

Automated Storage & Retrieval System for Aluminum Sheet Metal



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Overview of Groupe Tekdata

- Tekdata → Leader in metal solutions
 - Founded by Magdy Rizk in 1984
 - Located in Brossard
 - Present mainly in transportation, medical and telecommunication sector.
 - Conception and Manufacturing of high-performance industrial products
 - High utilization level of metal sheets

Problem Statement

- **Problems with the current storage system**
 - Manual handling of metal sheets leads to a high number of execution steps
 - High labor cost
 - Fork lift increases risk of accident
 - Non-standardized wooden skids
 - Production interruption
 - Machine waiting for material feeding
 - Wasted time through the inventory process
- **Need for improvement**
 - Efficient racking system

Mandate

- Design an automated storage and retrieval system for aluminum sheets
 - Increase productivity by minimizing labour time
 - Facilitate storage and retrieval of raw material
 - Maximize storage space
 - Standardize skids
 - Generate savings
- Use Value Engineering for the design process

Value Engineering approach planning of study

- Five main steps of Value Engineering to solve the issues and address the needs
 1. Information phase
 2. Functional analysis
 3. Creativity Session
 4. Evaluation of ideas
 5. Final recommendation

Information phase

Client Constraints

- The following information was gathered through a facility visit and by discussing with our client

Constraints	Value
Support weight of sheet metal	2500lbs/skid
Allow to fit different size sheets	Width: 3' or 4' Length: 8', 10', 12' Thickness: varying
Take advantage of the entire height of the facility	24'
Be completely automated	
Have a standardized skid/shelving system	
Comply with CSST health and safety rules	
The savings generated by the system should outweigh the costs	

Functional Analysis

- The functional requirement of the product were broken down using the following 3 analyses:
 - Environment
 - Interaction between the racking system and the facility / personnel
 - Efforts and movements
 - Static and dynamic function of the manipulators
 - Sequential
 - Decomposing the actions performed by the product

Functional Analysis

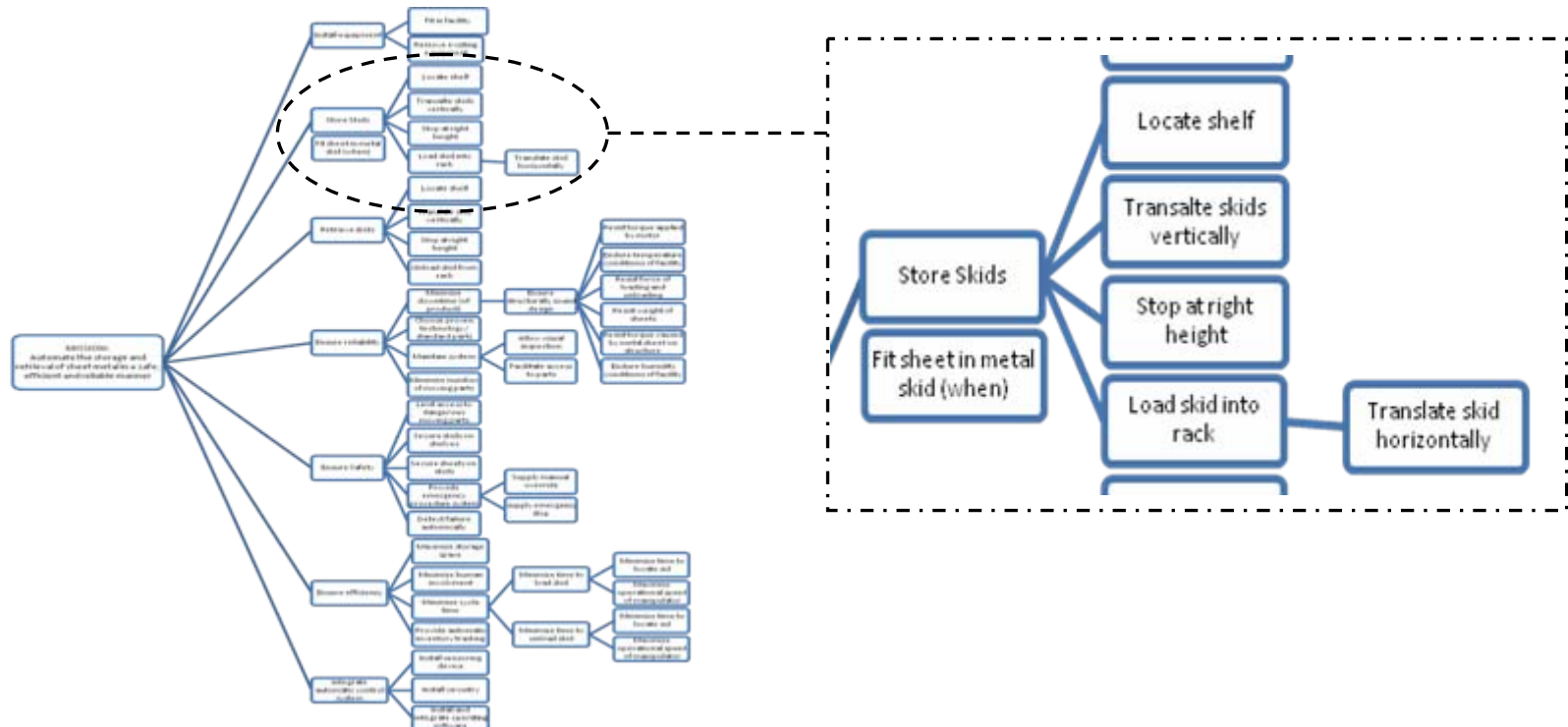
- **Environmental analysis**
 - Store and retrieve skids
 - Facilitate access to parts
 - Maximize storage

- **Efforts and movements**
 - Translate skids vertically
 - Translate skids horizontally
 - Resist weight of sheets

- **Sequential**
 - Elevate skid
 - Stop at right height

Functional Analysis

- By grouping these functions we obtained the FAST Diagram for the Tekdata project

