Value Engineering

Jitech

Gantry Robot for the Fabrication of Structural Steel

Team Members

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Overview of Presentation

1	System Task & Opportunity
2	Value Engineering Job Plan
3	Proposed Solutions
4	Overview of Complete Solution with CAD
5	Summarize & Questions

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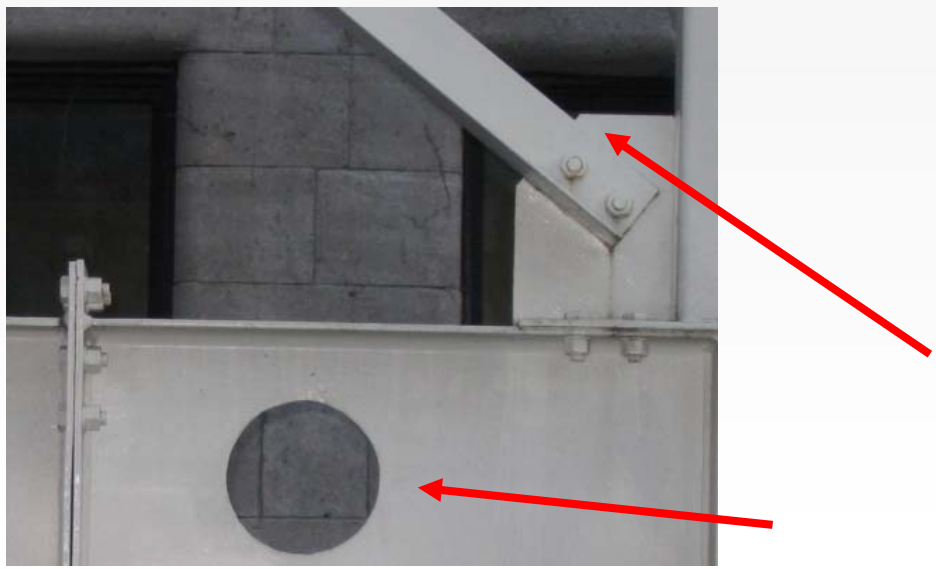
System Task

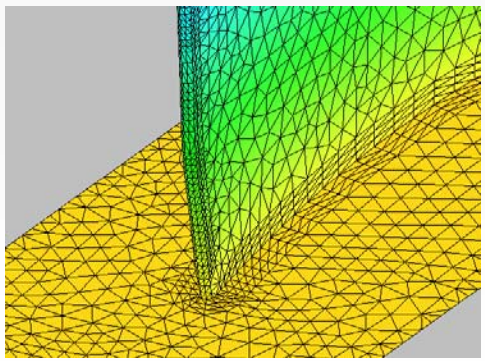
- I-Beam is placed in workspace
- 3D cut is selected by user (geometry and location)



System Task

•Scanner scans area that needs to be cut and reconciles profile with a computer model

•Computer sets coordinates: torch moves to correct location and cut is performed



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Opportunity

What is the opportunity (problem)?

-Jitech would like to enter the market for 3D automated cutting and welding of structural steel.

-No feasible, automated solution currently commercially available

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Opportunity

Why do we believe this is an opportunity?

- Jitech has seen a high demand for 3D cuts in structural steel industry

- Currently cuts are done manually, which is a costly and time intensive process

Opportunity

What are the consequences of not solving this problem?

- Jitech would be “sitting back” on a growing sector of the structural steel industry

- Philosophy is to always use cutting edge technology in order to create value for the client

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Value Engineering Job Plan

1. Organization Phase
2. Information Phase
3. Functional Analysis
4. Creativity Phase
5. Evaluation Phase
6. Development Phase
7. Implementation Phase

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Organization Phase

Problem Definition:

Fully automatic system for 3D plasma cutting of steel beams (I-Beams, Box Beams, etc.)

