MODELING, SIMULATION, PROTOTYPING & VALIDATION

A Tailored Analytical Approach to Design Synthesis from Concept to Reality

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Agenda

- Quick introduction
- Motivation for technical paper
- Bridge mechanism problem description
- Project approach
- Project execution
- Key takeaways

Introduction

- Mechanical engineering background
- Current position: Systems Engineering Team Lead
- Performed this project before I was involved in systems engineering
- An SE mindset made me reconsider the work I did on this project from a process perspective

GS ENGINEERING

Motivation for Tech Paper

- All design and engineering is a means to an end; namely, a product that meets a user need in the marketplace.
- This applies to analytical tools as well – they are the means, not the end!
- How do we use analytical tools to reach that end as efficiently as possible?

- This project is an interesting case study in the tailored use of analytical tools to successfully develop a product.

Design Problem

- The Army needed a new bridge launching mechanism for the Heavy Assault Scissoring Bridge, to:
- Reduce the dead weight of the bridge system itself, to reallocate that weight to load capacity
- Eliminate the reliance on gravity to refold the bridge during retrieval
- GS Engineering developed a linkage-type mechanism which:
- Weighs 36% less than the legacy system
- Enables positive control of the bridge through the full range of motion
- Integrates cleanly into the existing structure and hydraulic systems of the HASB

Phased Design Approach

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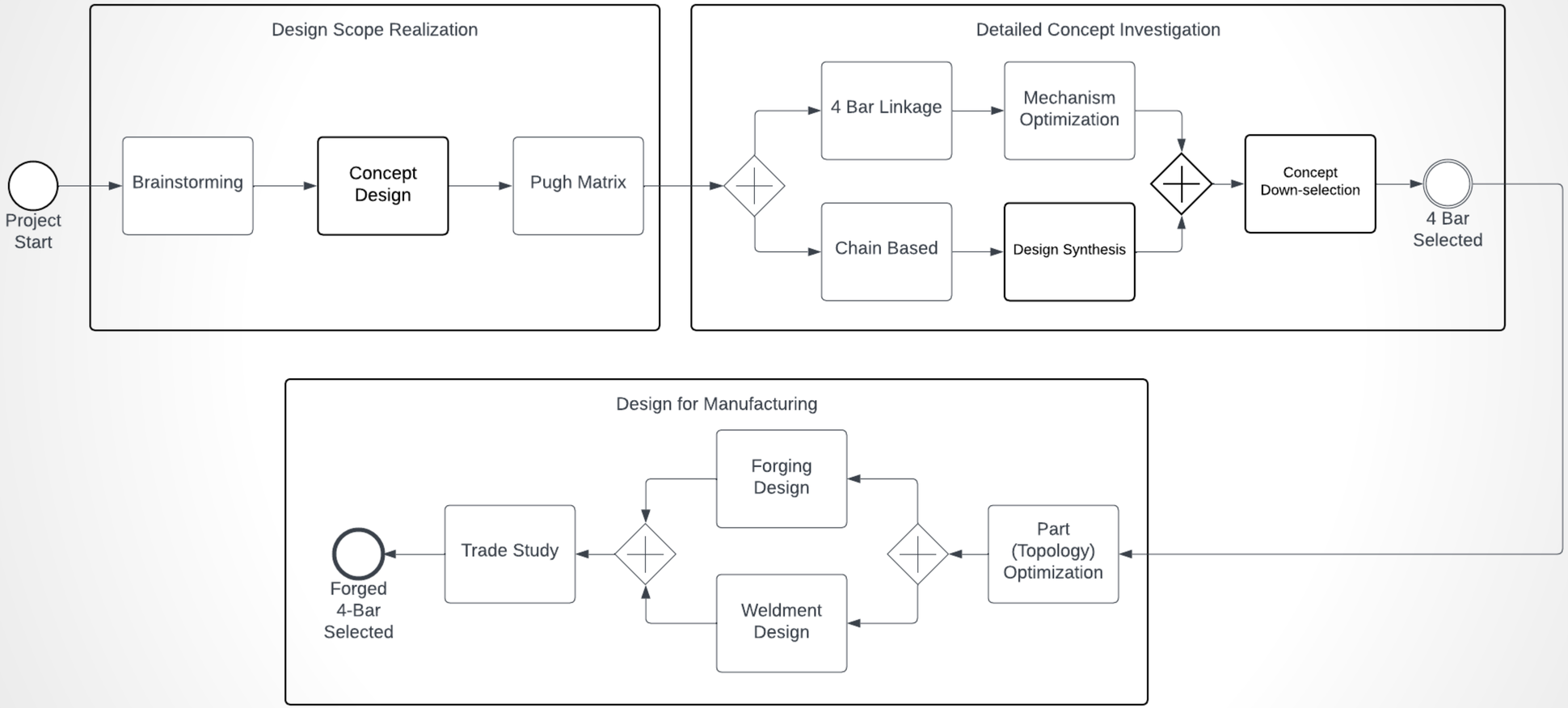
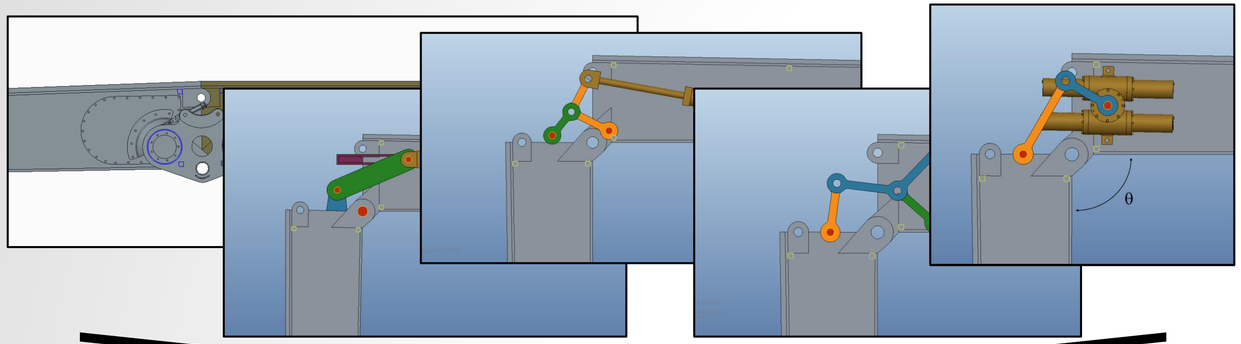
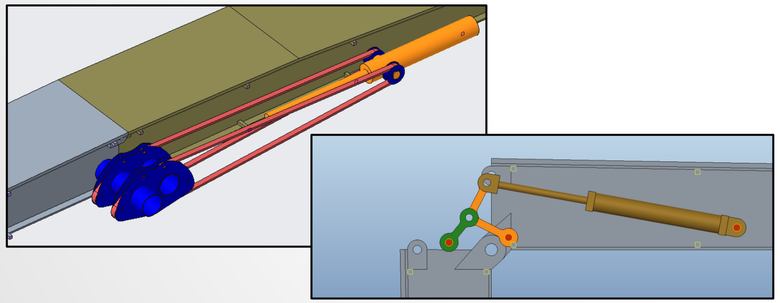


