P09701: Corning Tropel LightGage Metrology System

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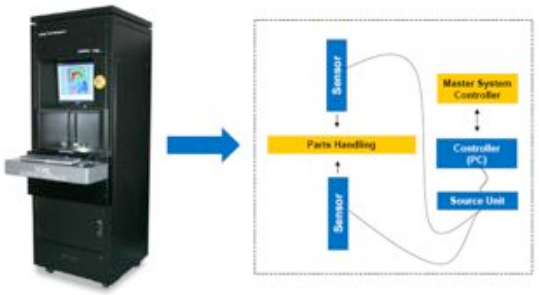
Outline

Purpose: To present P09701 System Level Design in preparation for the project's Detailed Design Phase.

Objective: Obtain approval of preliminary design and analysis before the initiation of detailed design.



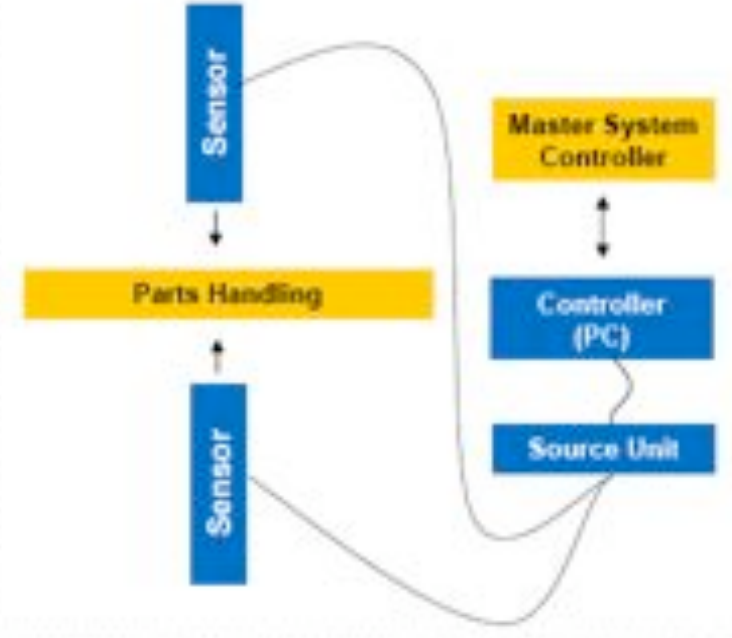
LightGage Gen.1 LightGage Gen.2

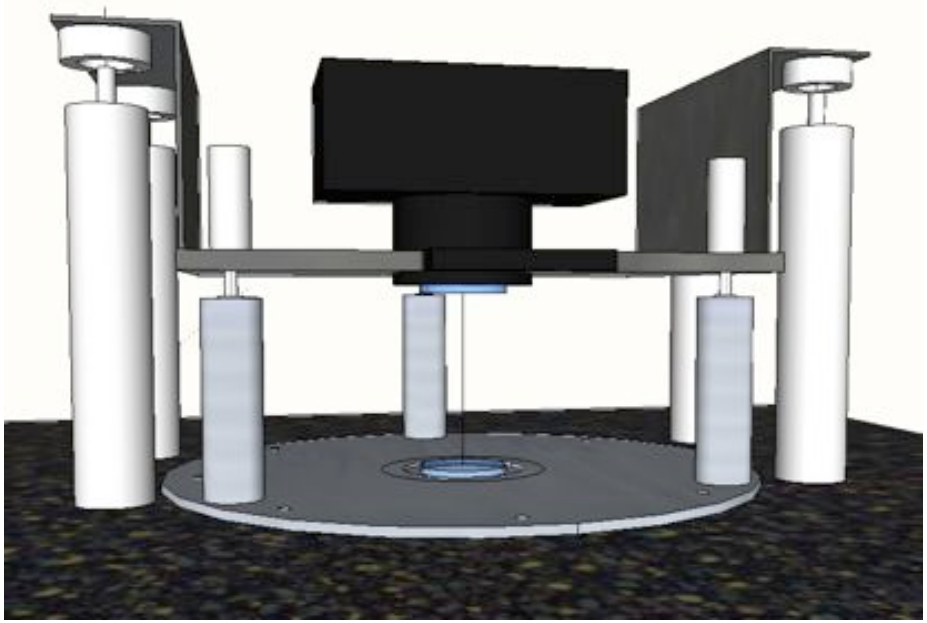
Agenda

- Project overview (15 min)
  - Purpose/Goal
  - Team Roles
  - Customer Requirements
  - Engineering Metrics
- Concept Selection Process (15 min)
  - Process Summary
  - Selection Matrix
  - System Architecture
- Preliminary Concept (15min)
  - How it Works
- Engineering Analysis (10 min)
  - Drift
  - Thermal
  - Vibrations
- Issues, Risk, Challenges (<2 min)
- Forward Plan (<2 min)
- Schedule (<2 min)
- Q&A, Further Discussion (30 min)

Problem Statement:

- Develop a system around two LightGage sensors that will allow for both sides of an object to be measured simultaneously.
- In order to achieve this, two “heads” will be aimed at one another.
- The team will develop a fixture capable of supporting the two heads as well as the part being measured.





Team Roles & Responsibilities

Name	Discipline	Contact Info
Matthew Bradley	Mechanical Engineering	mjb8482@rit.edu
Cara Portka	Industrial & Systems Engineering	csp1106@rit.edu
Benjamin Arkin	Electrical Engineering	bja1717@rit.edu
Nicholas Schneider	Mechanical Engineering	nms0286@rit.edu

More detailed descriptions can be found here.

Customer Requirements as Interpreted by Team

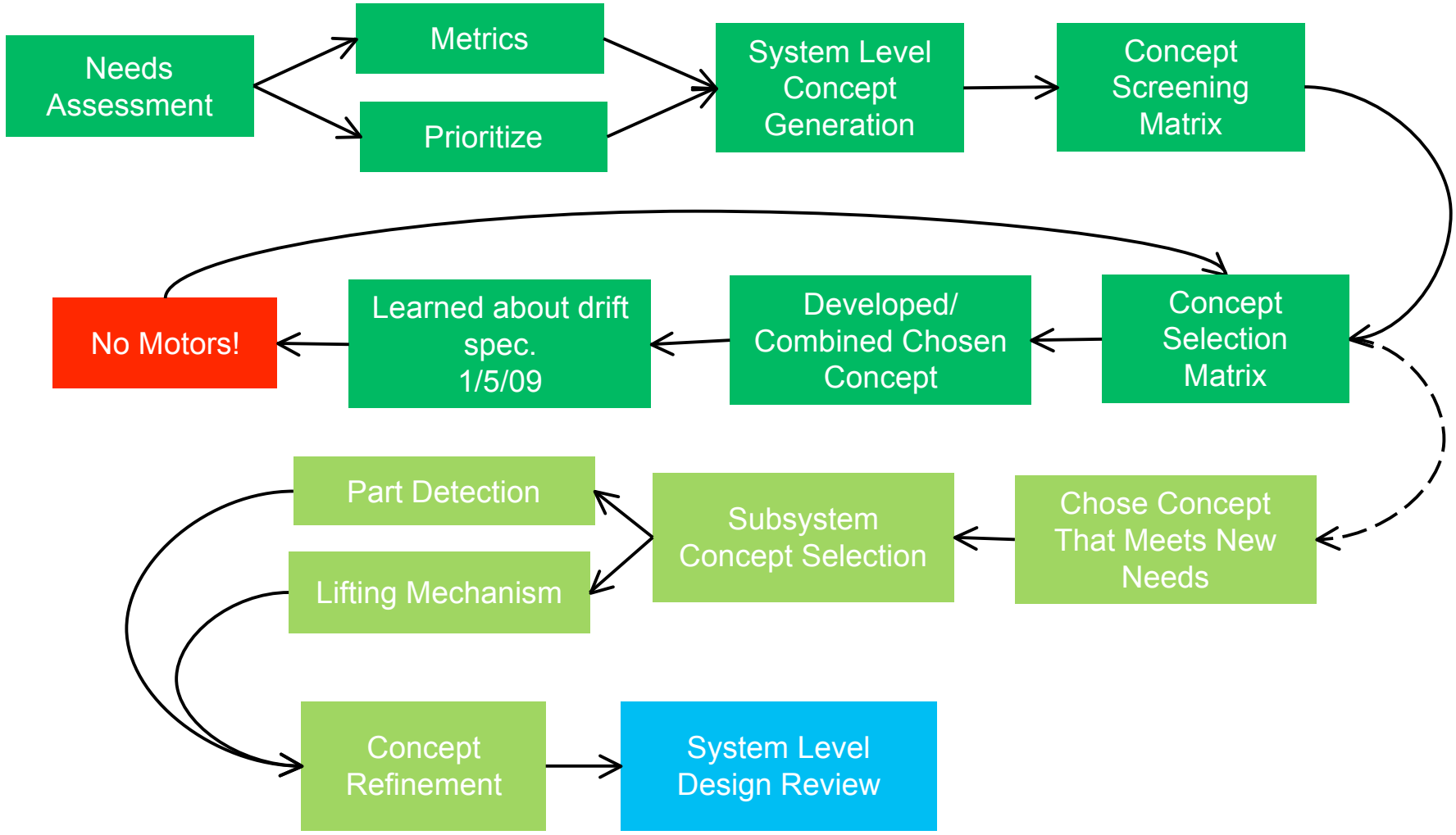