Goals

- **Cost-effective**
- **Highly reliable, accurate cuts**
- **Safe for all users and workpiece**
- **Relatively easy construction**
- **System adaptable for welding (tool changer)**

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Organization Phase

Scope:

- **Mechanical design (frame / rail system)**
- **Tooling options research and analysis**
- ***No programming***
- ***"Iron Dust" solution not considered***

Constraints:

- **Must accommodate 3' x 60' I-Beams**
- **No overhead gantries**
- **2 cutting areas: 2D & 3D**
- **Reasonable cost**
- **2 year overall time frame**

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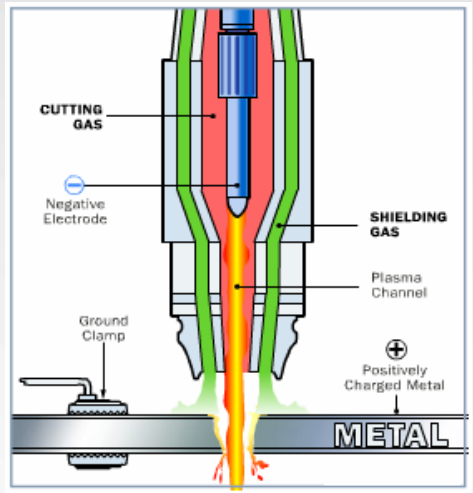
Information Phase

- Plasma cutting theory and constraints
- Research on existing 3D plasma cutting solutions
- 2D / 3D Scanners
- Existing gantries
- Servos / Rails
- Steelwork industry



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Functional Analysis Phase

Identify the functions the system must perform:

- **Intuitive Research (cut steel, control position, ...)**
- **Sequential Analysis (locate piece, scan piece, ...)**
- **Environment Analysis**
- **Movement & Effort Analysis**

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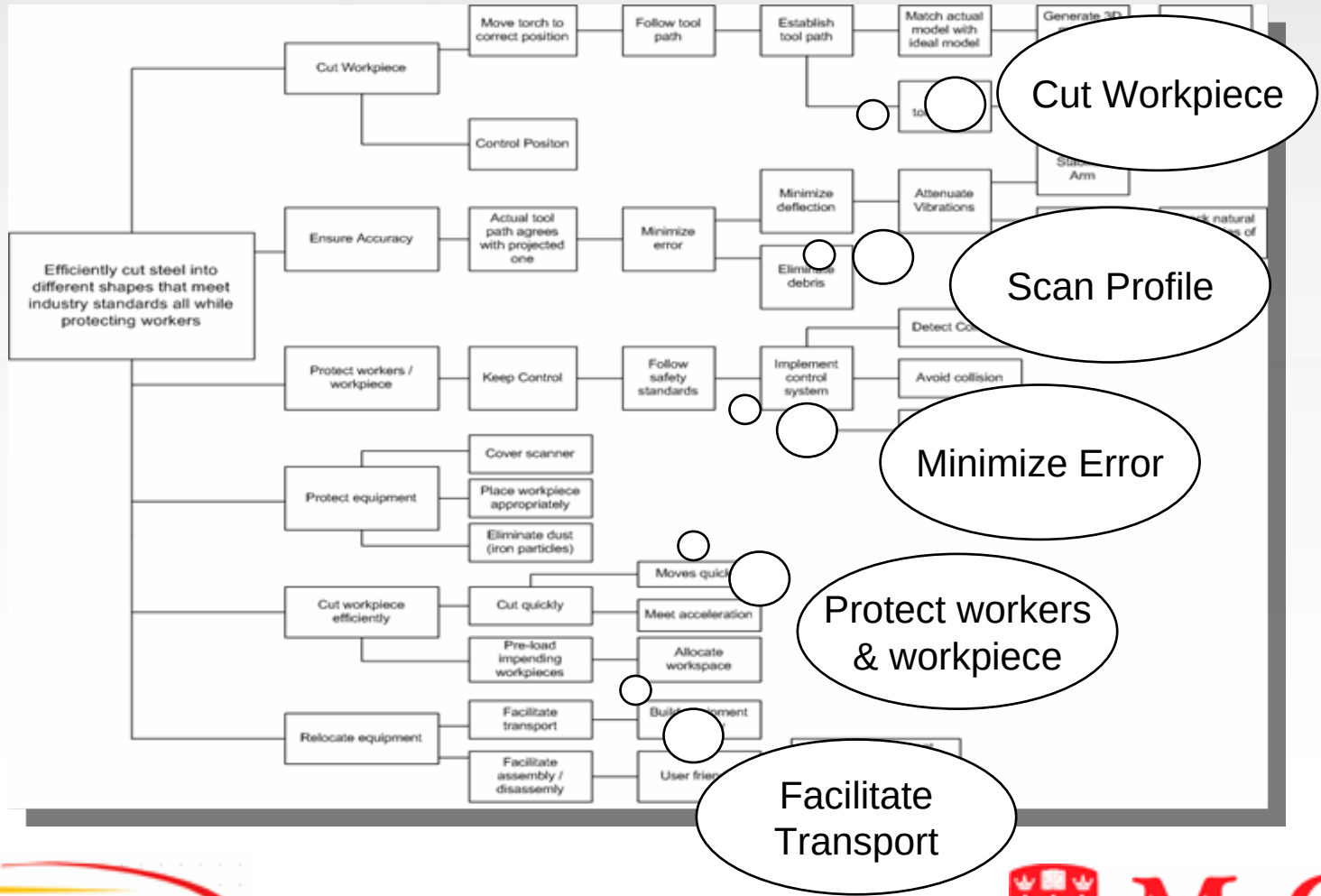
Functional Tree