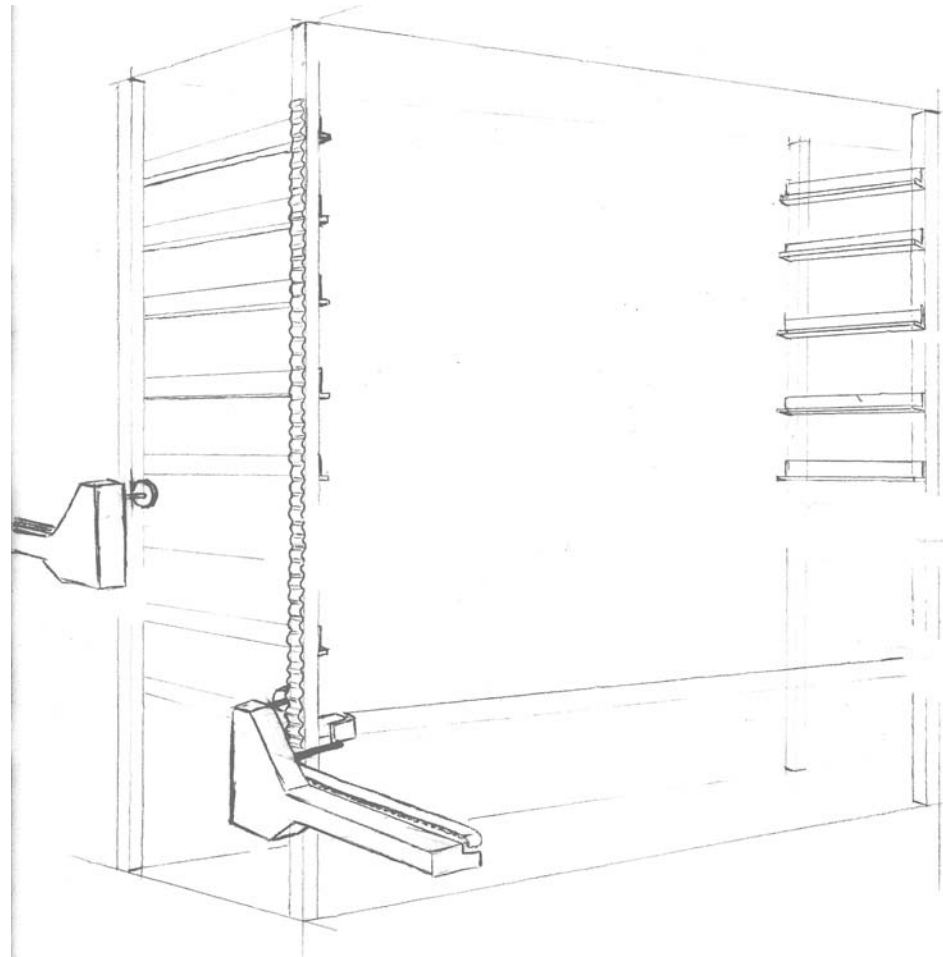


- Solutions must be found for each functions

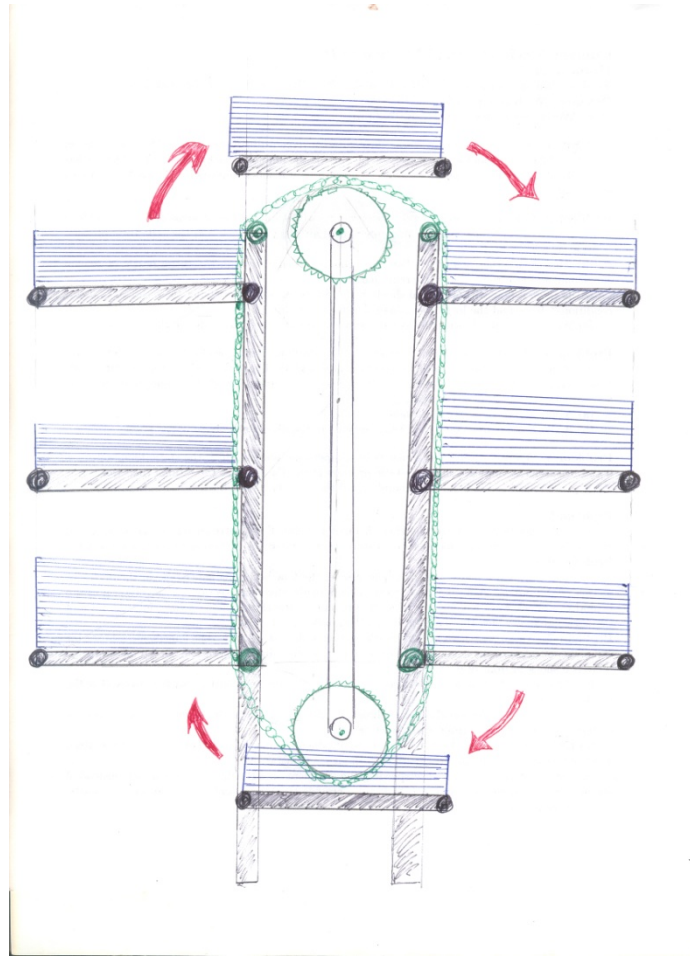
Creativity Session

- Creative and innovative solutions are generated to satisfy functional requirements
- Three main general concepts developed through brainstorming session :
 1. A rack with two manipulators on each side moving vertically
 2. A system based on the concept of a Ferris Wheel where all the shelves would be moving around the rack
 3. A system where the sheets would be held vertically in dividers disposed around a rotating disk

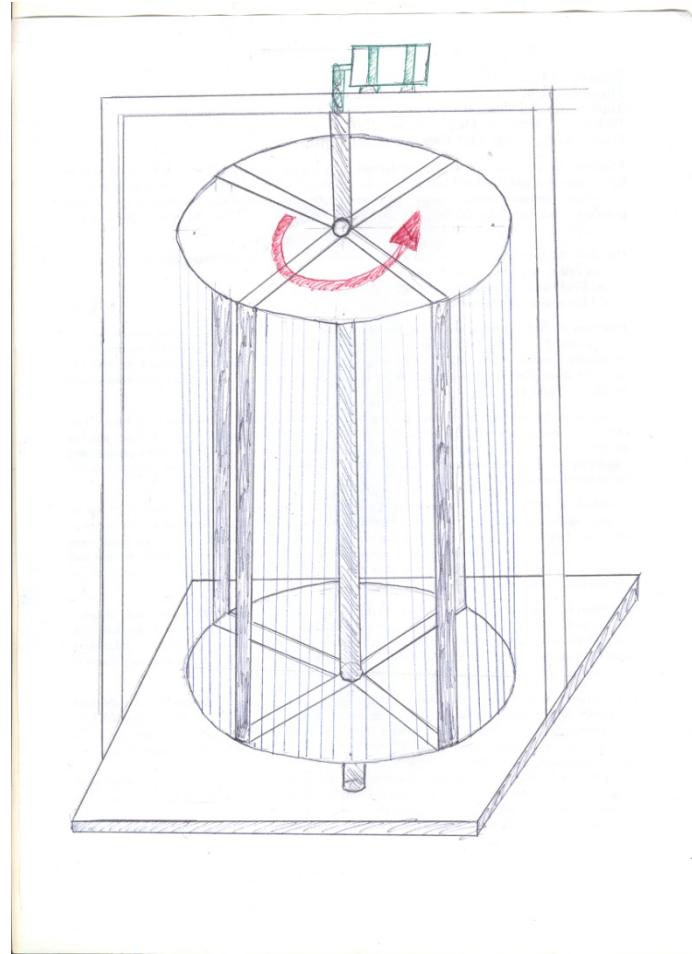
Concept 1 - Rack with manipulators



Concept 2 – Ferris wheel



Concept 3 - Vertical rotating disk



Evaluation phase

- Choosing General Concept
 - Assign weight to each top level function (from FAST diagram) based on level of importance
 - Measure how well each general concept perform each function
 - Concept with highest mark was chosen

