

EmTech

The Library Service Center

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Georgia Institute
of **Tech**nology®

*This document has been created in the framework of a student design project and the Georgia Institute of Technology does not officially sanction its content.

PROJECT OVERVIEW

Problem

Relocating 1.5 million books

Ingesting 2.5 million books

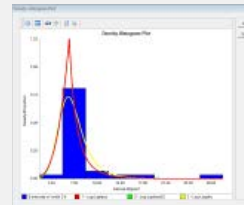


Methodology

Problem Definition

Data Collection
and Validation

Interpretation



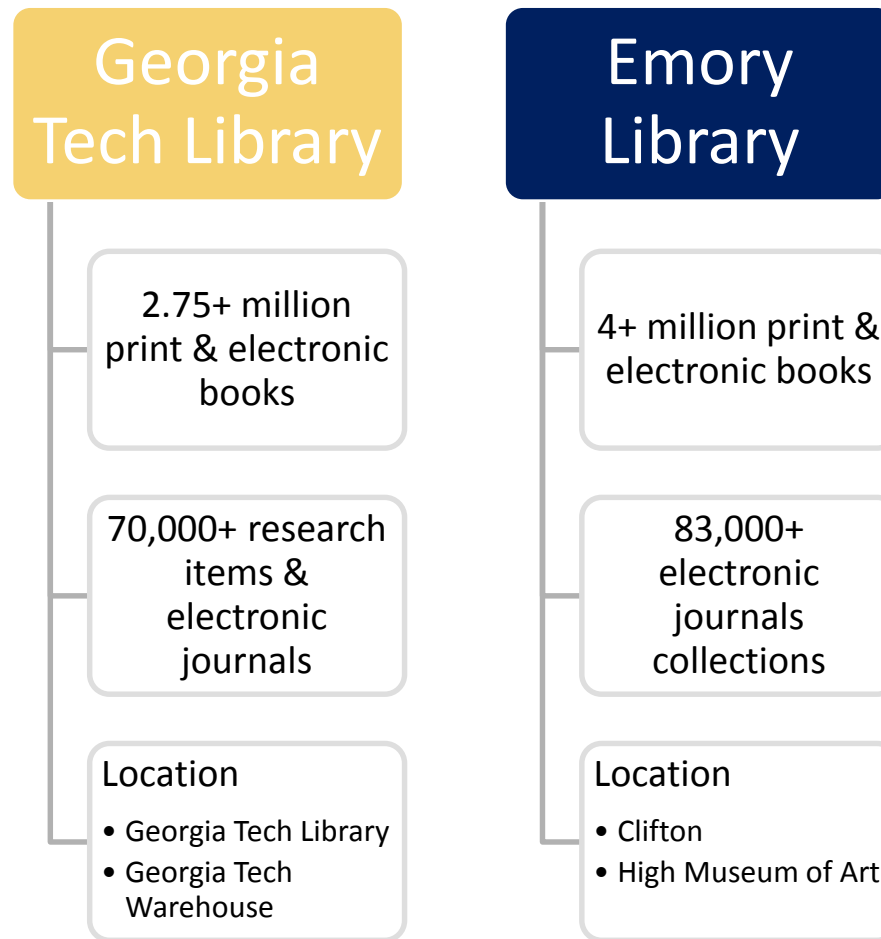
Deliverables

Library Relocation Portfolio

Cost Function Model



EmTech: “serves as a single, off-site collection for both Georgia Tech & Emory University.”