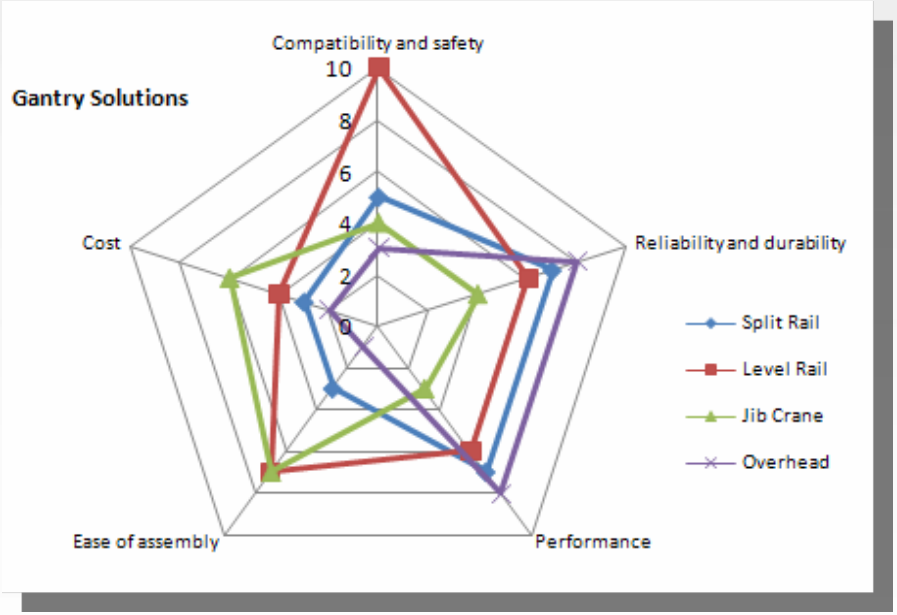
WHY ↔ HOW



Evaluation Phase

- Performance Criteria
- Paired Comparison Matrix
- Evaluation Matrix
- Spider Diagrams

Environment compatibility and safety	30%
Reliability and durability	25%
Performance	23%
Ease of assembly	10%
Cost	8%
Adaptability	5%