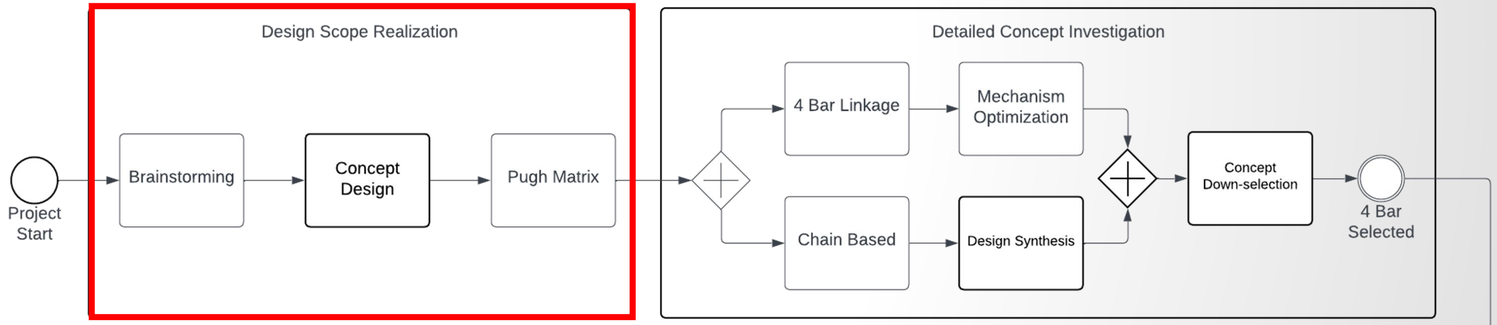
Design Scope Realization

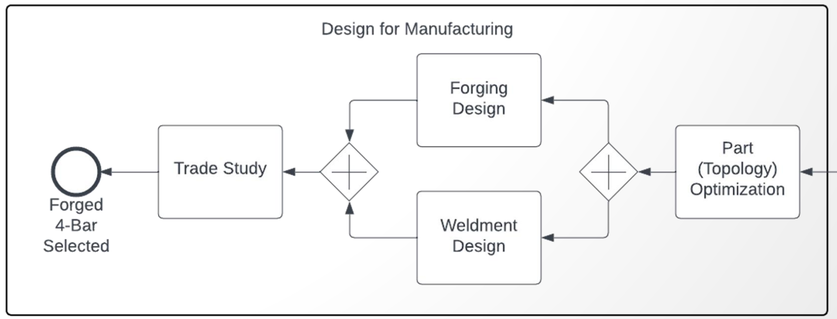


- Minimal effort was spent on adding detail to the initial concepts. Engineering judgement was used to assess performance.
- Multiple concepts were selected for further investigation.

Performance Categories								
Category	Description	Weighting Factor	Baseline	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5
1	Simplicity	4	0.9	0.9	0.7	1.1	1.1	1.1
1.1	Number of Moving Parts	5	3	4	2	4	4	4
1.2	Number of Unique Parts	3	3	3	2	4	4	4
1.3	Simple Mechanics and Actuat	5	3	2	2	4	4	4
1.4	Ease of Maintainance	3	3	3	3	4	3	3
1.5	Modularity	3	3	3	3	3	3	3
2	Robustness	3	0.6	0.6	0.6	0.7	0.6	0.8
2.1	Environmental Tolerance	3	3	3	3	3	2	4
2.2	Impact Tolerance	3	3	3	3	3	3	4
2.3	Load Tolerance	3	3	2	2	4	3	3
2.4	Abuse Tolerance	3	3	3	3	3	3	3
3	Cost	3	0.6	0.6	0.6	0.6	0.5	0.8
3.1	Use of COTS Parts	3	3	2	2	3	2	4
3.2	Manufacturable w/ conv. Pro	3	3	3	3	3	3	4
3.3	Loose Tolerances	3	3	3	3	3	2	3
4	Ease of Integration	4	0.9	0.9	0.7	1.0	0.9	1.0
4.1	Use of available power sourc	3	3	4	3	3	3	3
4.2	Distributed Loading	3	3	2	2	4	3	4
	TOTAL IMPACT SCORE		3.0	2.9	2.5	3.4	3.0	3.6
	RANK			4	5	2	3	1