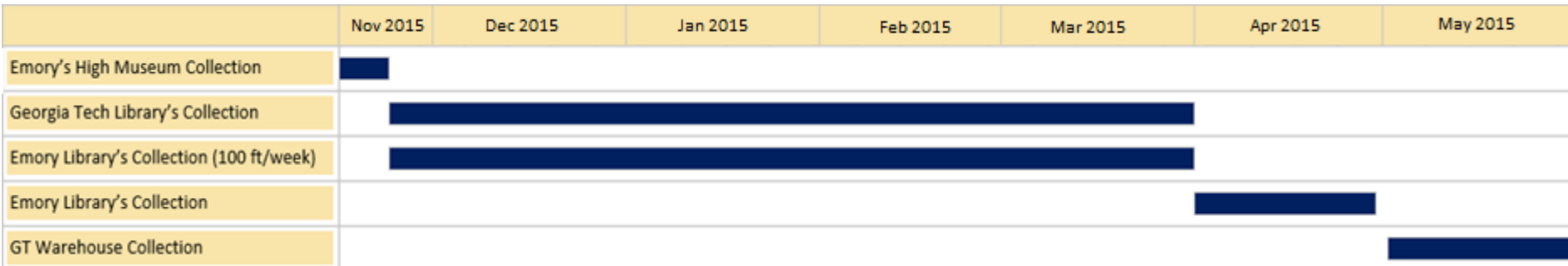
PROBLEM

Design a plan to relocate 1.5 million books from Georgia Tech, and ingest a 2.5 million combined collection.