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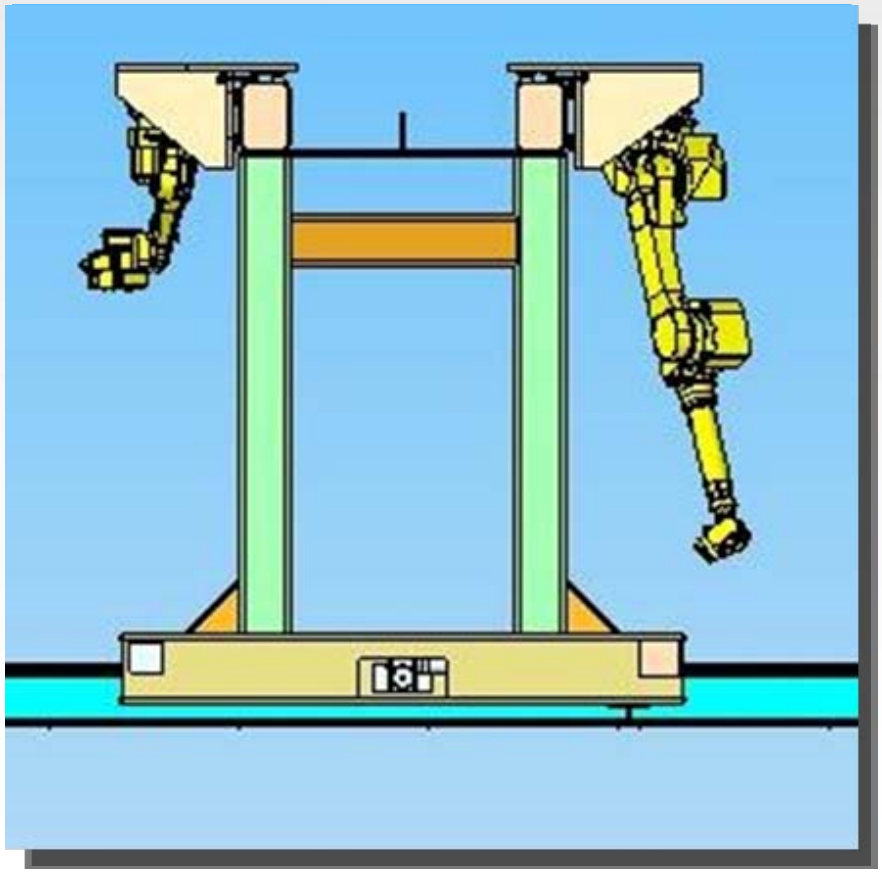
Ground Rail Gantry



- Non-invasive
- Out of harms way
- Few constraints

- Quick and easy disassembly and assembly
- Adequate rigidity

- 3-D cutting inside
- 2-D cutting on cantilever side

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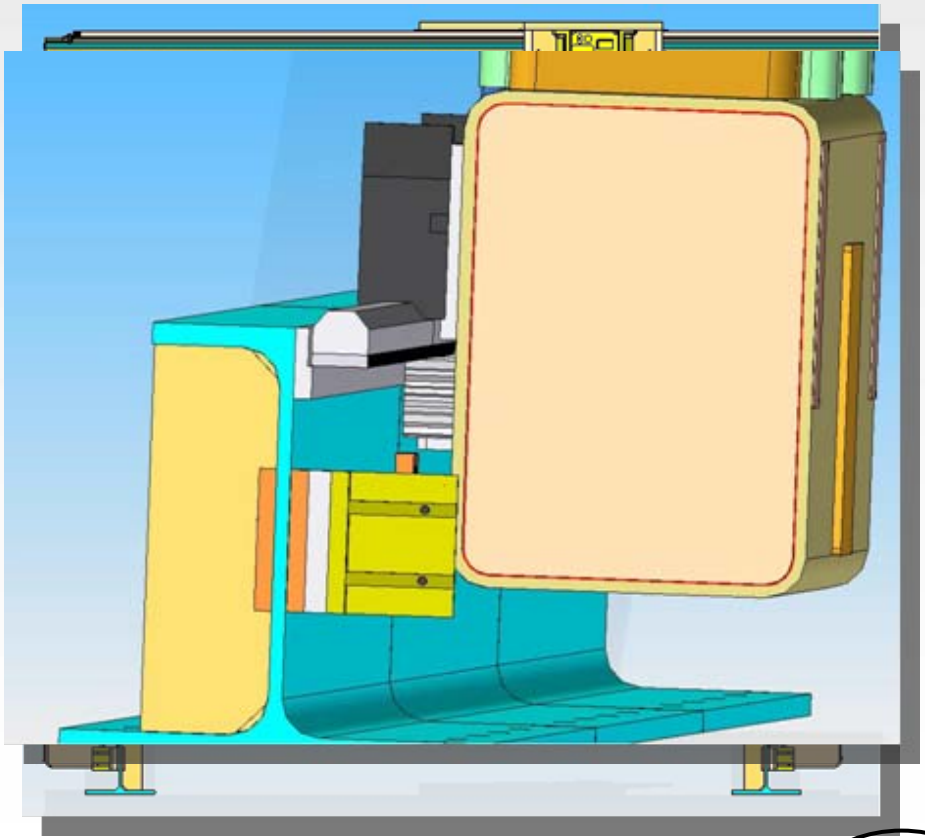
Gantry Rail Support