Detailed Concept Investigation

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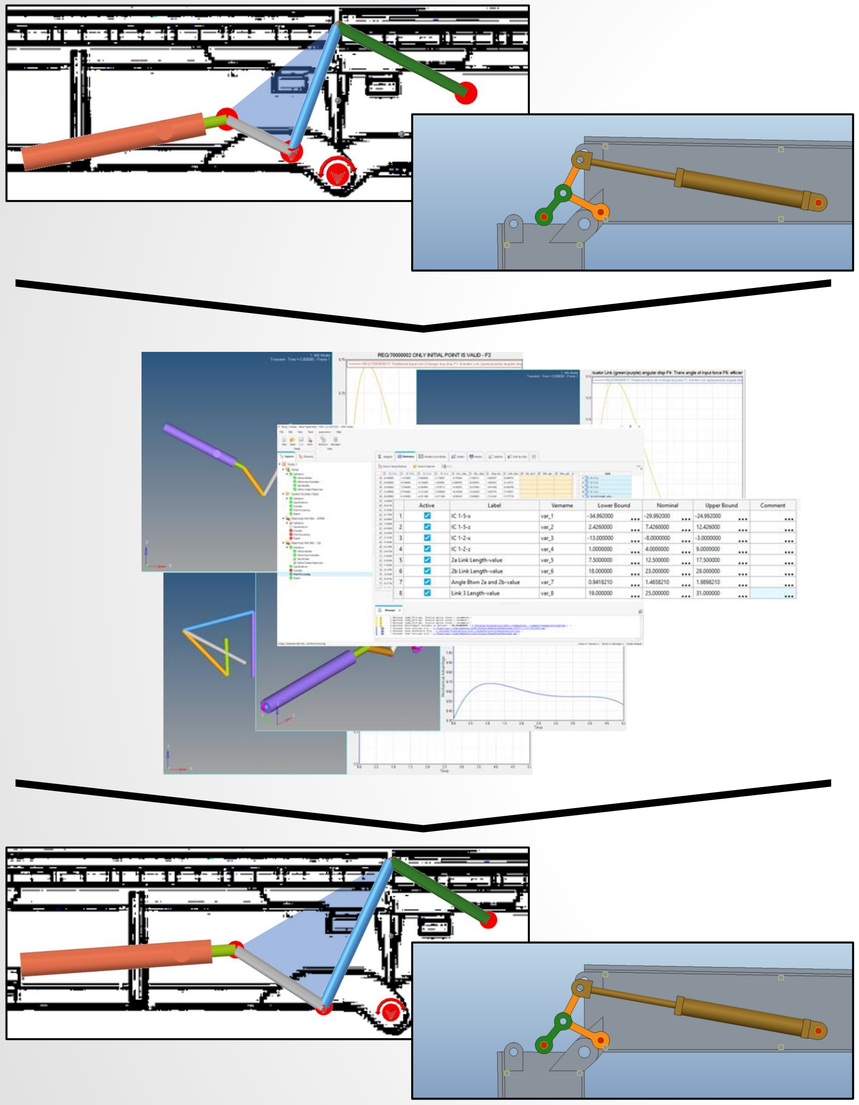