Evaluation phase

■ Weighted evaluation

Function	Weight (1 - least important, 5 - most important)	■ Ferris Wheel	■ Mounted Manipulator	■ Horizontal Carousel
Fit in facility	2	14	10	18
Remove existing equipment	1	0	0	0
Locate shelf	3	25	25	25
Translate skids vertically	3	50	100	100
Stop at right height	5	49	70	49
Load skid into rack	3	100	70	100
Minimize downtime	5	32	80	64
Choose proven technology	2	56	63	49
Maintain system	5	48	56	64
Minimize number of moving parts	5	40	56	64
Limit access to dangerous moving parts	3	64	64	64
Secure skids on shelves	3	21	27	9
Provide emergency procedure system	2	25	45	25
Detect failure automatically	1	25	25	25
Maximize storage space	4	12	20	4
Minimize human involvement	5	25	25	25
Minimize cycle time	5	45	35	25
Provide automatic inventory tracking	5	25	25	25
Automatic control system	5	64	48	64
		720	844	799

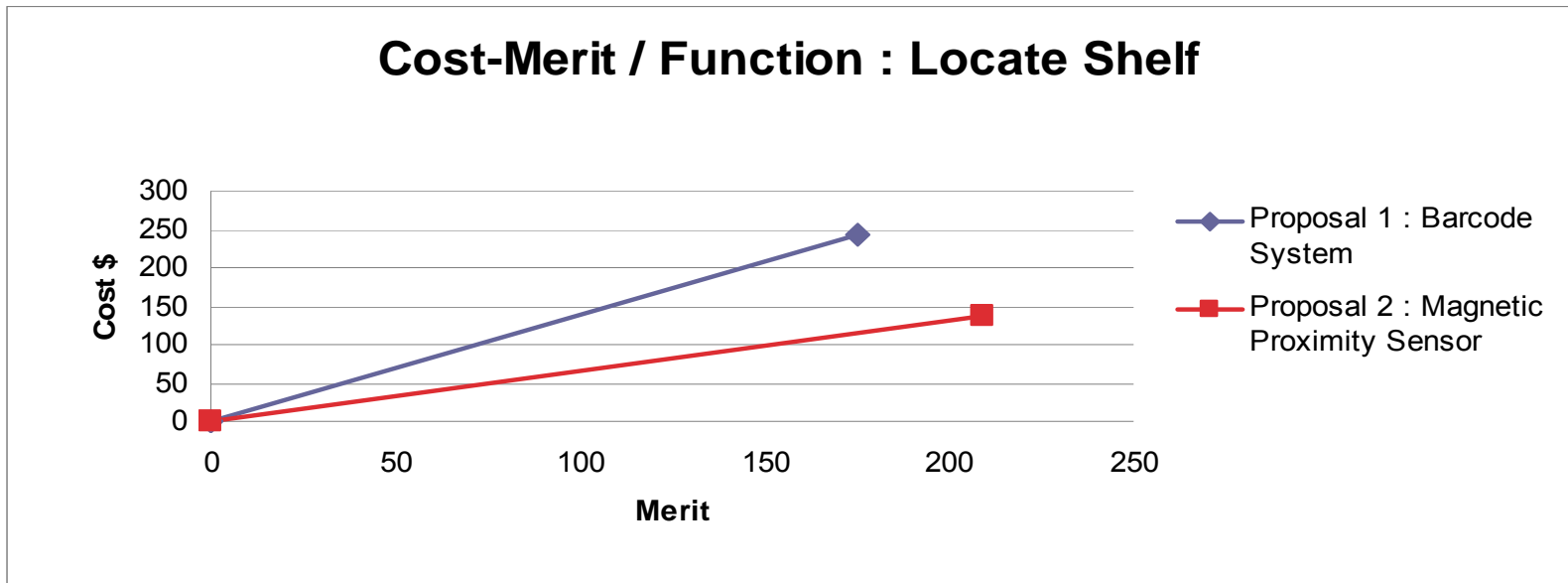
Detailed Creativity Phase

- Opened up black box of winning general concept
- Brainstormed solutions fitting general concept to perform Bottom Level Functions
- Ex:

Functions	Proposal 1	Proposal 2
Locate Shelf	Bar Code System read by lift	Magnetic Proximity sensors