- Modified I-beam

- Reliable and accurate alignment
- Cost effective
- Simple and non-invasive
- Low-maintenance

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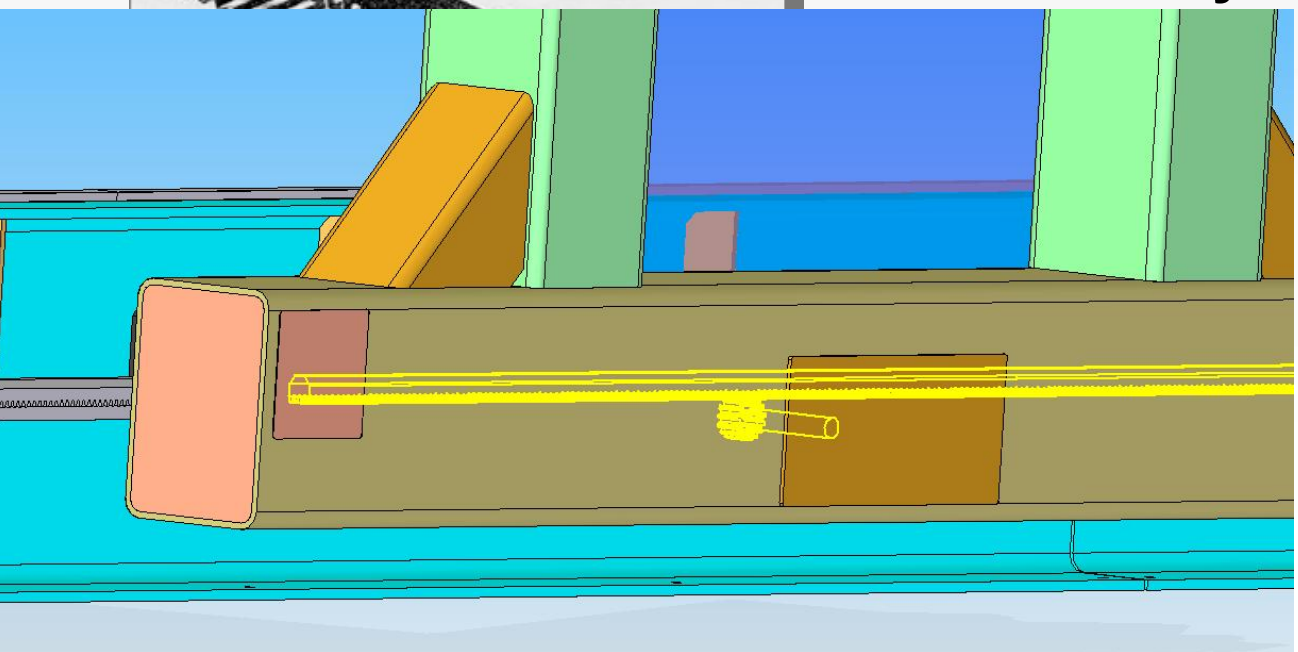
Gantry Rack and Pinion Drive

- Straight with no lateral forces
- Reliable and accurate enough for our purposes
- Comes in a package with rail system