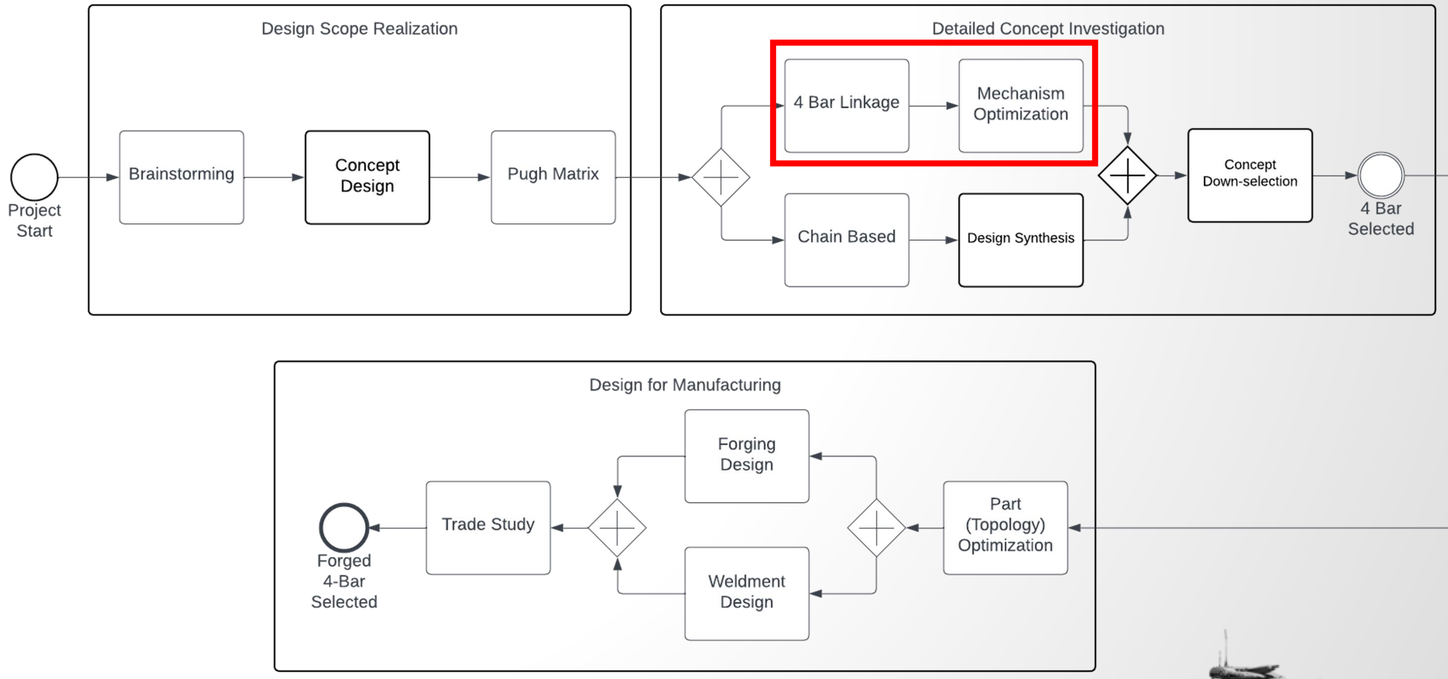
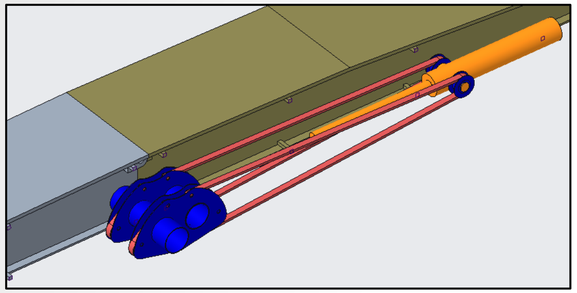
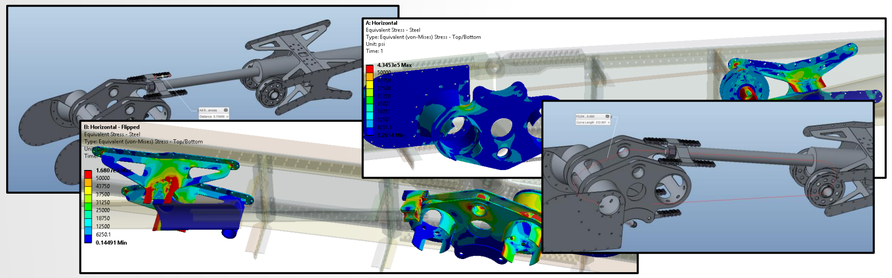