Customer Need	Need Status	Ranking	Explanation
Measure both sides of a part simultaneously	Critical to project success	# 1	This is the top-level goal of this project
Motorized LightGage head positioning	Negotiable	5	This is a proof-of-concept—manual head positioning is OK if scope needs to be narrowed.
Accommodate part thicknesses from 1mm to 100mm	Customer spec.	2	While not critical, this is one of the key goals of this project.
Ease of use for end-user	Negotiable	4	This is a proof-of-concept—customer likely to further refine concept after MSD. The MSD timeline may limit the degree to which we can achieve this.
Low complexity	Critical to meeting MSD timeline	2	Product must be sufficiently simple as to be completed within the MSD timeline.
Small form factor	Customer spec.	8	Customer would *like* relatively portable form factor. Not critical
Short setup time	Customer spec./Negotiable	5	This is a proof-of-concept—customer may relax specifications if necessary to complete within timeline.
Fast part measurement	Negotiable/Dependent on customer hardware	6	This is a proof-of-concept—measurement time depends mainly on the hardware given by the customer. Our control of this is minimal.
Environmental isolation (thermal, optical, etc.)	Critical to project success	1*	Isolation is critical to being able to measure a part—inherent in design challenge.
Repeatable Measurements	Customer spec./Negotiable	3	Product must pass customer acceptance tests—requirements may be relaxed somewhat depending on circumstances.
Polarized light between LG heads	Critical to project success	1*	Cannot measure parts unless light is polarized—one sensor will blind the other. Critical to top-level goal.