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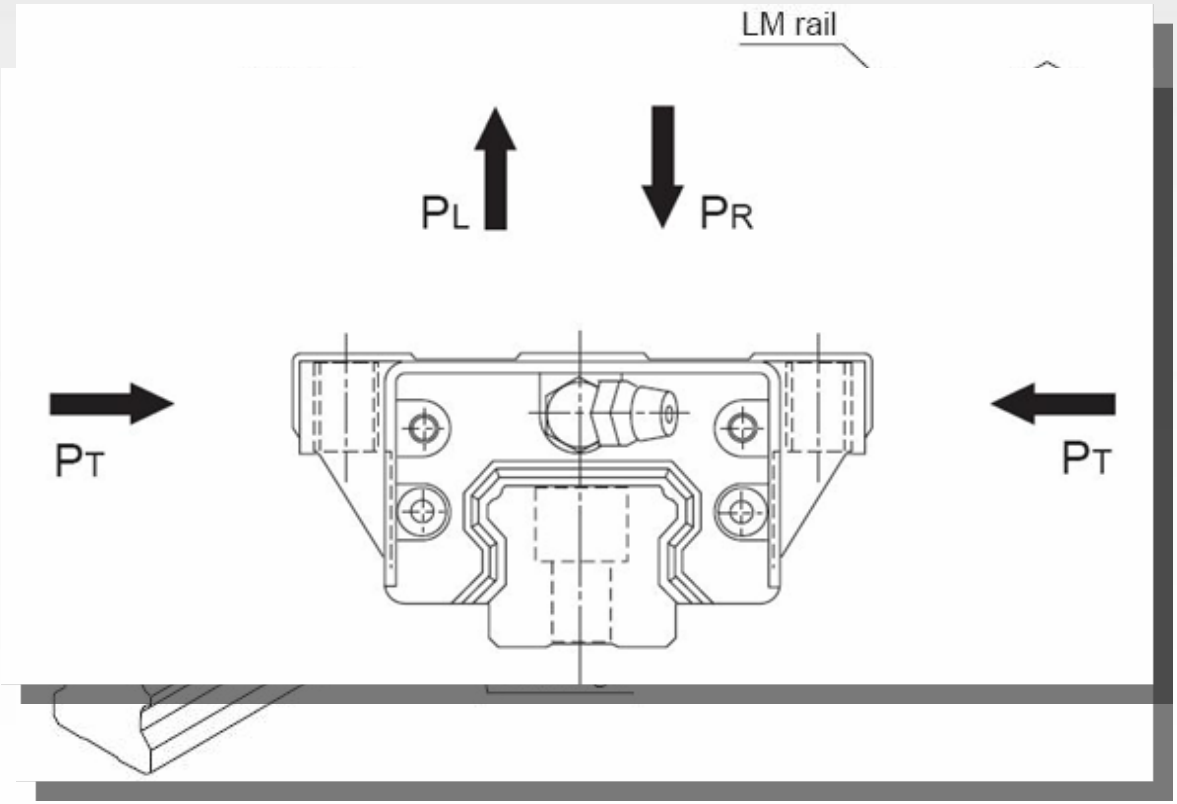
Trolley Cage Ball LM Rail



-Seamless operation

-Carriages pinch the rail so they can be placed in various orientations as required

-Low-maintenance
-Reliable

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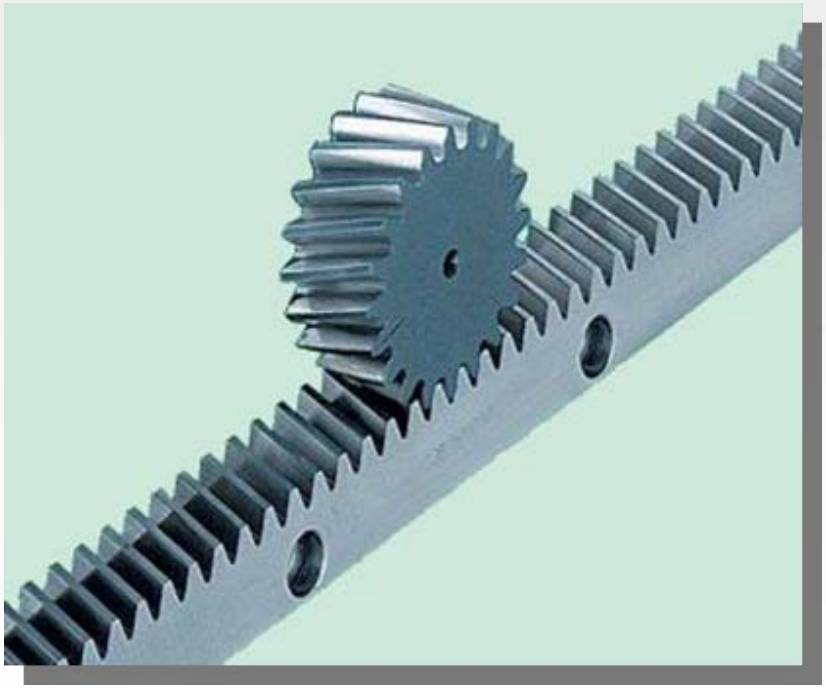
Trolley Helical Rack and Pinion Drive