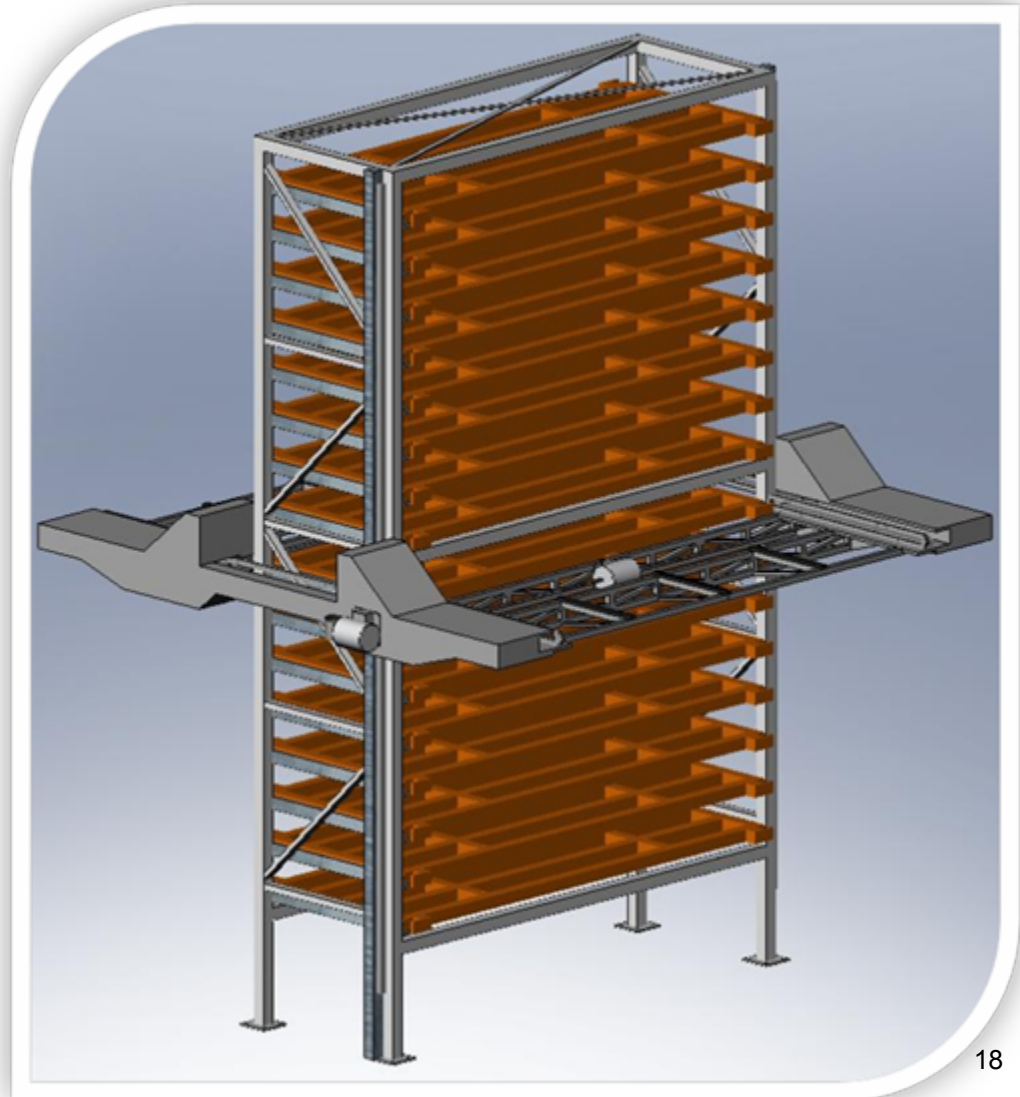
Detailed Evaluation

Cost-Merit / Function : Locate Shelf					
		Proposal 1 : Barcode System		Proposal 2 : Magnetic Proximity Sensor	
Weight	Criteria	Mark	Weighted Mark	Mark	Weighted Mark
8	Reliability	8	64	8	64
8	Speed	7	56	9	72
9	Maintenance	5	45	7	63
2	Safety	5	10	5	10
Merit		175		209	
COST \$		243.24		138	



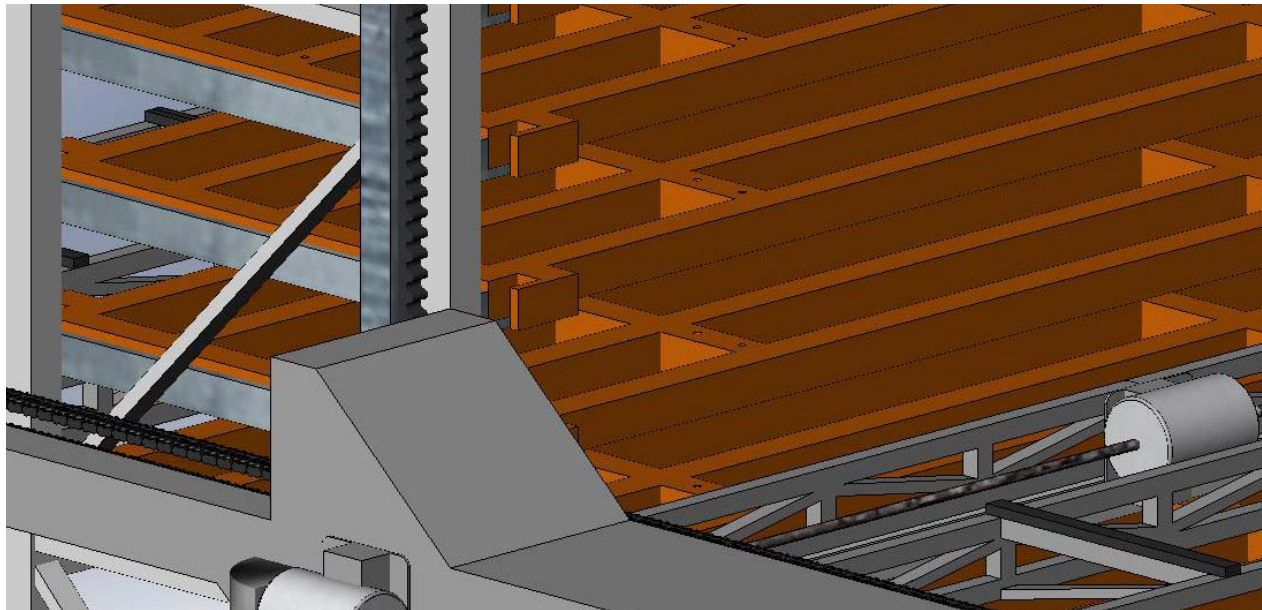
Final Recommendation

- Features:
 - One manipulator
 - 2 motors
 - 24 feet high
 - 16 storage levels
 - Secure rack



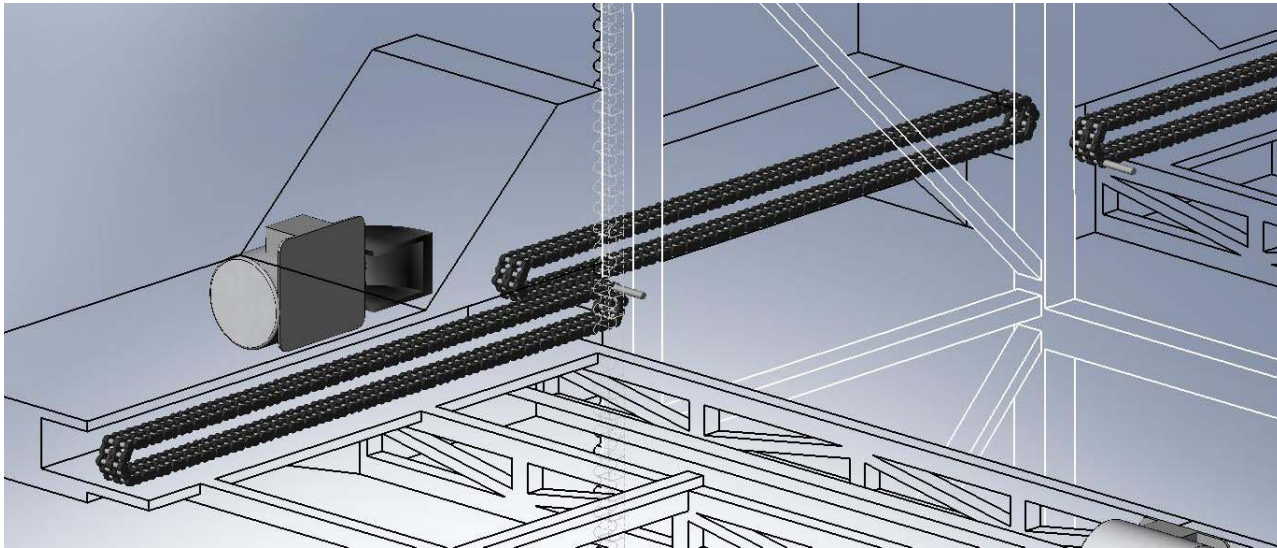
Final Recommendation

- Vertical Motion:
 - Vertical motion driven by one motor with rack and pinion
 - Stops at the appropriate height as requested by the worker's input command



