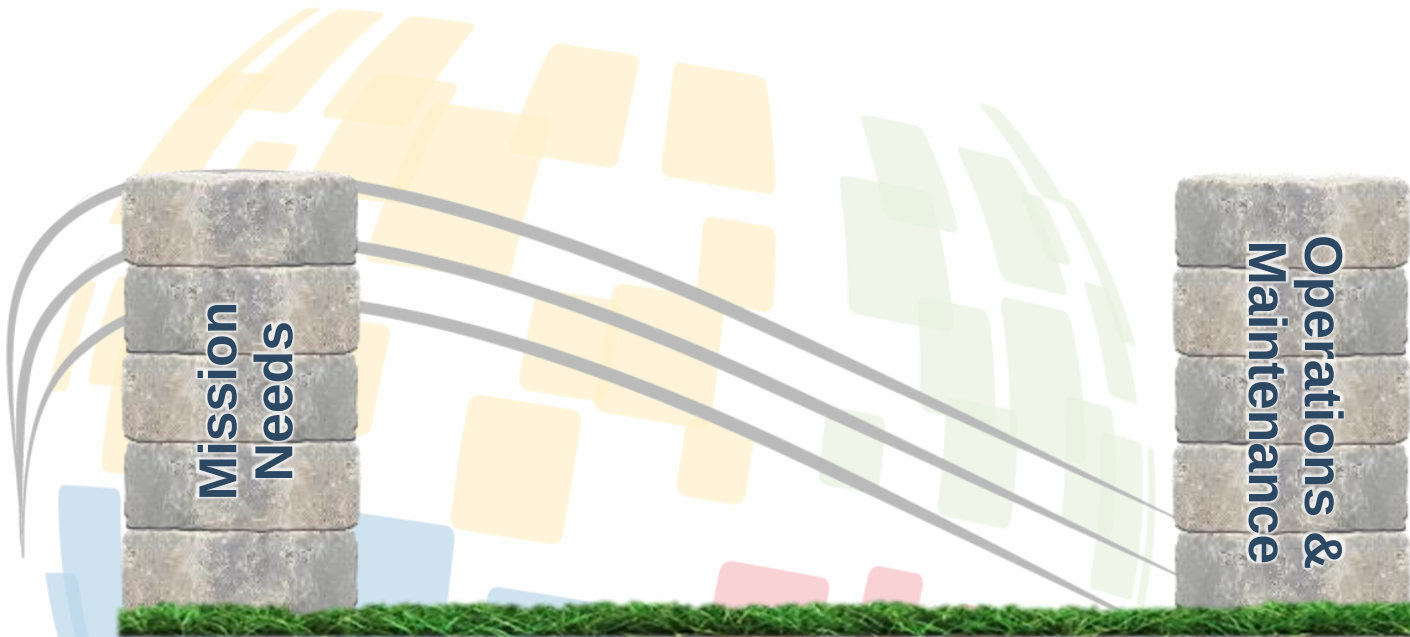
# Building the Arch Model

Mission/Operations

Digital Engineering  
Ecosystem

Systems Development

Step 1: Create the Foundation



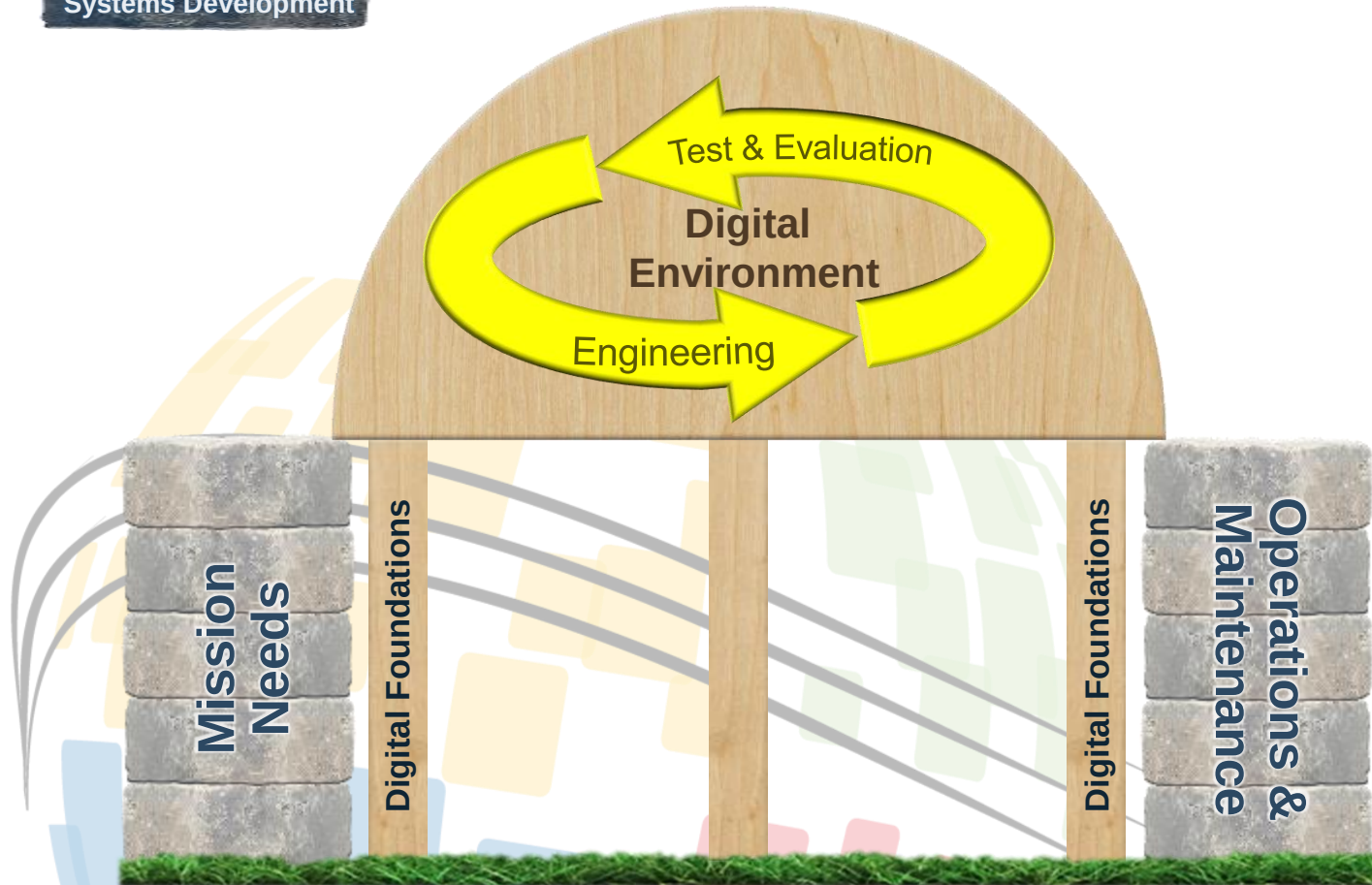
2-6 July 2024

[www.incose.org/symp2024](http://www.incose.org/symp2024) #INCOSEIS

# Building the Arch Model



## Step 2: Build the Supporting Frame



### Digital Engineering Ecosystem:

“The interconnected infrastructure, environment, and methodology (process, methods, and tools) used to store, access, analyze, and visualize evolving systems’ data and models to address the needs of the stakeholders.” – Defense Acquisition University (US Department of Defense, CTO, 2022)

### Digital Environment

#### (aka Digital Engineering Environment):

“A secure digital framework that allows cross-functional teams to collaborate and make better decisions as they manage, create, and test digital prototypes.” – General Dynamics Information Technology (2022)

### Digital Foundation (aka Digital Threads):

Enterprise models and data sources that are cross-cutting in their support of multiple systems or missions. – Seal (2018)