- High contact ratio
- Good power transmission
- Accurate and reliable
- Easily adjustable
- Lateral forces countered by cage bearing system

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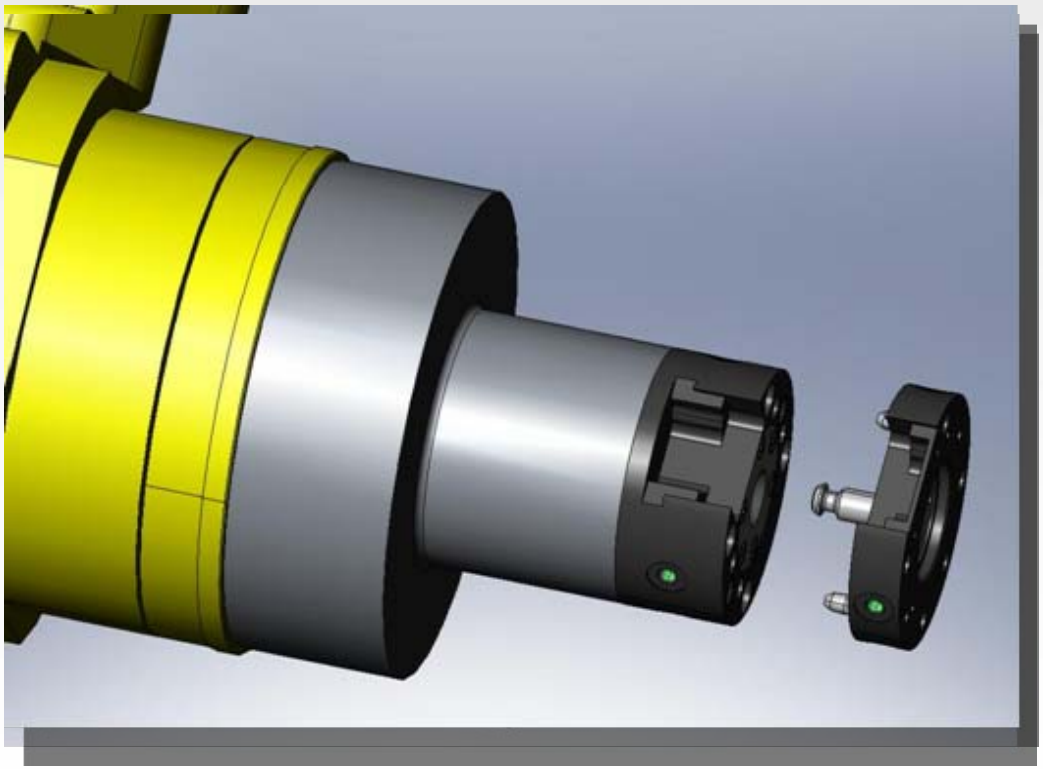
Tool Changer



- Feeds bypass tool changer
- Quick operation
- Light and non-invasive
- Air pressure operated
- Relatively inexpensive

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Scanners

Laser Line Scanners (Perceptron V5)

- **Very effective**
- **High resolution -** 14 microns
- **High number of points -** 458 000 points per second

Limitations

- **Expensive -** $55 000
- **Bulky**

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Proximity Probes

- No additional Cost
- Easy to implement

Limitation

- Cannot obtain a profile

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Scanners

Laser Probe Scanners (*MicroScan)*

- **High Accuracy -** 0.1 microns
- **High Resolution -** 0.04 microns
- **Easily Adaptable**
- **Portable**
- **Relatively Cheap -** $4 000

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Robotic Arm and Servos

Fanuc Robotic Arm M710i

- **6-DOF**
- **Electrically Servo Driven**
- **High Payload**
- **Long Reach 67 inches**

FANUC Servo Drives

Monitors feedback signals from the motor and continually adjusts for deviation from expected behavior (this is critical for any high precision applications)

Same controller as robotic arm can be used with FANUC servo drives (easy to integrate)