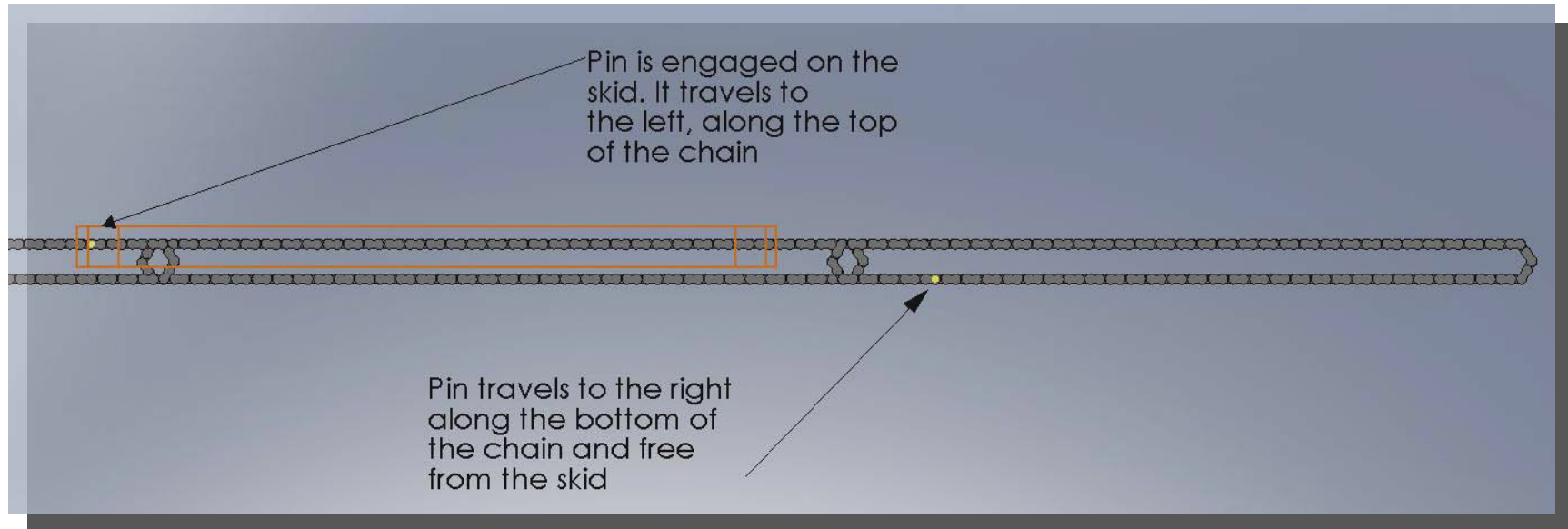
Final Recommendation

- Horizontal Motion:
 - 6 chain system (3 chains per side) with 1 motor
 - Sprockets and shafts transfer motion and force
 - 3 chains allow horizontal motion over the entire length of the manipulator bed with no interference from other components



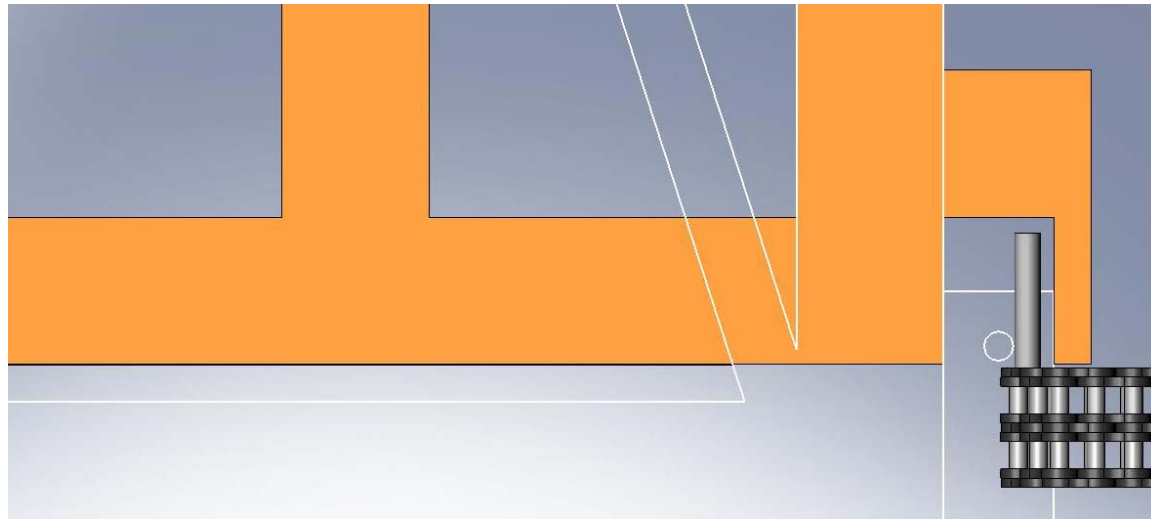
Final Recommendation

- Horizontal Motion of Skids – Side View:
 - Pins must not obstruct the movement of skid
 - Chains actuate only after the manipulator's vertical motion has stopped