*Needs that MUST be satisfied in order for system to operate at any level—these are fundamental to LightGage operation.

Engineering Metrics

- How we judge if it works when its done:
  - Does it measure part within spec?
  - Can we get a part thickness measurement?
  - Can we get two precise surface measurements?
  - Easy to use UI
  - Does it pass Tropel Acceptance tests*?
    - Repeatability
    - Throughput
    - Accuracy

Summary of Concept Selection Process



Summary of Concept Selection Process

- Criteria used to judge concepts:
  - COTS Item
  - Cost
  - Complexity
  - Ease of Use (End User, Setup, etc…)
  - Repairability (Accessibility)
  - Stability
  - Aesthetics
  - Envelope (size)
  - Meets customer requirements

Concept Screening Matrix

P09701 Tropel LightGage

Step #1 Screening

	Concepts							
Selection Criteria	A Lego (Reference)	B Linear Stage w/ Rails	C Cantilevered	D 3Post Below Granite	E Hand Crank	F Scissors Lift	G Electromagnetic Suspension	H Elevator w/ Cables
COTS Item	0	+	0	-	+	+	-	-
Cost	0	0	-	-	+	+	-	-
Complexity	0	+	+	-	+	-	-	-
Ease of Use (End User, Set-up)	0	+	+	0	0	-	+	0
Repairability (Accessibility)	0	0	+	-	0	-	-	-
Stability	0	+	-	-	0	-	+	-
Aesthetics	0	0	0	+	-	-	+	0
Envelope	0	0	-	0	0	0	-	0
Meets Customer Requirements	0	+	+	+	-	-	-	0
Sum + 's	0	5	4	2	3	2	3	0
Sum 0's	9	4	2	5	4	1	0	4
Sum -'s	0	0	3	2	2	6	6	5
Rank		1	2	4	3	6	5	7
Continue?	N/A	Yes	Yes	No	No	No	No	No