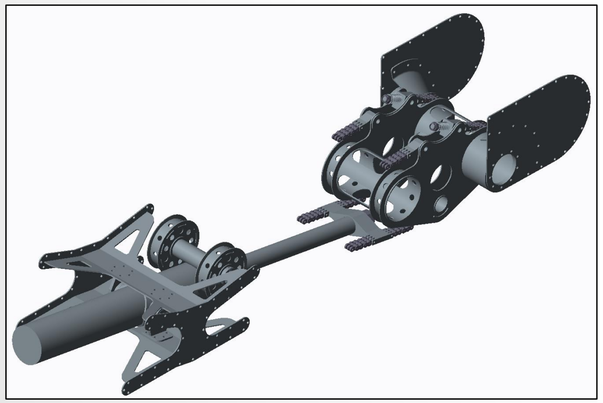
- Multi-body dynamics in coordination with design of experiments was used to optimize the linkage design.
- Approach selected due to relatively complex kinematics.



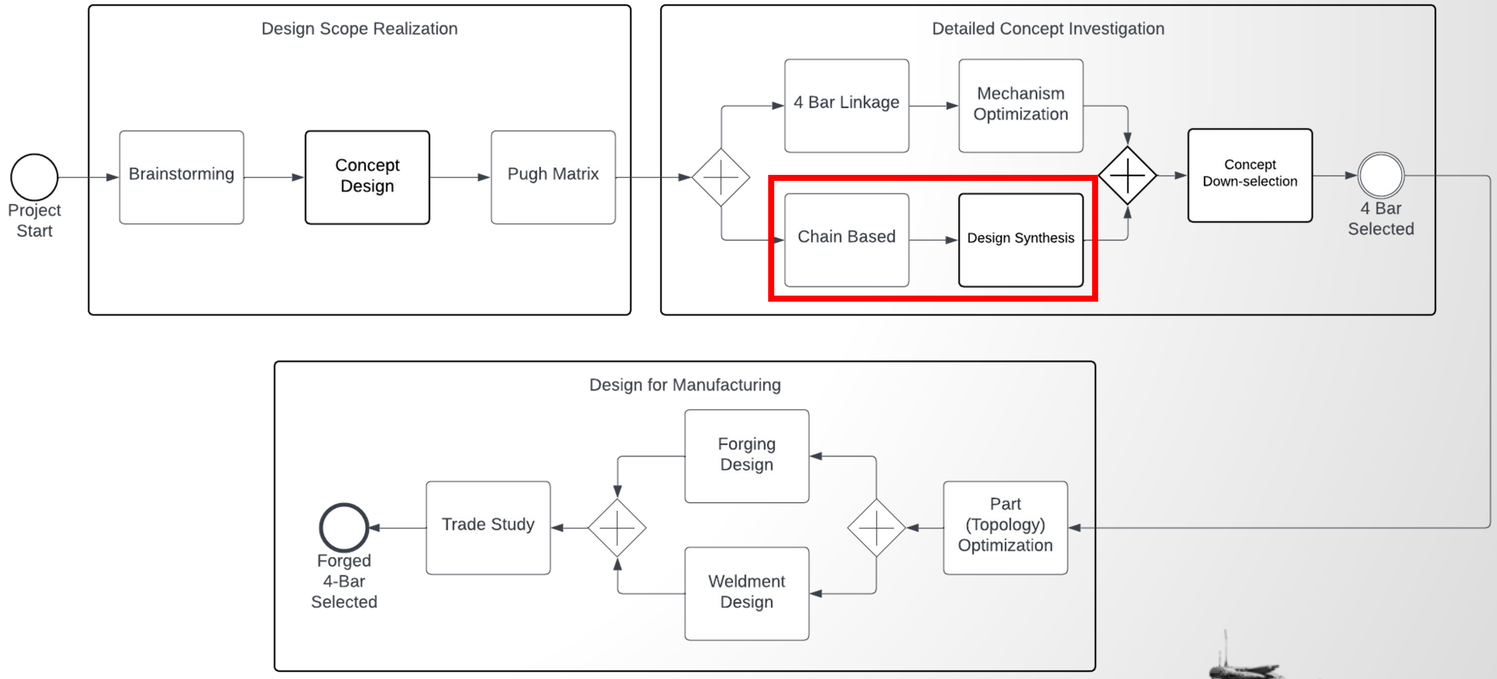
Detailed Concept Investigation





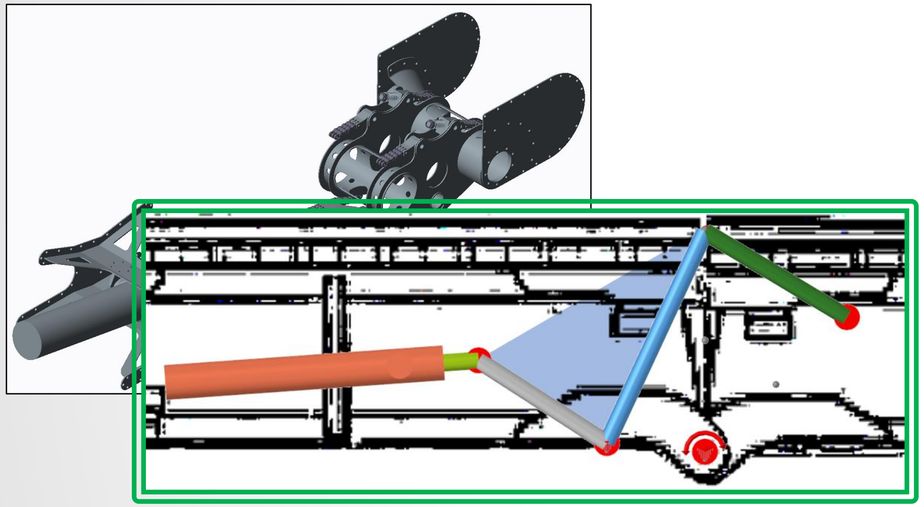