Final Recommendation

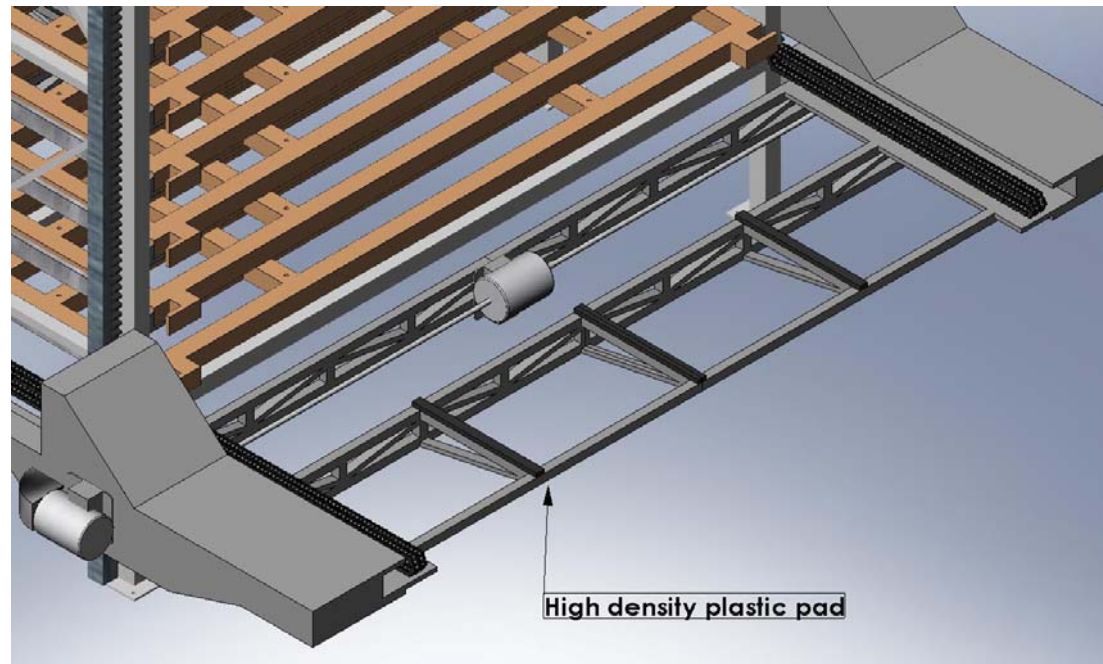
- Horizontal Motion of Skids – Top View:
 - Pins engage skid



Final Recommendation

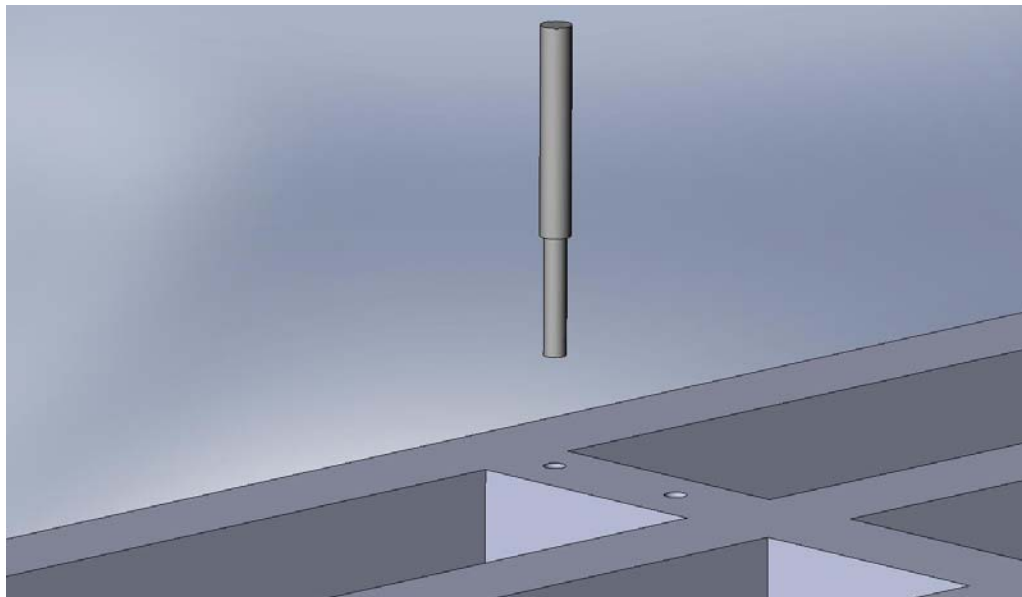
Manipulator:

- Plastic pads reduce friction → reduces the required force output of the motor
- Trusses improve manipulator's load bearing qualities
- Both motors mounted on manipulator



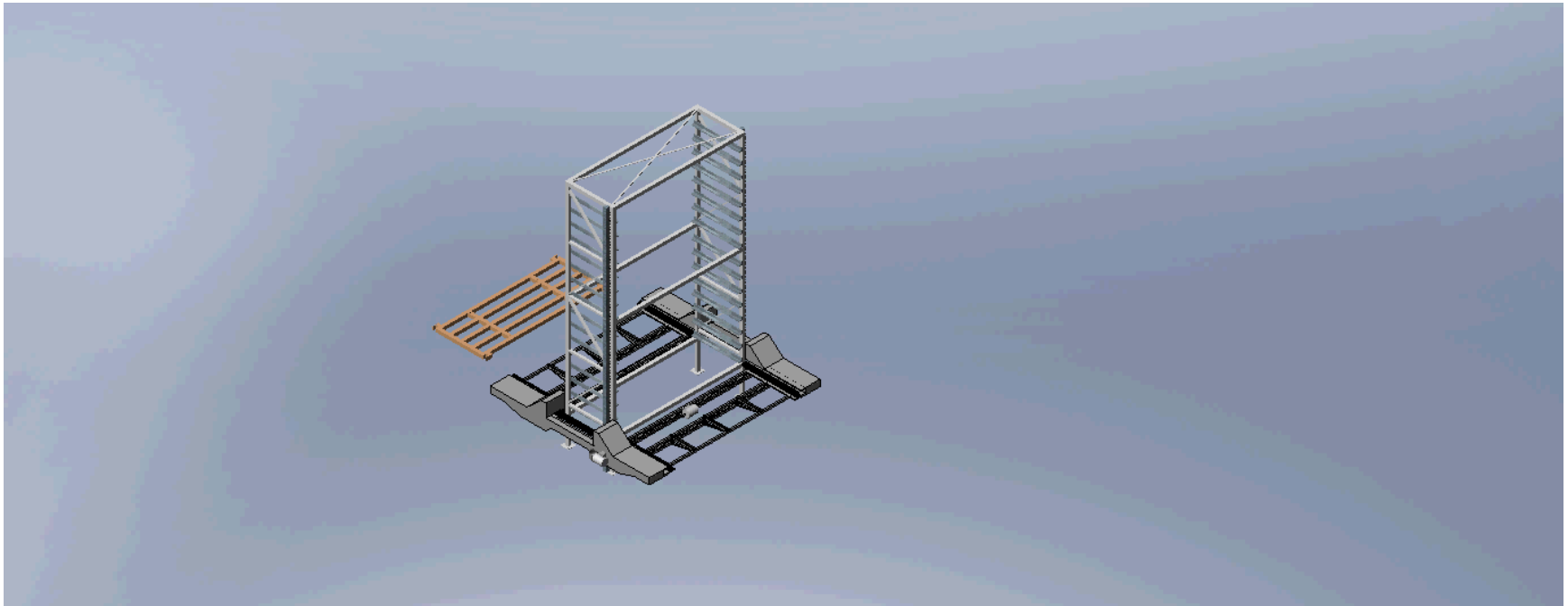
Final Recommendation

- Skids
 - Square cross-section pipes
 - Accommodates all the available sizes of aluminum sheets
 - Sheets are secured by easily removable pins
 - L - Brackets