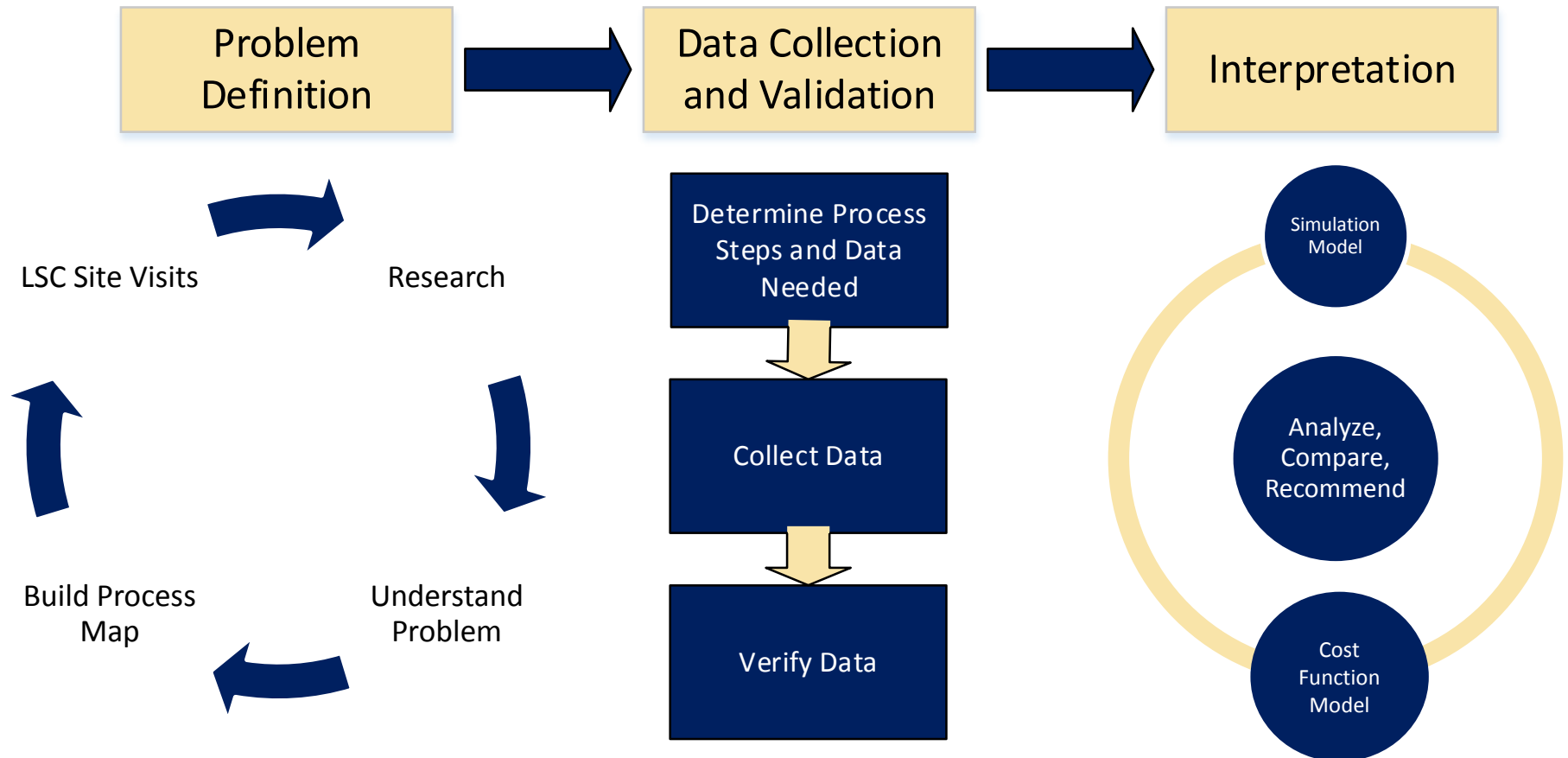
Five month
total timeline

Twenty-four
hour cycle time

\$2 per book
estimation



METHODOLOGY OVERVIEW



We visited University of Georgia, Duke University, and University of South Carolina to learn more about their LSCs

Key Takeaways

- Many LSCs use the same type of equipment:
 - Raymond pickers
 - Gryphon book trucks
 - Zebra barcode printers
- Standardized barcode placement is important
- Book trucks and plastic totes were used for book transportation
- Processing layouts varied