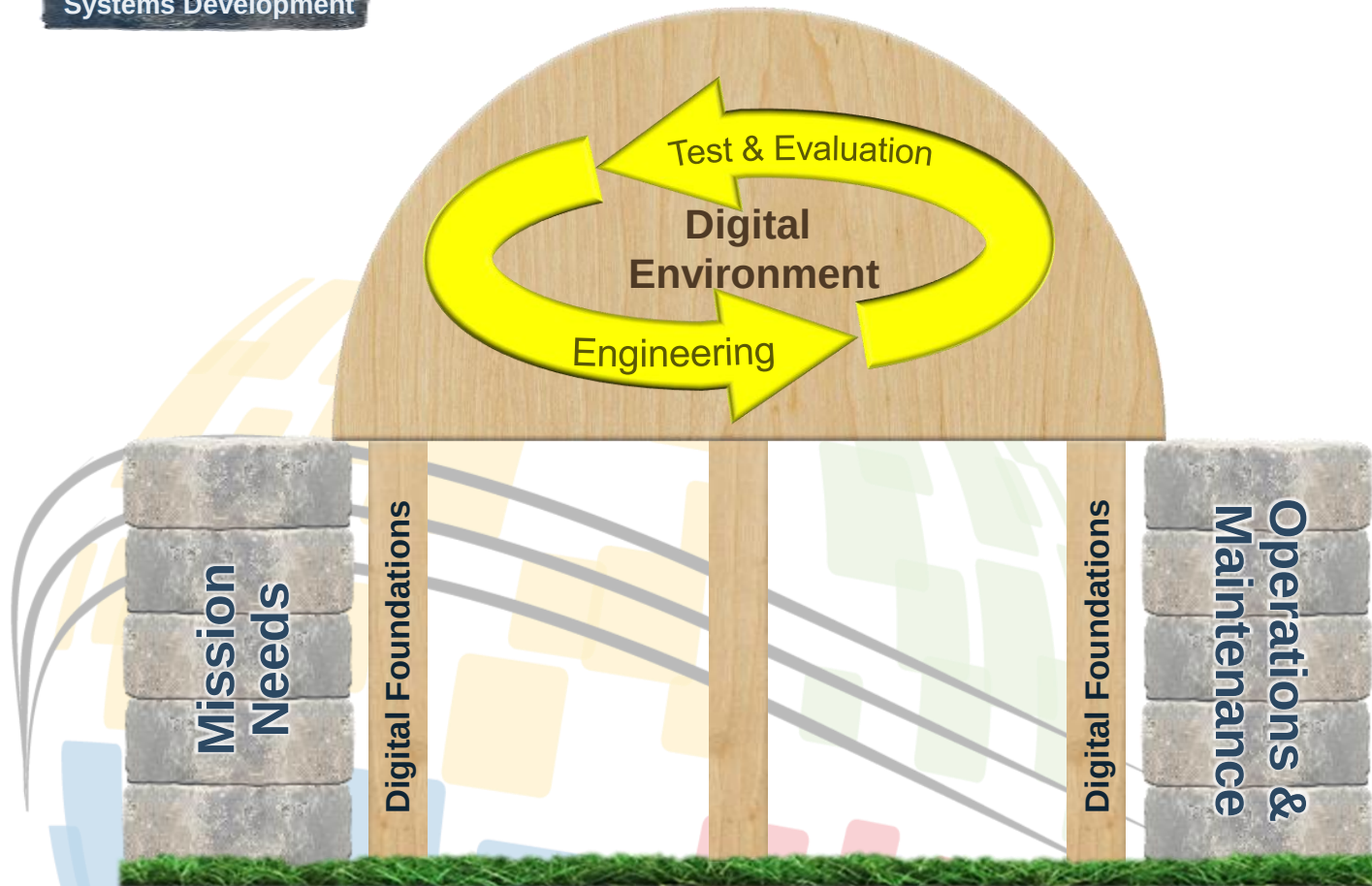
# Building the Arch Model

Mission/Operations

Digital Engineering  
Ecosystem

Systems Development

## Step 2: Build the Supporting Frame



### Digital Foundation (aka Digital Threads):

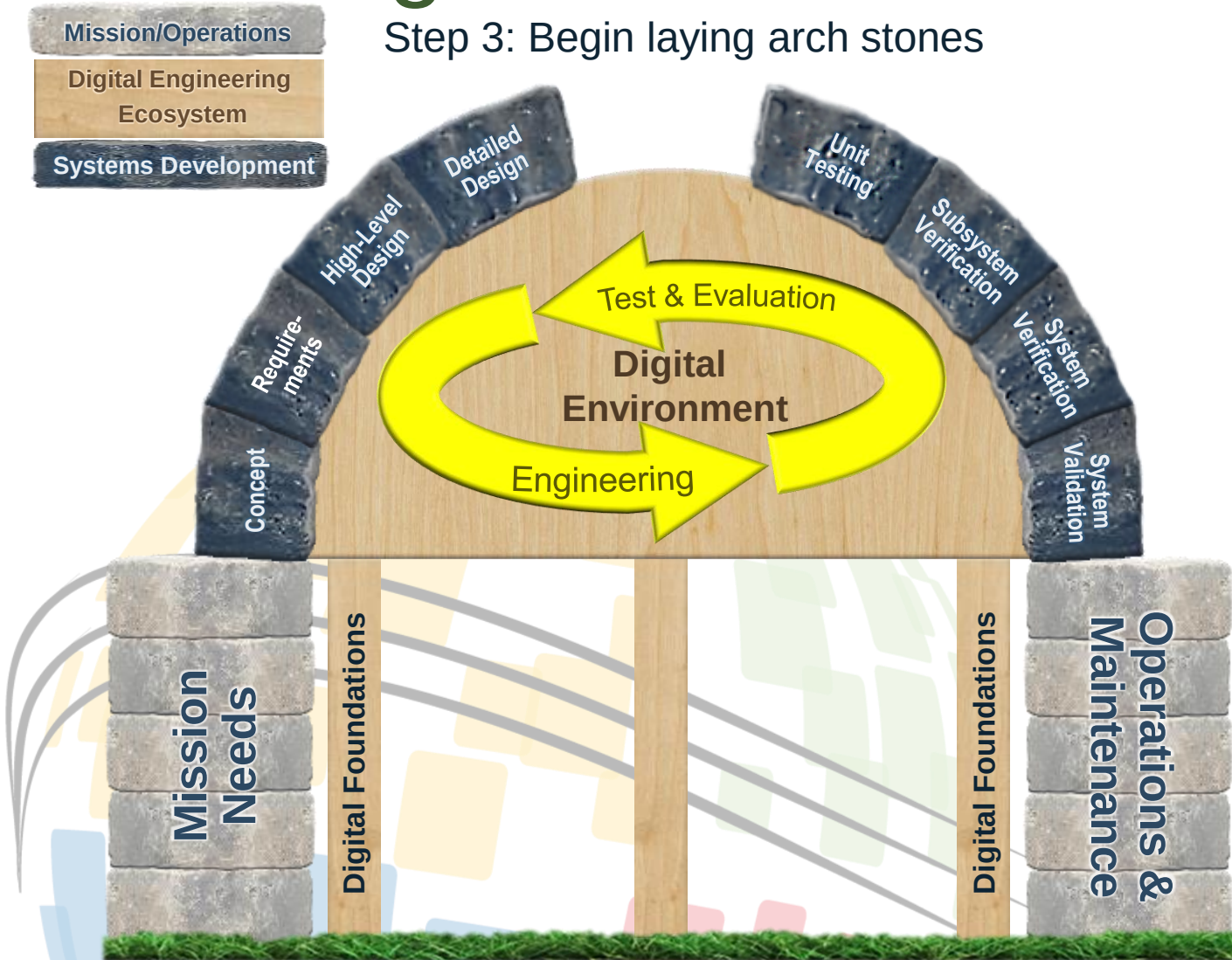
Enterprise models and data sources that are cross-cutting in their support of multiple systems or missions.

#### Examples:

- Reference Architectures
- Mission Engineering Models
- Modeling and Simulation Models
- Supply Chain Models
- Threat Intelligence
- Enterprise Risk Management
- Etc.