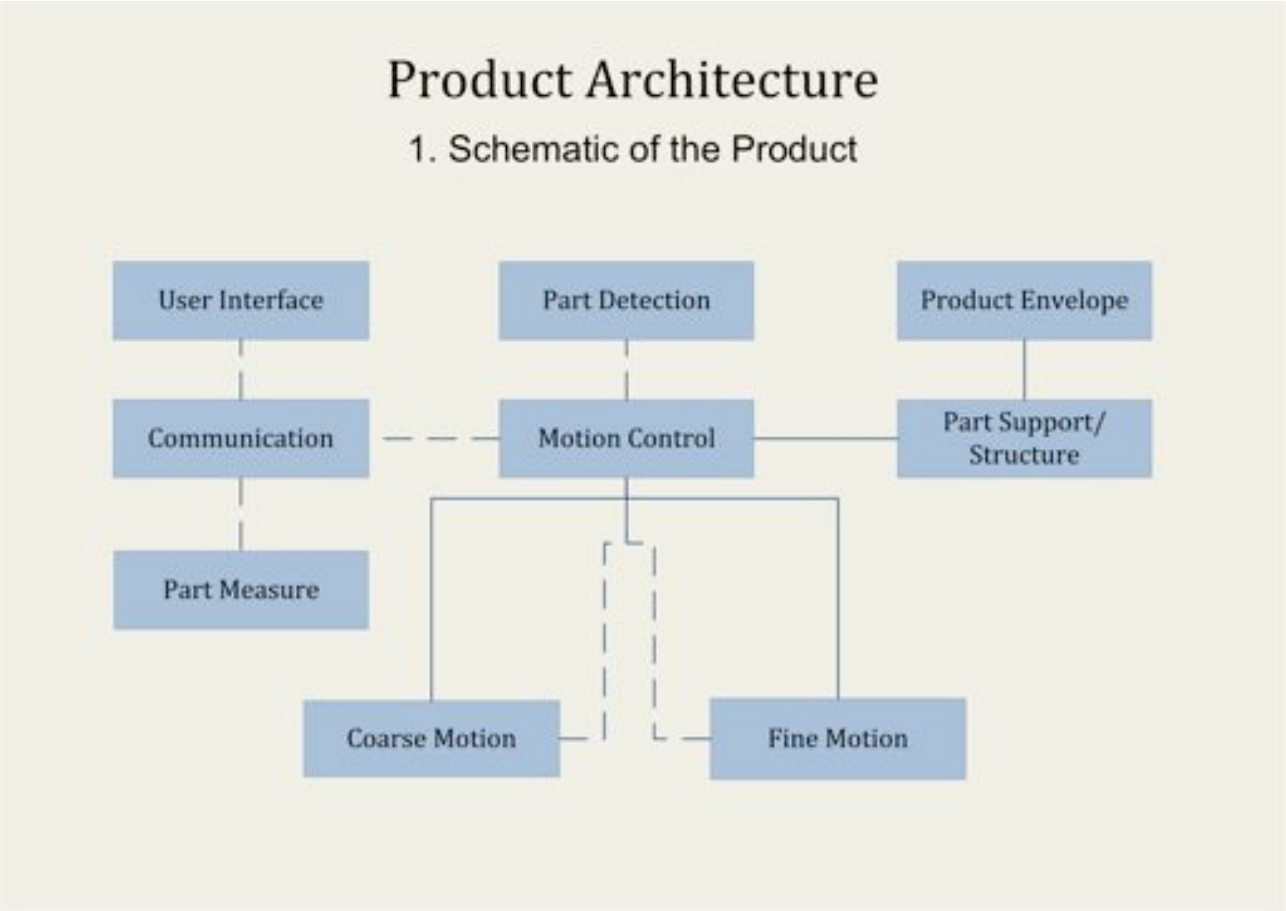
- See Week 3 deliverables

Concept Selection Matrix

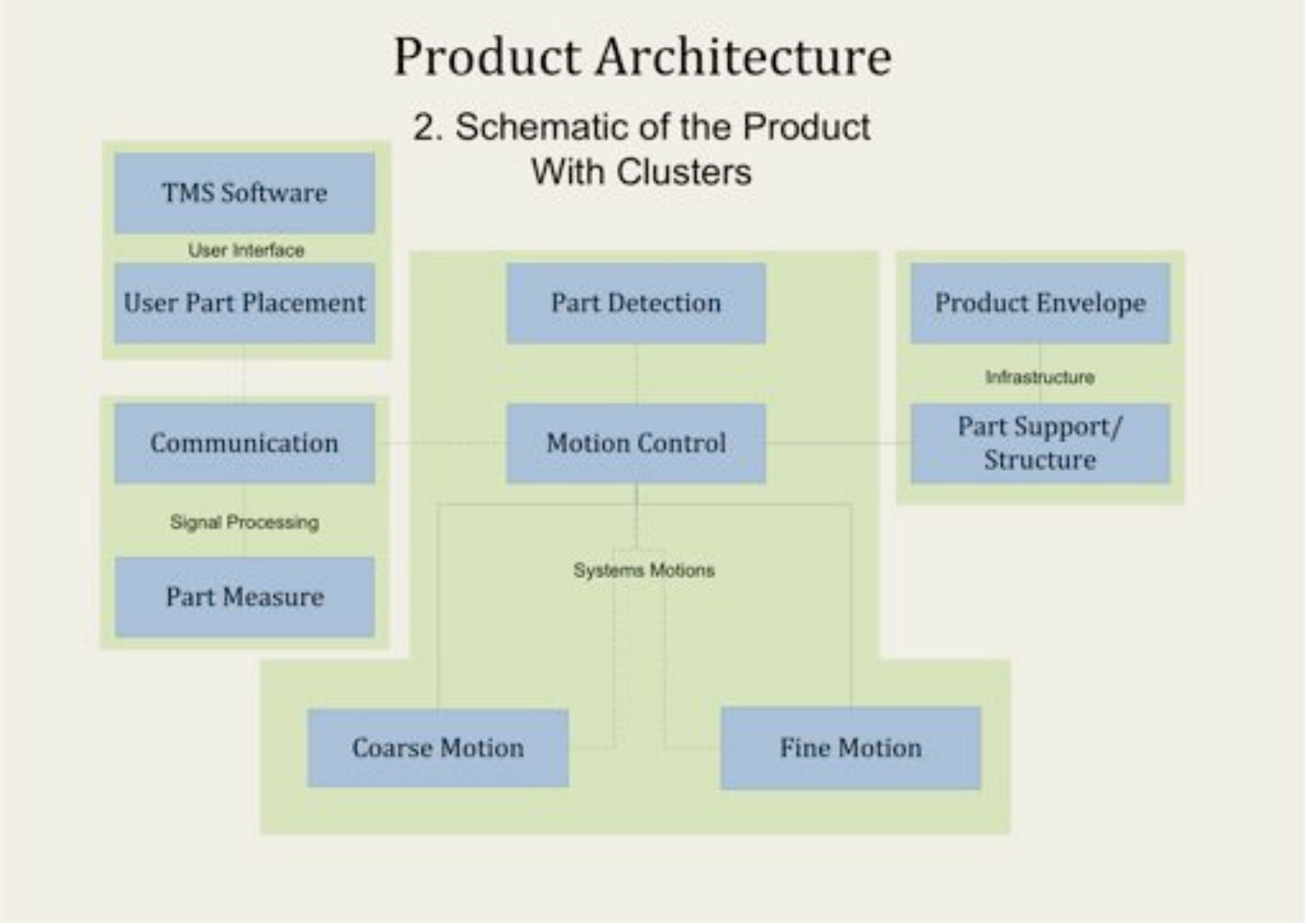
		Concepts								
		A Lego (reference)			B Linear Stage w/ Rail			C Cantilevered		
Selection Criteria	Weight	Rating	Notes	Wtd	Rating	Notes	Wtd	Rating	Notes	Wtd
COTS Item	23%	5		1.15	8		1.84	4		0.92
Cost	13%	7		0.88	5		0.63	3		0.38
Complexity	10%	9		0.90	7		0.70	8		0.80
Ease of Use (End User, Set-up)	13%	3		0.38	9	Automatic	1.13	9	Automatic	1.13
Repairability (Accessibility)	11%	8		0.88	9		0.99	9		0.99
Stability	20%	9		1.80	7		1.40	2	Inherently Unstable	0.40
Aesthetics	1%	6		0.06	6		0.06	6		0.06
Envelope	10%	9		0.90	9		0.90	1	Does not Fit	0.10
	Total Score	6.94			7.64			4.77		
	Rank	2			1			3		
	Continue?				Yes					