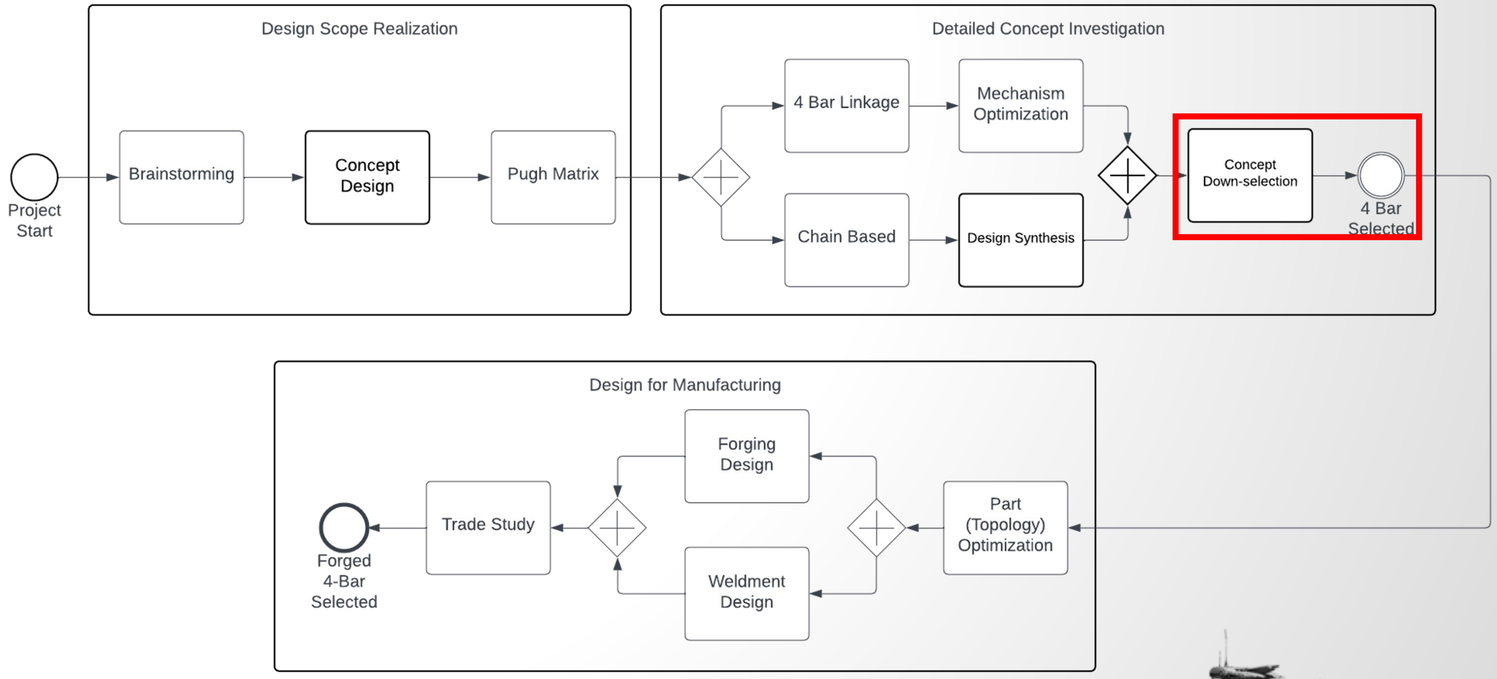
- Iterations of design synthesis and structural analysis were used to explore the chain concept.
- Approach selected due to relatively complex interfaces.



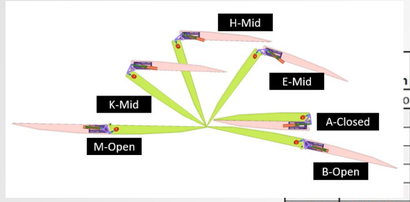
Detailed Concept Investigation

- Linkage concept was selected based on weight and simplicity.