Raymond picker at USC

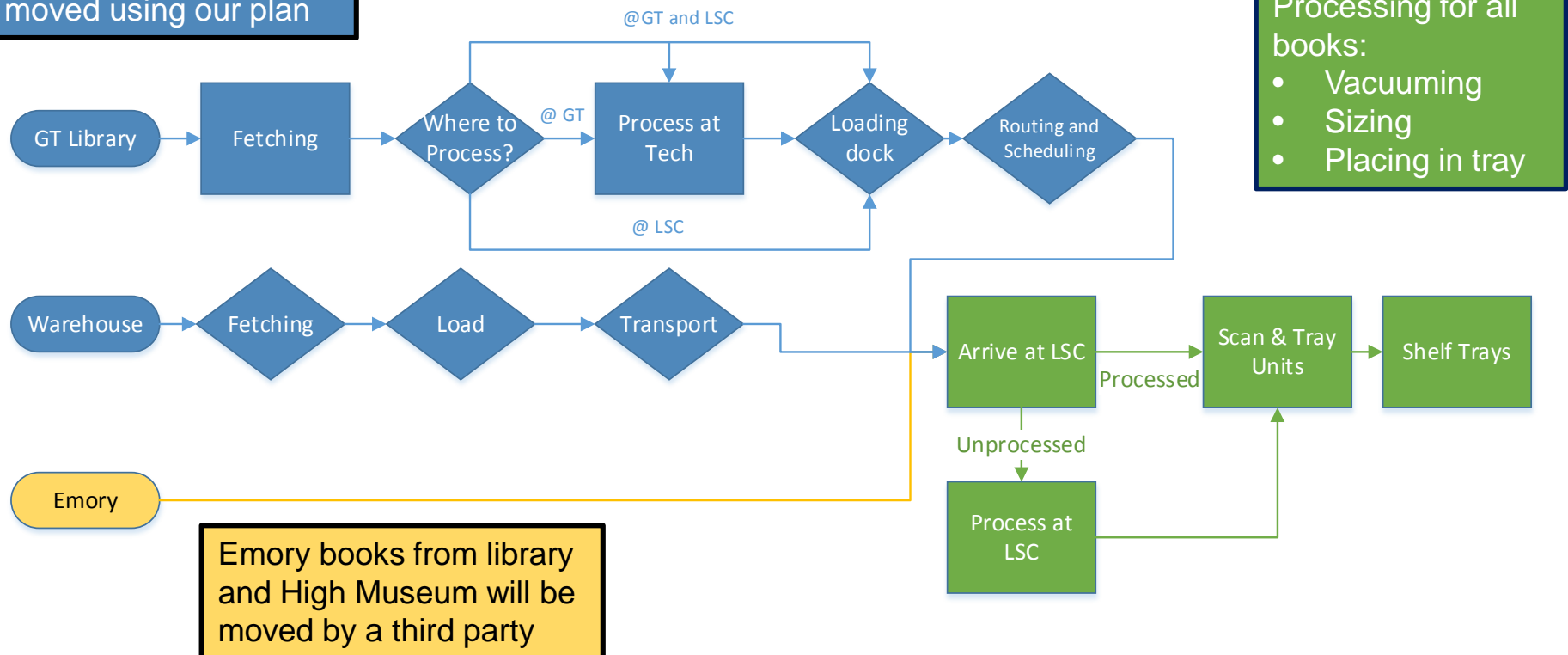


Vacuum table at Duke

OVERALL PROCESS MAP

We have created a process map for the scope of our project, separated by book origin.