- See Week 3 deliverables

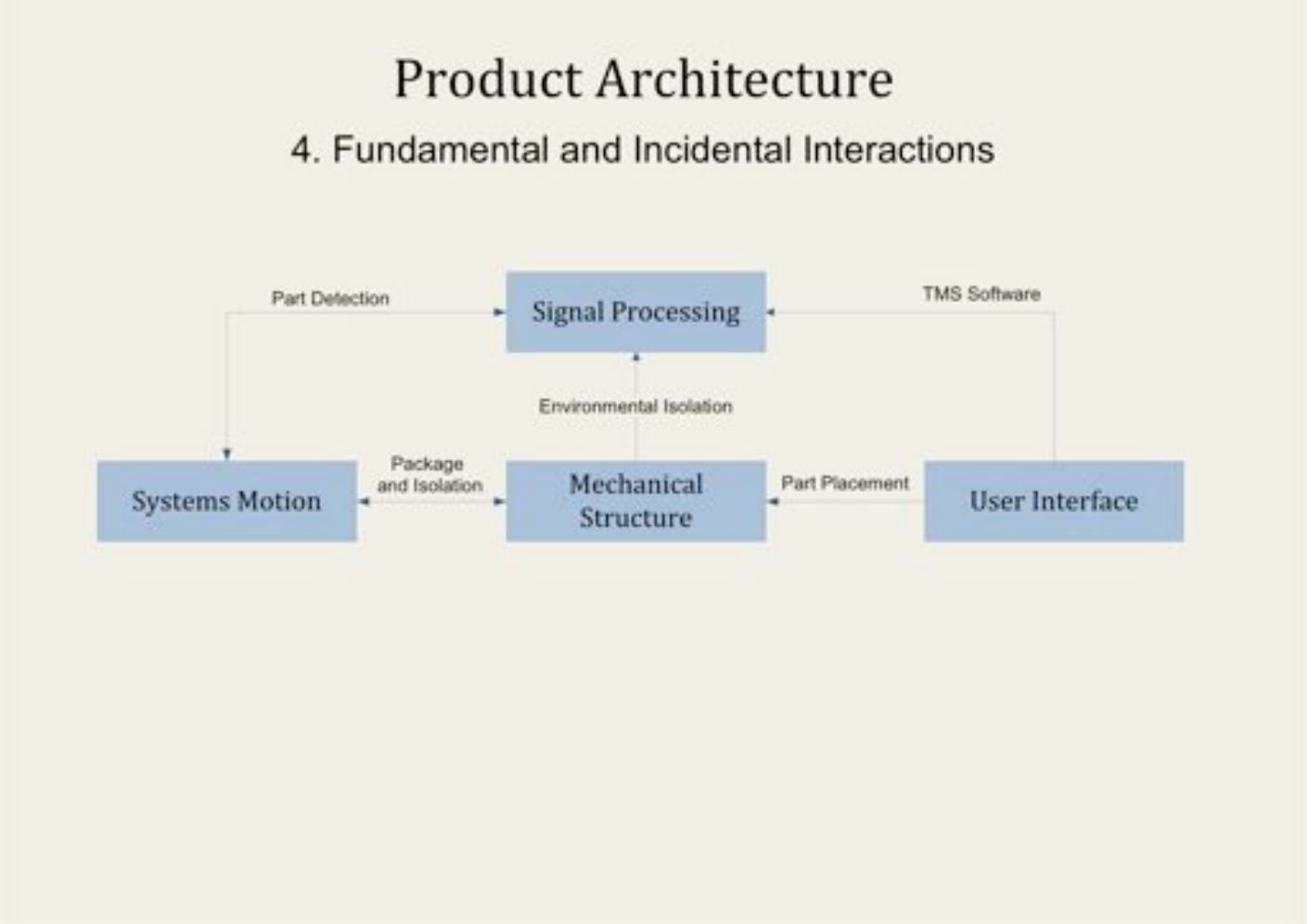
System Architecture



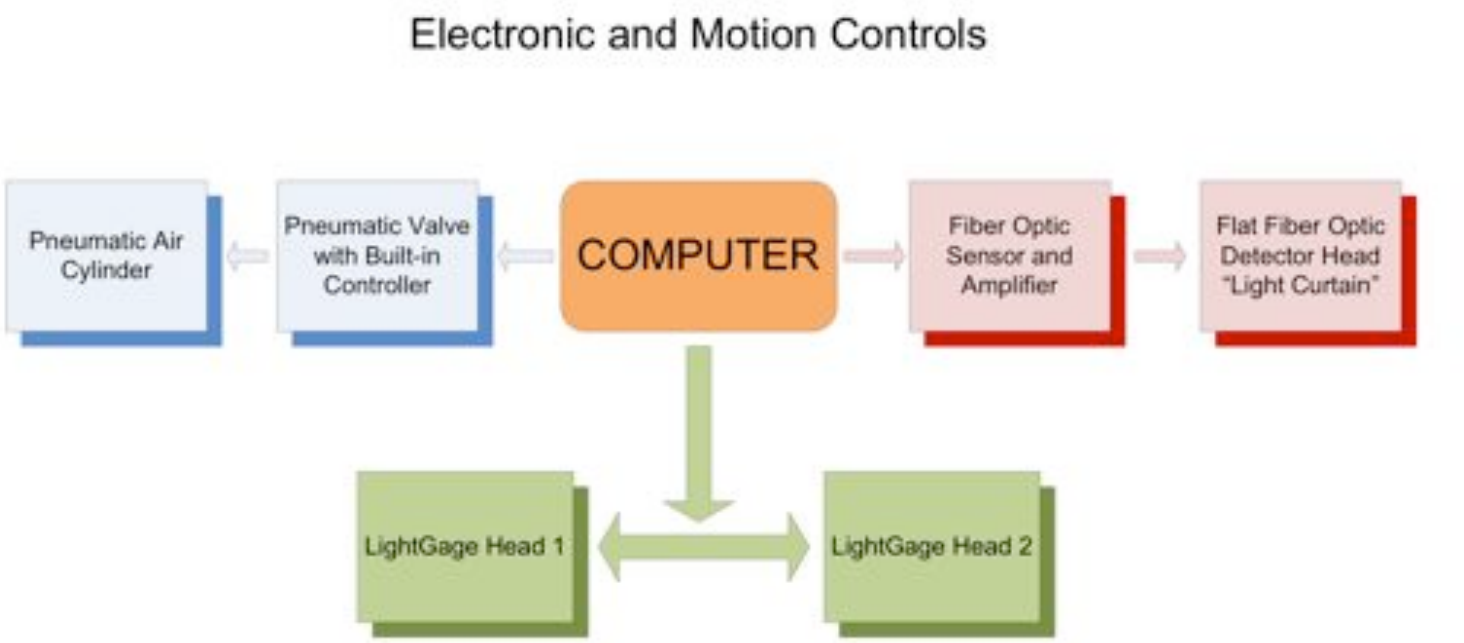
System Architecture



System Architecture



System Architecture



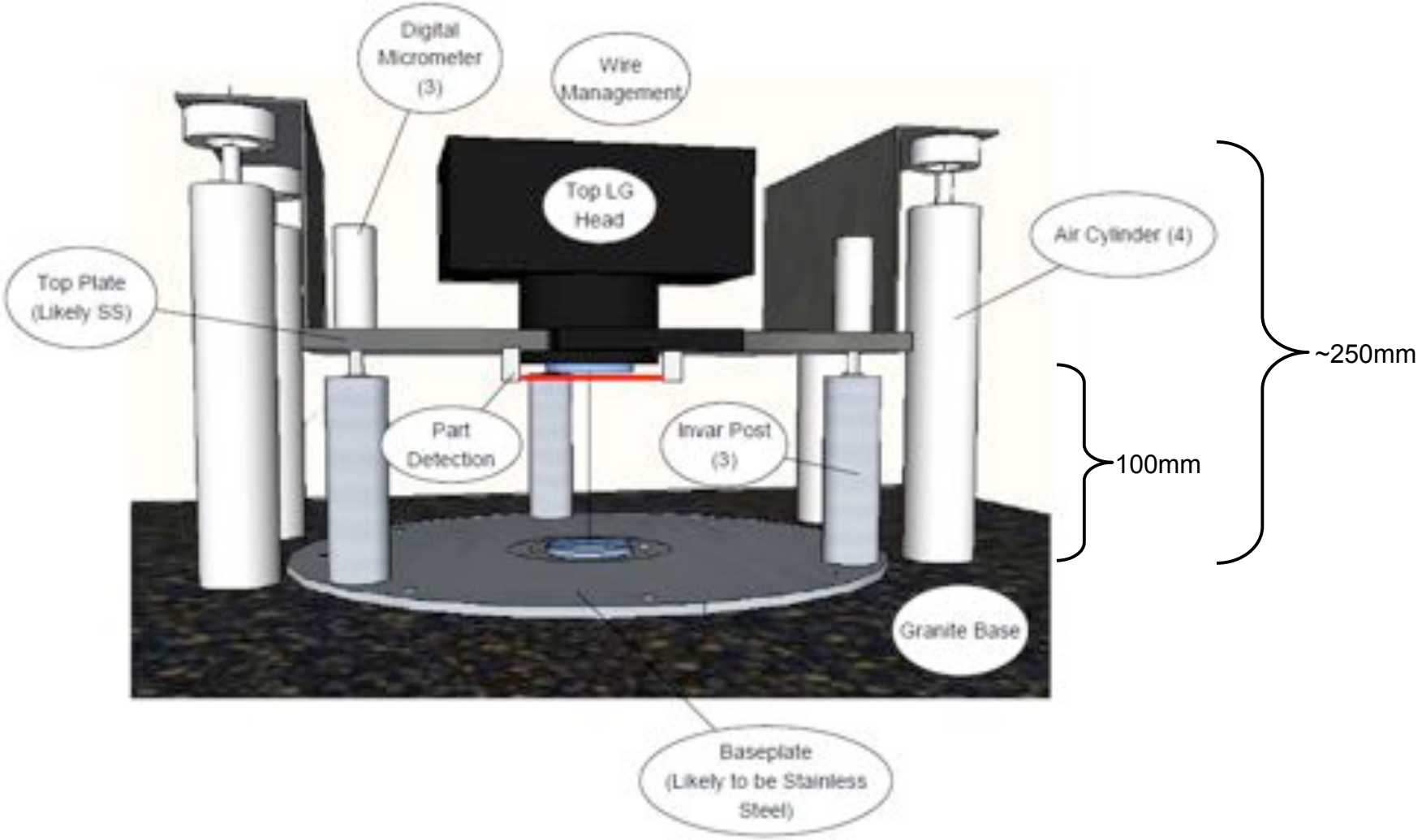
Concept Summary: System Component Descriptions

- Motion Control:
  - Coarse: Designed to require minimal fine adjustment
  - Fine: Allow for nulling and fine adjustment
- Part Detection: Prevents damage to LG Head
- User interface:
  - Computer: Provides user interface with software and measurement control
  - Structure: Allows for part placement and height adjustment
- Envelope: Provides isolation and structural support

Concept Summary: System Component Solutions

- Motion Control:
  - Coarse: Three Invar posts designed for specific part sizes—to set distance between LightGage fizeaus.
  - Fine: Three Digital Micrometers for precise positioning
- Part Detection: Light Curtain informs user when part is at ideal distance from top fizeau and serves as safeguard.
- User interface:
  - Computer: Laptop isolated from product structure
  - Structure: Allows for part placement and height adjustment
- Envelope: Pneumatic cylinder used for lifting during part placement.

Concept Summary: Proof of Concept



Concept Summary: How the System Works

1. System begins in the elevated position, held above posts by air cylinders. This allows user to place part on harp and/or change post size between measurements.