# Building the Arch Model

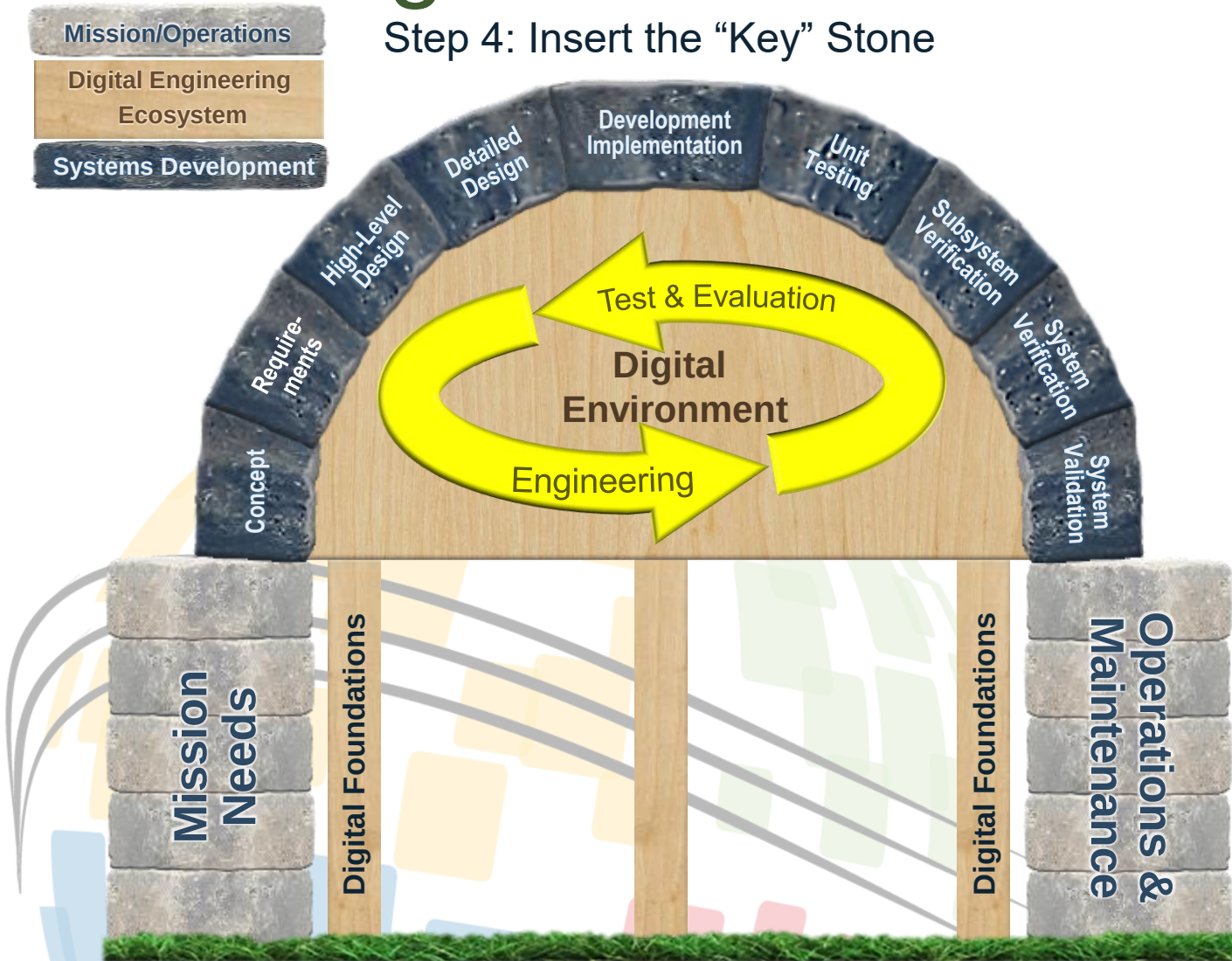
Step 3: Begin laying arch stones





# Building the Arch Model

Step 4: Insert the “Key” Stone



# The Arch Model vs. V Model

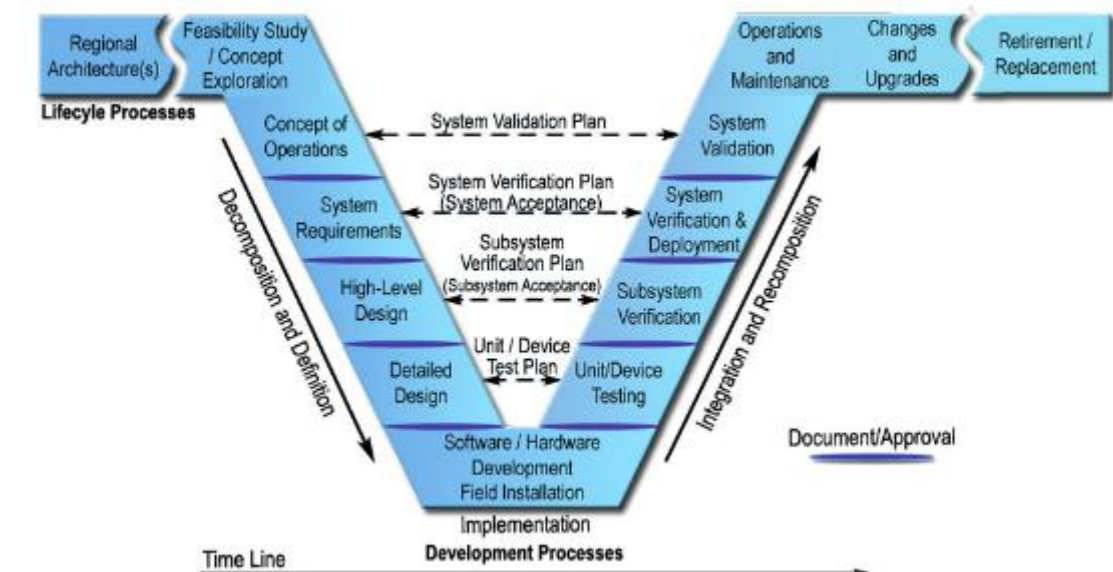
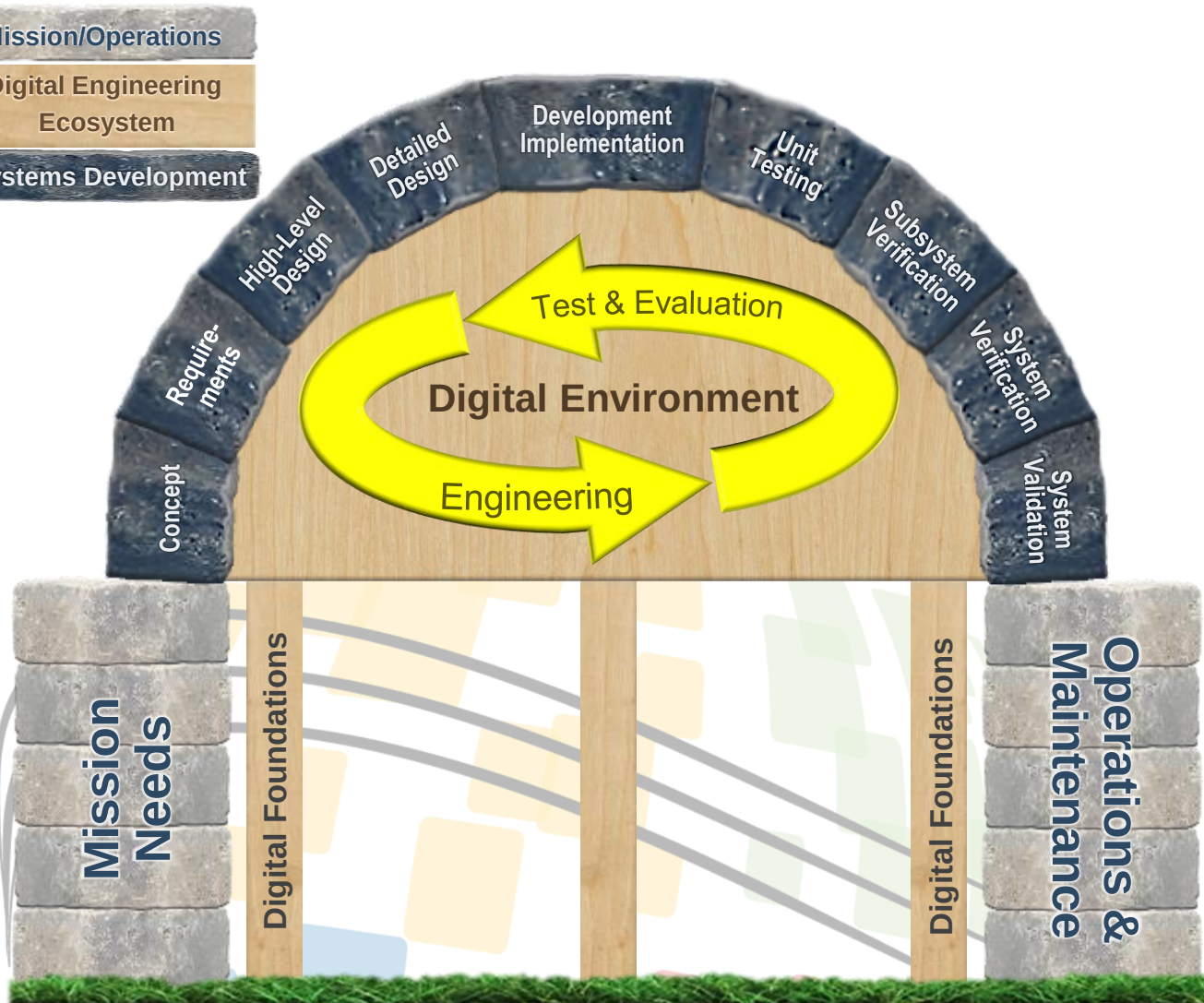