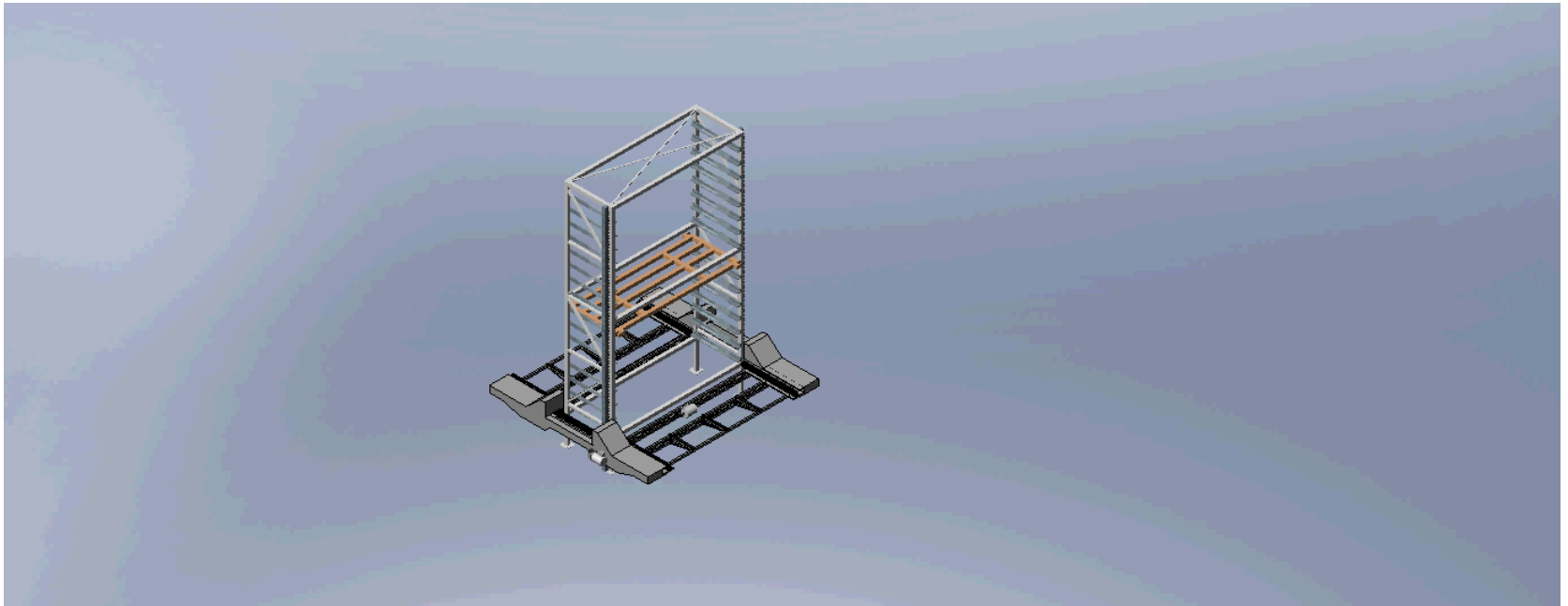
Final Recommendation

- Storage of sheet metal:



Final Recommendation

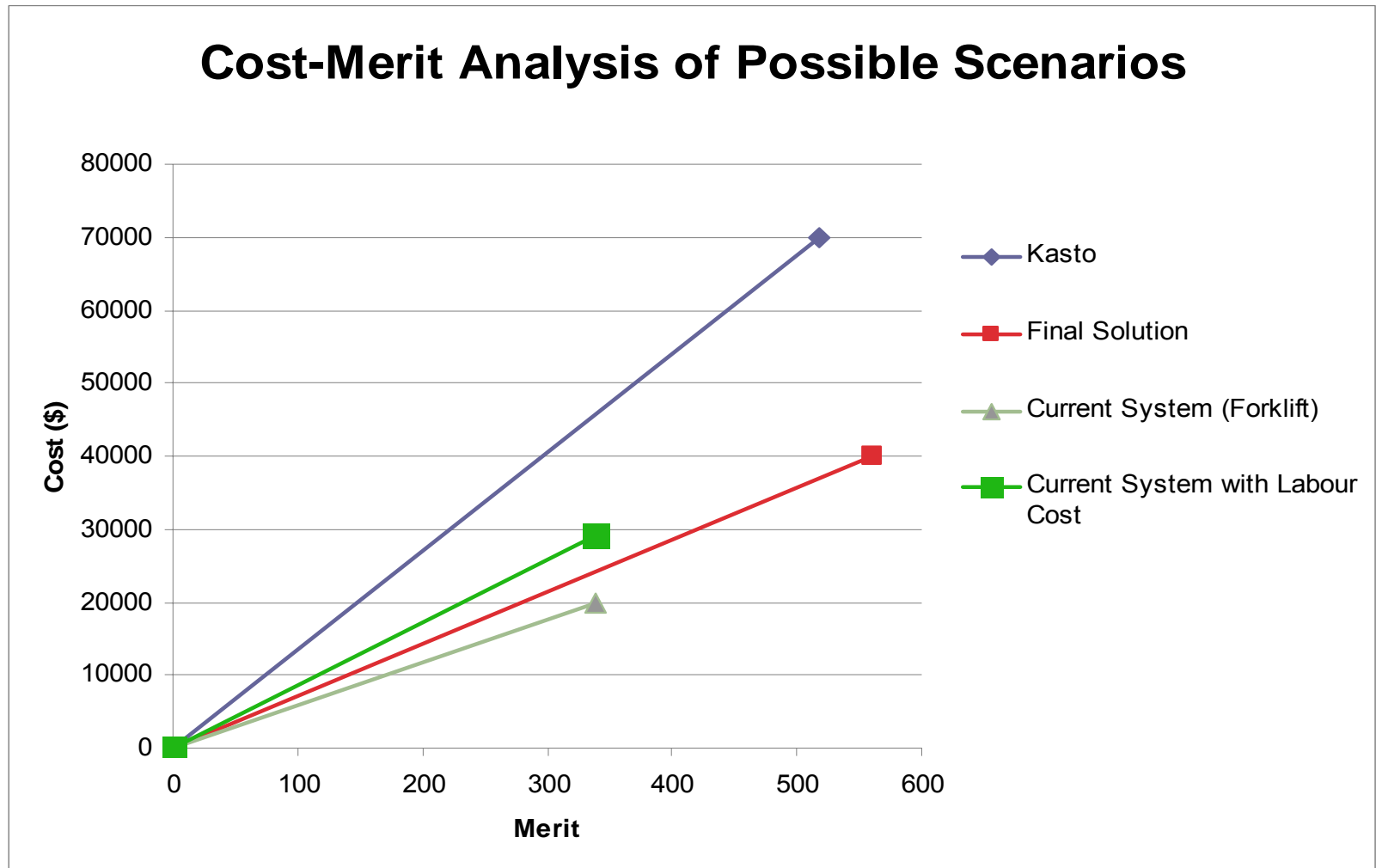
- Retrieval of Sheet Metal:



Cost-Merit For Final Solution

- Perform Cost-Merit Analysis of 3 proposals versus market standard (Kasto) and current system implemented by Tekdata
 - Set weighted criteria
 - Assign marks based on merit
 - Associated Cost
 - Value = Merit/Cost

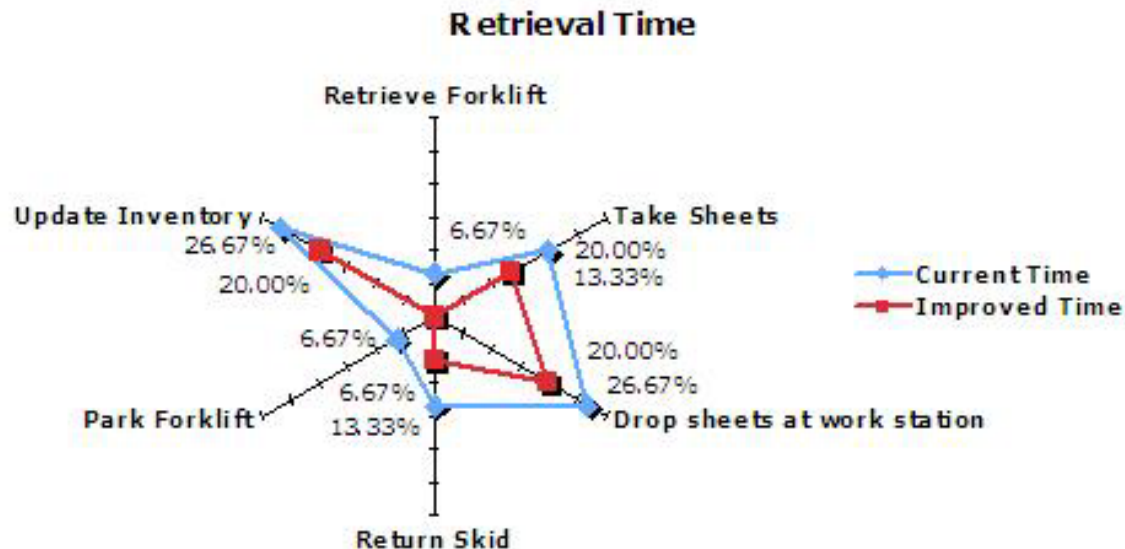
Cost - Merit Graph



Final Recommendation Evaluation



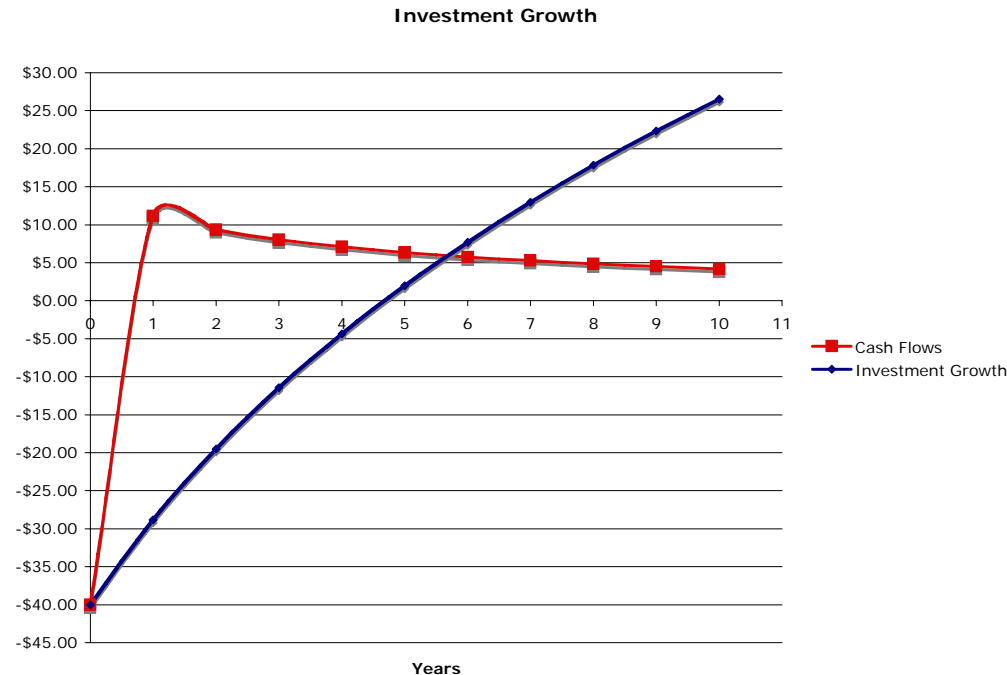
- Reduced Cost
 - In house production of the main structure
 - Initial cost estimate of 40,000\$
- Substantial time improvements
 - Yearly time savings of 342 hours
 - Yearly labour cost savings of 8,200\$
 - Improved production rate



Final Recommendation Evaluation



- Rapid payback
 - Regular payback with no discount
 - Payback period of only 4.9 years
- Positive NPV
 - Considering a growth in savings, a discount rate, and the tax shield from depreciation
 - The NPV considering the initial investment is 27,000\$
- High return on investment
 - Based on the NPV, ROI is 66%



Conclusion

- The value engineering approach to the design process helped us create an efficient and low cost system
- Our automated storage and retrieval system based on the manipulator design would:
 - Reduce labour cost to retrieve and store material
 - Increase safety on the shop floor
 - Increase the process productivity
 - Maximize the storage
- The 40,000\$ investment required would generate savings of 8,200\$ yearly
 - NPV of the savings of 27,000\$

Questions?