GT books from library and warehouse will be moved using our plan



Time Studies

- Broken down by task
- Ensure statistical significance

Research

- Industry standards
- Equipment costs

Processing at GT

Unload cart to
waiting area or
first station

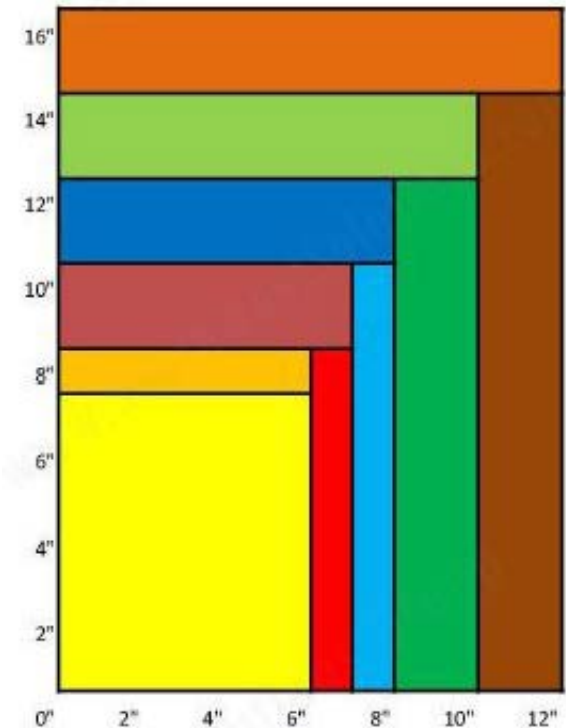
Vacuum books

Size books

Tray books

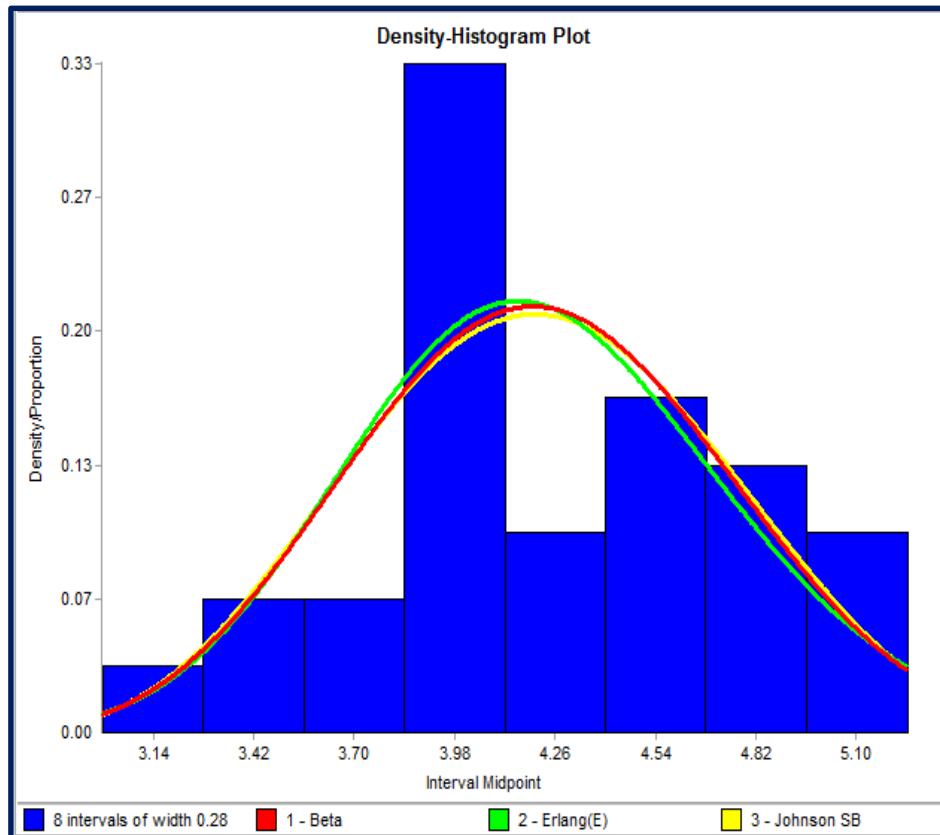
Time Study

- 30 trials sizing 10 books each trial
- Different sets of books for each trial
- Multiple people switching roles



Book sizing template

ExpertFit outputs for book sizing data:



Density-Histogram Plot overlaying distributions on sizing books

Anderson-Darling Test with Model 1 - Beta

Sample size 30
Test statistic 0.32825

Note: No critical values exist for this special case.
The following critical values are for the case where all parameters are known, and are conservative.

Sample Size	Critical Values for Level of Significance (alpha)					
	0.250	0.100	0.050	0.025	0.010	0.005
30	1.248	1.933	2.492	3.070	3.857	4.500
Reject?	No					

Anderson-Darling goodness-of-fit test of sizing data for the Beta distribution

Simio Representation of Model 1 - Beta

Use:

`2.202221 + 4.382335 * Random.Beta(8.196928, 9.587848, <stream>)`

Simio representation using the best fit distribution for sizing books

Sizing Example:

- Use ExpertFit to determine appropriate distribution
- Enter given distribution into Simio
- Run model and observe system effects
- Adjust number of stations in order to meet demand

Simio Representation of Model 1 - Beta

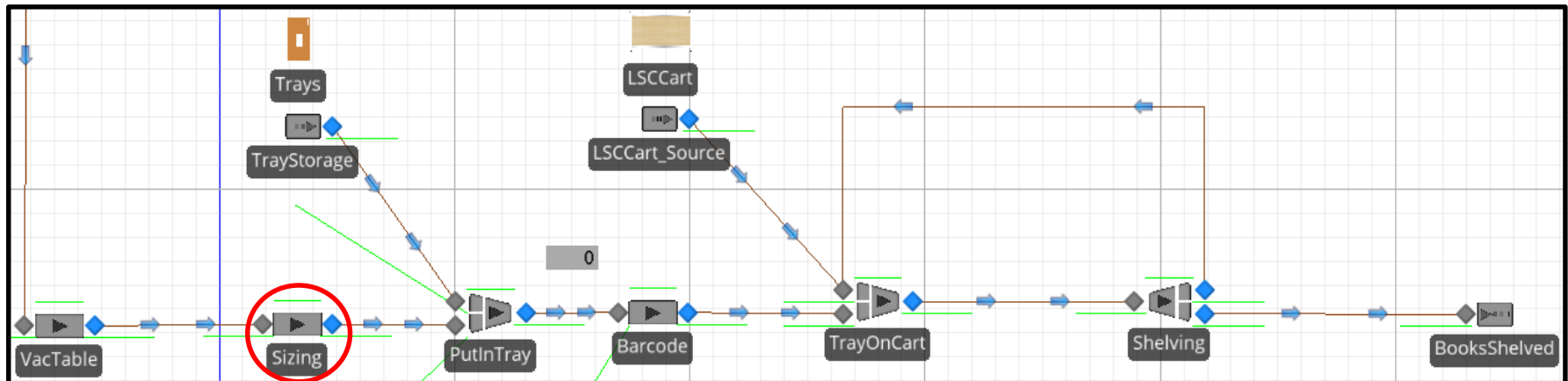
Use:

$2.202221 + 4.382335 * \text{Random.Beta}(8.196928, 9.587848, <\text{stream}>)$

ExpertFit Output

Process Logic	
Capacity Type	Fixed
Initial Capacity	3
Ranking Rule	First In First Out
Processing Time	$2.202221 + 4.382335 * \text{Random.Beta}(8.196928, 9.587848, <\text{stream}>)$
Units	Minutes

Simio Input



Processing and Shelving portion of Simio

COST FUNCTION MODEL

Labor Costs

- Expected time per sub process
- Overall time per process
- Labor hours associated with each

+

Equipment Costs

- Total equipment cost based on recommendations and client inputs

=

Total Cost Function

- Total cost of relocating and ingesting units

FLOOR 6			FLOOR 5			FLOOR 4			FLOOR 3		
10	take empty cart to elevator (seconds)		10	take empty cart to elevator (seconds)		10	take empty cart to elevator (seconds)		10	take empty cart to elevator (seconds)	
45	ride elevator to floor (seconds)		40	ride elevator to floor (seconds)		35	ride elevator to floor (seconds)		30	ride elevator to floor (seconds)	
20	push cart to shelf (seconds)		20	push cart to shelf (seconds)		20	push cart to shelf (seconds)		20	push cart to shelf (seconds)	
90	load cart (seconds)		90	load cart (seconds)		90	load cart (seconds)		90	load cart (seconds)	
30	push cart to elevator (seconds)		30	push cart to elevator (seconds)		30	push cart to elevator (seconds)		30	push cart to elevator (seconds)	
45	ride elevator to Ground (seconds)		40	ride elevator to Ground (seconds)		35	ride elevator to Ground (seconds)		30	ride elevator to Ground (seconds)	
30	push cart to loader (seconds)		30	push cart to loader (seconds)		30	push cart to loader (seconds)		30	push cart to loader (seconds)	
270	Total time of one trip (seconds)		260	Total time of one trip (seconds)		250	Total time of one trip (seconds)		240	Total time of one trip (seconds)	
166530	books on floor		170100	books on floor		169470	books on floor		177030	books on floor	
90	capacity of cart		90	capacity of cart		90	capacity of cart		90	capacity of cart	
1850.3333	# of trips		1890	# of trips		1883	# of trips		1967	# of trips	
499590	total seconds task takes		491400	total seconds task takes		470750	total seconds task takes		472080	total seconds task takes	
138.775	total hours task takes		136.5	total hours task takes		130.7639	total hours task takes		131.1333	total hours task takes	
\$8.25	hourly wage		\$8.25	hourly wage		\$8.25	hourly wage		\$8.25	hourly wage	
\$1,144.89	total cost		\$1,126.13	total cost		\$1,078.80	total cost		\$1,081.85	total cost	

Models give us the flexibility to observe the effects that labor, equipment, and processing have on cycle time, total time, and total cost.