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Plasma Torch

HPR 260

- High quality efficient cutting
- Reliable
- Jitech Approved

Delimited Work Area

- Extremely Cheap
- However not fool proof

Cost Summary

Component	Cost (Approximate)
Robotic Arm & Controller Fanuc M710i	$35,000
Plasma Torch HyperTherm HPR260	$55,000
Gantry Rails	$6,000
Laser Scanner (inc. software)	$4,000
Trolley Rails & Structure	$15,000
Servo Drives	$15,000
Manufacturing Labor	$30,000
TOTAL	**$160,000**

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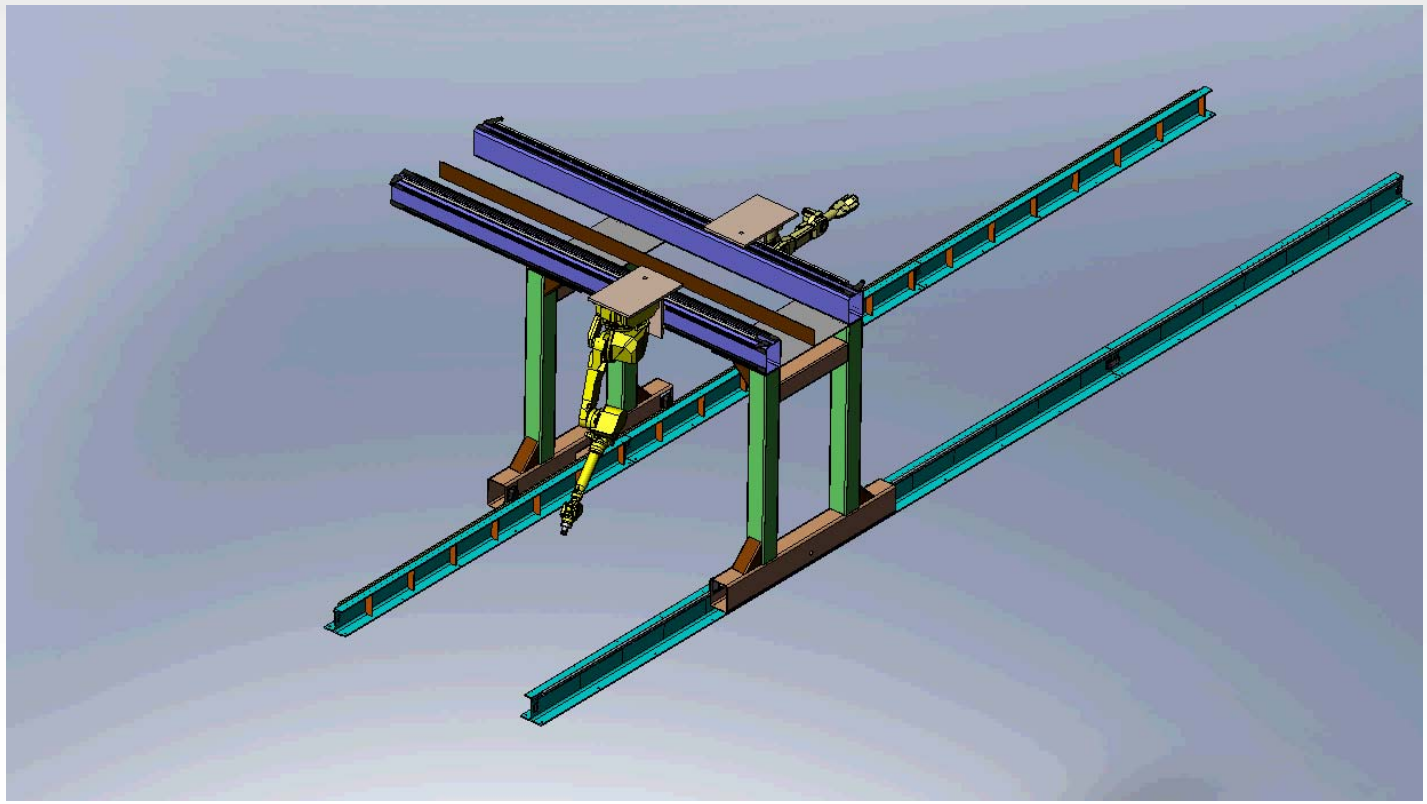
Final Concept



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Summary

Market for 3D automated cutting and welding of structural steel

Use Value Engineering methodology to develop a concept which answers Jitech's needs, and more

Future applications

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Questions

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