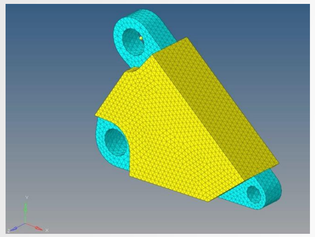


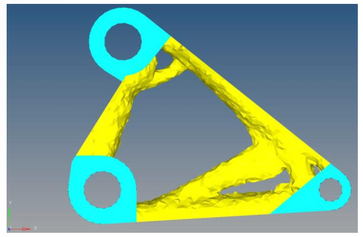


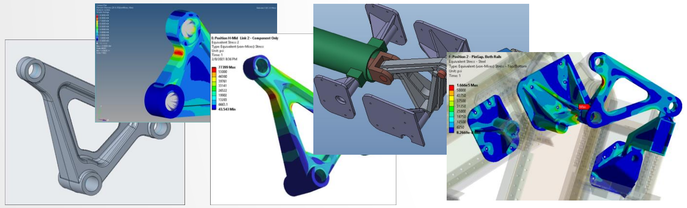
Design for Manufacturing

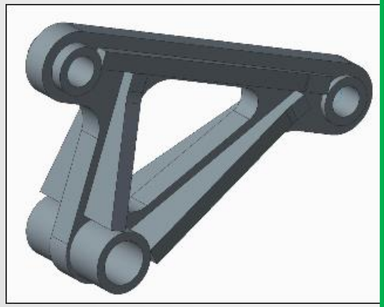


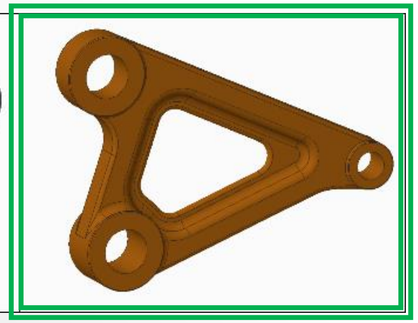
		Half 1 Orientation (o Horizontal)	Cylinder Force (lbf)	Notes
		0°	252,896	Nominal deployed position for reference
		180°	209,918	Maximum extension force for cylinder at full extension
		11.3° CW	254,198	Maximum force for cylinder
		21.53° CW	175,524	Represents peak mechanical advantage for cylinder
		4.363° CW	205,085	Maximum force for Link 3 Mount
K-Mid	144° CCW	2.505° CW	201,137	Maximum force for IC 1-2
M-Open	180°	180°	252,896	Maximum extension force for cylinder at full retraction



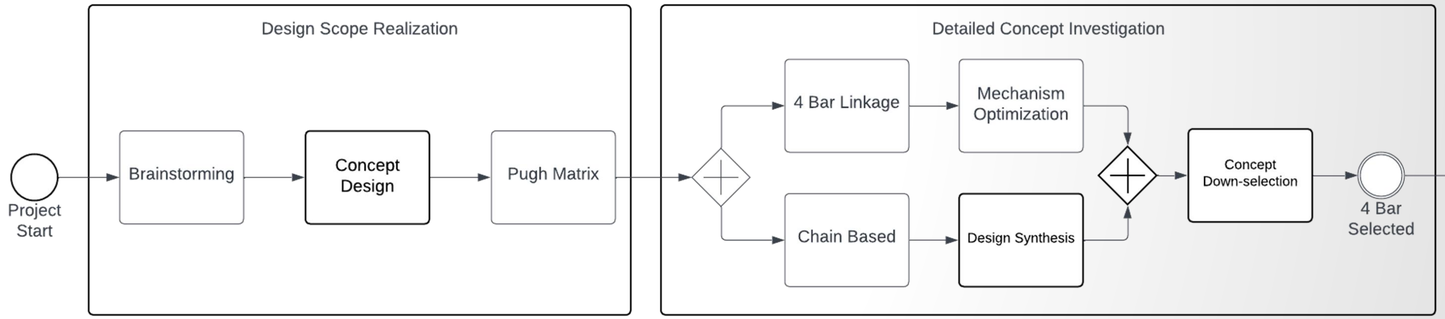


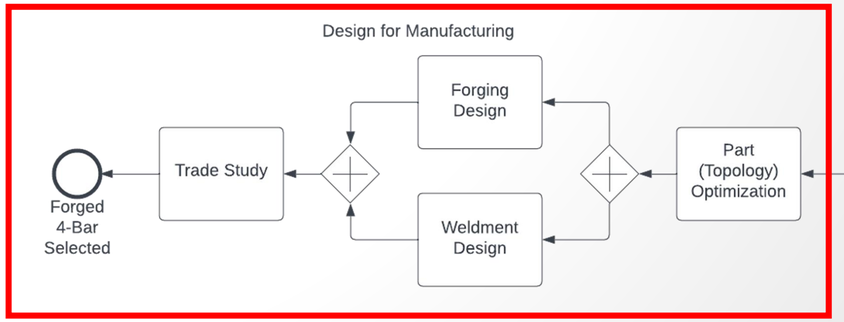






- Topology optimization was used to identify ideal structure prior to design synthesis.
- Forged design was selected based on weight.





Key Takeaways

- Scope the design problem to provide a quick and effective analysis.
- Tailor the use of analytical tools based on the challenges of specific designs or design processes.
- Do not attempt to solve every problem with an analytical tool.