Figure 7: Systems Engineering "V" Diagram

U.S. Department of Transportation (2007)



# References

- **Clark, J. (2015).** SoSE from the SE Standards, INCOSE SE Handbook, and Dual V-Model Perspective". INCOSE Webinar 72.
- **General Dynamics Information Technology. (2022).** Digital Engineering Environment Enabling Collaboration at the Speed of Mission. (General Dynamics Information Technology) Retrieved November 23, 2022, from General Dynamics Information Technology: <https://www.gdit.com/digital-engineeringenvironment/#:~:text=The%20GDIT%20Digital%20Engineering%20Environment,before%20investing%20in%20live%20solutions.>
- **Google (2024).** Google Image Search of "SE Vee Model, Date Retrieved 22 April 2024, from: [https://www.google.com/search?sca\\_esv=ffa6a5b912f672b6&sca\\_upv=1&rlz=1C1CHZN\\_enUS973US974&q=se+vee+model&uds=AMwkrPuNPthKjKnwIB2kzOzS6zlGY3XWtAp1mldAnrZOfqkifW\\_adCaBOtwgU\\_\\_vwhF8MsKMAau5tShLRM6-aZLHisXcUQTWq0UAAQ3zqHesMAb4Rhm0vApGg\\_vgNbeReB8afm\\_BIFYBehlN1aMxgJ26aHhgXyqaRqV9JWez\\_Lm\\_Cbb8NW6Q14t-QsuBko4BzD\\_yHU0vPc-Bxir9ww4PDcM-ldoNMsBMMQQtTVzSpGybzIH49-FcXsCOkO16o0qeZ7ou4l9r\\_KbnyZWRD4f46TiAzWLxAB4Qx\\_d6hvgMhvSPNgAup0SW8rAem-RDCEyiVc5brVFI3f98zH&udm=2&prmd=ivsnmbt&sa=X&ved=2ahUKEwjSstzwr9aFAxUQFlkFHV7QBaeQKtKgLegQIERAB&biw=1745&bih=835&dpr=1.1](https://www.google.com/search?sca_esv=ffa6a5b912f672b6&sca_upv=1&rlz=1C1CHZN_enUS973US974&q=se+vee+model&uds=AMwkrPuNPthKjKnwIB2kzOzS6zlGY3XWtAp1mldAnrZOfqkifW_adCaBOtwgU__vwhF8MsKMAau5tShLRM6-aZLHisXcUQTWq0UAAQ3zqHesMAb4Rhm0vApGg_vgNbeReB8afm_BIFYBehlN1aMxgJ26aHhgXyqaRqV9JWez_Lm_Cbb8NW6Q14t-QsuBko4BzD_yHU0vPc-Bxir9ww4PDcM-ldoNMsBMMQQtTVzSpGybzIH49-FcXsCOkO16o0qeZ7ou4l9r_KbnyZWRD4f46TiAzWLxAB4Qx_d6hvgMhvSPNgAup0SW8rAem-RDCEyiVc5brVFI3f98zH&udm=2&prmd=ivsnmbt&sa=X&ved=2ahUKEwjSstzwr9aFAxUQFlkFHV7QBaeQKtKgLegQIERAB&biw=1745&bih=835&dpr=1.1)
- **Google (2024).** Google Image Search of "SE Vee Model, Date Retrieved 22 April 2024, from: [https://www.google.com/search?sca\\_esv=ffa6a5b912f672b6&sca\\_upv=1&rlz=1C1CHZN\\_enUS973US974&q=se+vee+model&uds=AMwkrPuNPthKjKnwIB2kzOzS6zlGY3XWtAp1mldAnrZOfqkifW\\_adCaBOtwgU\\_\\_vwhF8MsKMAau5tShLRM6-aZLHisXcUQTWq0UAAQ3zqHesMAb4Rhm0vApGg\\_vgNbeReB8afm\\_BIFYBehlN1aMxgJ26aHhgXyqaRqV9JWez\\_Lm\\_Cbb8NW6Q14t-QsuBko4BzD\\_yHU0vPc-Bxir9ww4PDcM-ldoNMsBMMQQtTVzSpGybzIH49-FcXsCOkO16o0qeZ7ou4l9r\\_KbnyZWRD4f46TiAzWLxAB4Qx\\_d6hvgMhvSPNgAup