Simulation Model

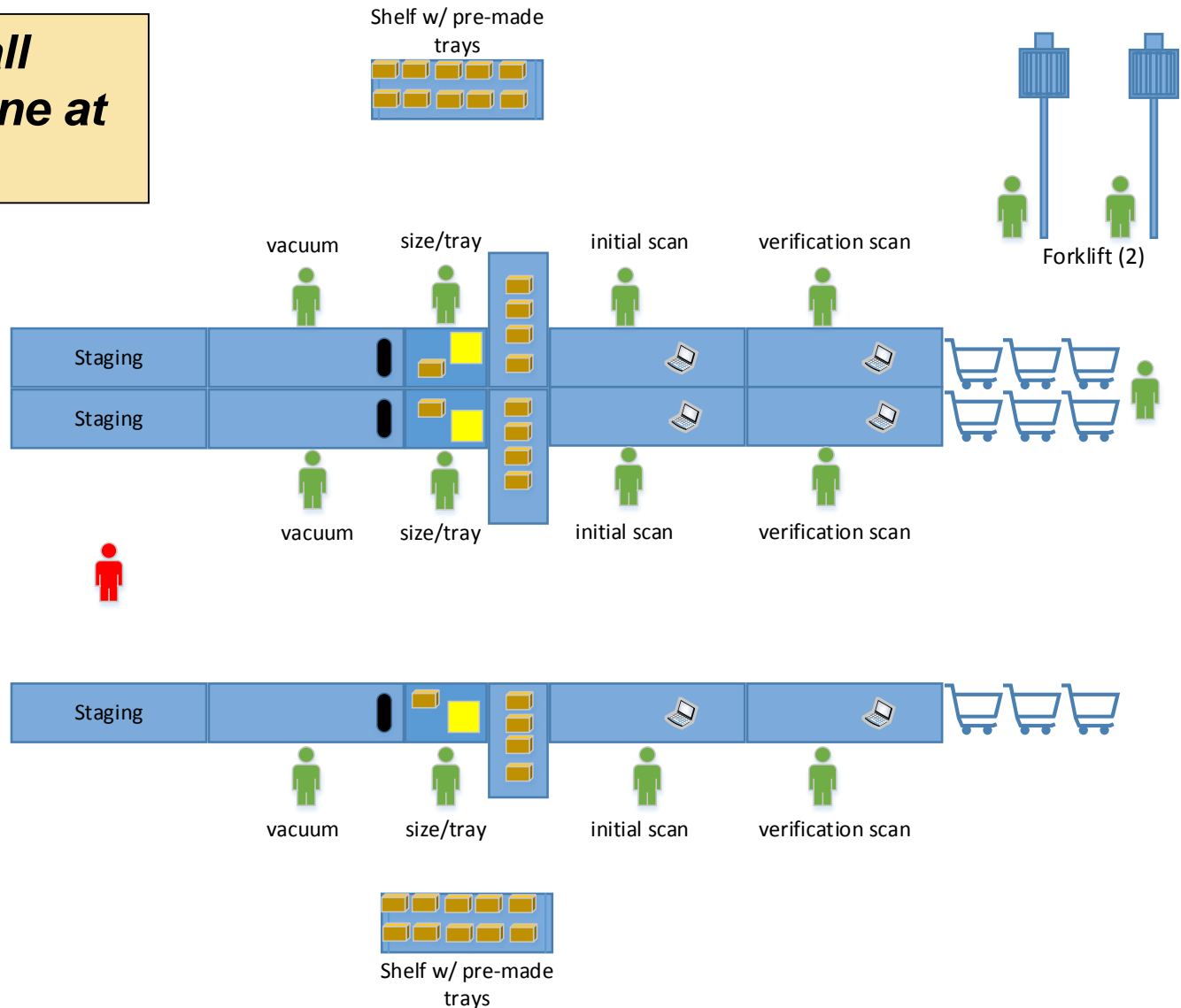
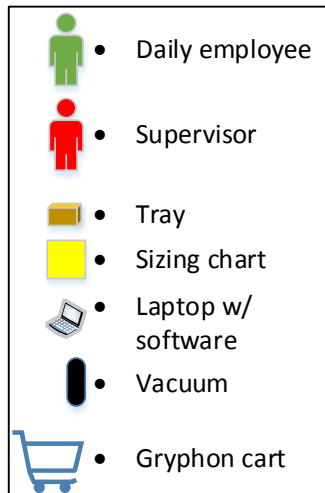
- Models total relocation time start to finish per unit
- Identifies bottlenecks
- Ability to model variability in processing times

Cost Function Model

- Cost estimation tool based on expected labor hours per process
- Includes fixed costs of purchasing equipment
- Evaluates the costs for client based on user input

PROCESSING LAYOUT

Example where all processing is done at LSC.





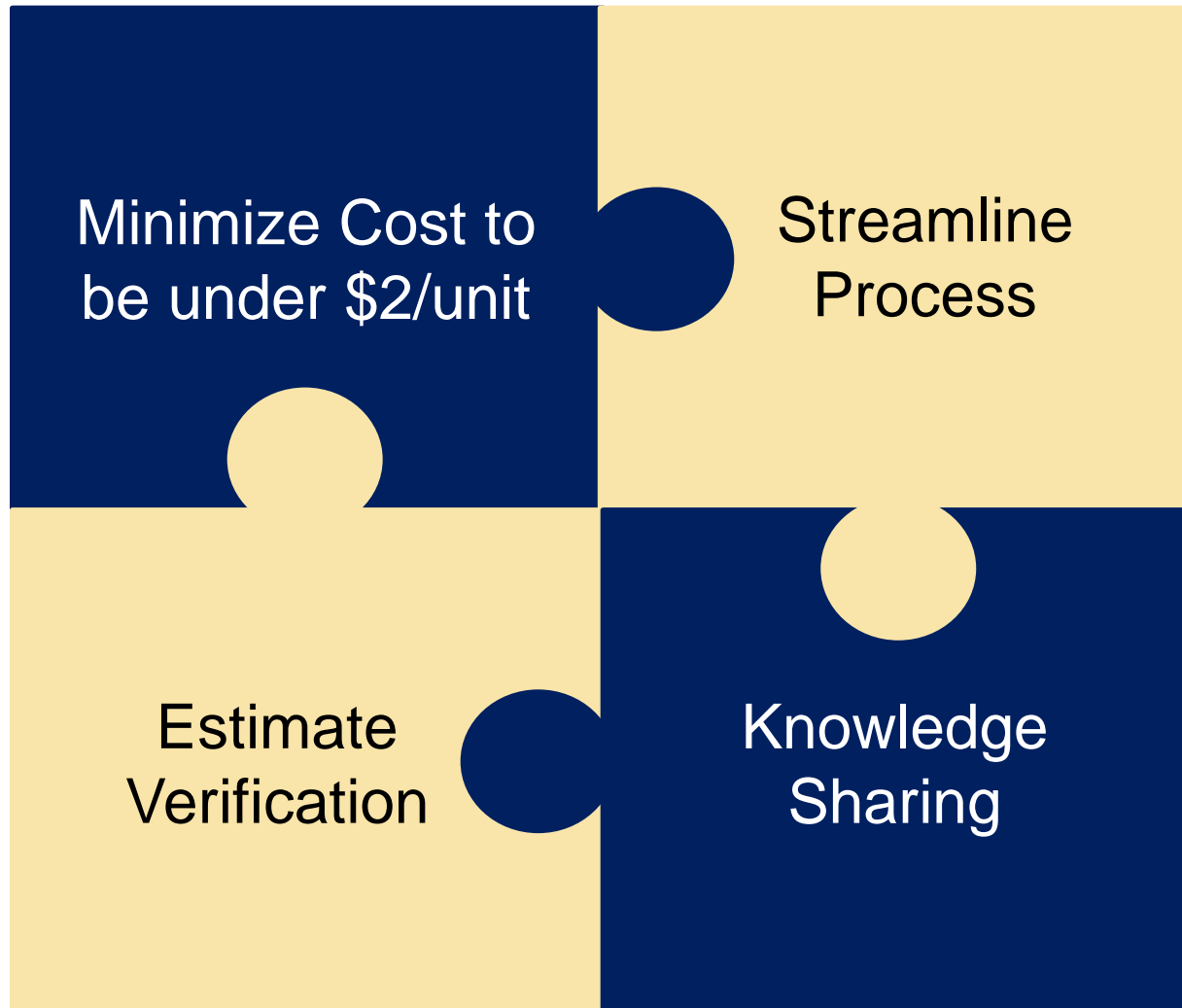
Book Relocation Portfolio

- Equipment and Labor Recommendations
- Processing layout/configuration
- Estimated timelines



Cost Function Model

- Breakdown of costs by process
- Outline of fixed and variable costs
- Estimated labor hours per process



Data Collection

- Finalize data collection and replications
- Fit data sets to appropriate distributions using ExpertFit

Simulation Modeling

- Finalize Simio
- Input distributions into model and observe effects
- Identify bottlenecks and evaluate alternatives

Cost Modeling

- Research expected labor and equipment costs
- Update cost estimates depending on Simio output

THANK YOU