0SW8rAem-RDCEyiVc5brVFI3f98zH&udm=2&prmd=ivsnmbt&sa=X&ved=2ahUKEwjSstzwr9aFAxUQFlkFHV7QBaeQKtKgLegQIERAB&biw=1745&bih=835&dpr=1.1](https://www.google.com/search?sca_esv=ffa6a5b912f672b6&sca_upv=1&rlz=1C1CHZN_enUS973US974&q=se+vee+model&uds=AMwkrPuNPthKjKnwIB2kzOzS6zlGY3XWtAp1mldAnrZOfqkifW_adCaBOtwgU__vwhF8MsKMAau5tShLRM6-aZLHisXcUQTWq0UAAQ3zqHesMAb4Rhm0vApGg_vgNbeReB8afm_BIFYBehlN1aMxgJ26aHhgXyqaRqV9JWez_Lm_Cbb8NW6Q14t-QsuBko4BzD_yHU0vPc-Bxir9ww4PDcM-ldoNMsBMMQQtTVzSpGybzIH49-FcXsCOkO16o0qeZ7ou4l9r_KbnyZWRD4f46TiAzWLxAB4Qx_d6hvgMhvSPNgAup0SW8rAem-RDCEyiVc5brVFI3f98zH&udm=2&prmd=ivsnmbt&sa=X&ved=2ahUKEwjSstzwr9aFAxUQFlkFHV7QBaeQKtKgLegQIERAB&biw=1745&bih=835&dpr=1.1)
- **INCOSE. (2015).** Systems Engineering Jr. Handbook. version 1.0. Los Angeles, CA: INCOSE. Retrieved from [https://www.incose.org/docs/default-source/los-angeles/libraryresources/se-jr-handbook-2015.pdf?sfvrsn=1d3c80c6\\_2](https://www.incose.org/docs/default-source/los-angeles/libraryresources/se-jr-handbook-2015.pdf?sfvrsn=1d3c80c6_2).
- **Redshaw, M. C. (2010).** Building on a Legacy: Renewed Focus on Systems Engineering In Defense Acquisition. Defense Acquisition Review Journal, 17(53), 93-110. Retrieved from <https://apps.dtic.mil/sti/tr/pdf/ADA597940.pdf>.
- **Seal, D. (2018).** The System Engineering "V" - Is It Still Relevant In the Digital Age? Phoenix: Global Product Data Interoperability Summit 2018.
- **US Department of Defense, CTO. (2022).** Terms and Definitions: Digital Engineering and Modeling and Simulations Glossary. (Office of the Under Secretary of Defense for Research and Engineering, Chief Technology Office) Retrieved from Office of Under Secretary of Defense Research and Engineering: <https://ac.cto.mil/de-ms-glossary/>.
- **U.S. Department of Transportation. (2007).** Systems Engineering for Intelligent Transportation Systems. Washington, DC: Department of Transportation. Retrieved from <https://ops.fhwa.dot.gov/publications/seitguide/seguide.pdf>.
- **Weilkiens, T., Lamm, J. G., Roth, S., & Walker, M. (2016).** Model-Based System Architecture, First Edition (1 ed.). (W. Rouse, & S. P. Andrew, Eds.) Hoboken, US-NJ: John Wiley & Sons, Inc.

# Questions or Comments





# 34<sup>th</sup> Annual **INCOSE** international symposium

hybrid event

Dublin, Ireland  
July 2 - 6, 2024

[www.incose.org/symp2024](http://www.incose.org/symp2024)  
#INCOSEIS