EmTech
Library Service Center Ingestion

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*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 Description
• Relocating 1.1M books
• Ingesting 2.1M books

Methodology Overview
• System Definition
• Data Collection & Validation
• Model & Interpret

Model Development & Outcomes
• Cost Optimization Model (COM)
• Simulation Model
• Model Integration
• Model Validation

Deliverables & Recommendations
• Labor Schedule
• Staging Area Layouts
• Processing Floor Layout
• Equipment Purchasing Plan

Value
• 24-Hour Book Turnover
• Cost Savings
• Time Savings
How should the collections be fetched, packaged, transported, and processed?

Where and when should processing of Georgia Tech’s collections happen?

What equipment and labor will be needed to accomplish the tasks in minimal time and cost?

What is the expected overall cost of the project?
Tasks

- Identify each step in the process
- Fully understand the path of the collections from their current location to shelf in LSC

Constraints

- Timeline of relocation of GT Library
- Delivery restrictions
- 24-hour turnaround time

EmTech’s Proposed Timeline
Identifies each process for both Georgia Tech & Emory

**Fetching**
- Fetch units
- Use elevator
- Prepare carts
- Clean units (GT LRC)

**Transporting**
- Deliver
- Load/unload carts
- Return with empty carts

**Processing**
- Vacuum***
- Size* & Tray**
- Scan***
- Verify***

**Shelving**
- Load cart onto order picker
- Place trays on shelves

*Books  * Micro-documents  * Archival Boxes  * Flat Files

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Overview  Problem  Methodology  Models  Deliverables  Value
Three types of data were collected:

Library Data
- Collection figures
- Throughput requirements
- Delivery constraints

Research
- Equipment costs
- Time standards

Time Studies
- Minimum of 30 trials
- Randomized data
  - For replicable actions only
Observes the effect that labor, equipment, and processing have on cycle time, total time, and total cost.

Cost Optimization Model (COM)
- Uses Excel Solver to find minimum cost
- Uses data collected
- Evaluates cost based on expected labor hours
- Includes fixed costs of purchasing equipment

Simulation Model
- Models total relocation time
- Identifies bottlenecks
- Models variability in processing times
- Feasibility check
Our solution is the result of a three step approach:

**System Definition**
- Site Visits
- Process Map Development
- Task Identification

**Data Collection & Validation**
- Library Data
- Research
- Time Studies

**Interpretation**
- Cost Optimization Model (COM)
- Simulation Model
COST OPTIMIZATION MODEL (COM)

High-level calculations for each sub-process:

**Fetching**
- # of carts to transport
- Fetching time
- Labor cost
- Equipment cost

**Transporting**
- # of trips
- Transporting time
- Labor cost
- Equipment cost

**Processing**
- Cycle time
- Throughput
- Processing Time
- Labor cost
- Equipment cost

**Shelving**
- # of carts to shelf
- Shelving Time
- Labor cost
- Equipment cost
Fetching/Transportation Cycle in Simio

• Created in Simio
• Simulated flow of books through the entire process
• Accounted for variability and equipment failure
Final COM shows a required throughput of 108,125 books per week.
The Simio model assessed the feasibility of the COM
## COM INITIAL’s OUTPUT

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Horizon:</td>
<td>48 workdays</td>
</tr>
<tr>
<td># of Processing Lines:</td>
<td>3</td>
</tr>
<tr>
<td>One Line:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 Vacuum</td>
</tr>
<tr>
<td></td>
<td>1 Size &amp; Tray</td>
</tr>
<tr>
<td></td>
<td>1 Accession</td>
</tr>
<tr>
<td></td>
<td>1 Verify</td>
</tr>
<tr>
<td>Total Laborers:</td>
<td>24</td>
</tr>
<tr>
<td># of Gryphon Carts:</td>
<td>44</td>
</tr>
<tr>
<td>Purchase 22 carts:</td>
<td>+$22,550</td>
</tr>
<tr>
<td>Extend Timeline:</td>
<td>+$32,000</td>
</tr>
</tbody>
</table>

### Summary
- Ran Initial Output in Simio
- Obs. Throughput less than Req. Throughput
  - 10.6% below required throughput
- Bottleneck: # of carts
- Options:
  - Purchase Additional Carts
  - Extend Project Timeline
- Cost-Benefit Analysis

### Additional Notes
- COM INITIAL’s OUTPUT
- Initial Output ran in Simio
- Observed throughput was less than required throughput by 10.6%
- Bottleneck identified as the number of carts
- Options for improvement:
  - Purchase 22 additional carts (+$22,550)
  - Extend project timeline (+$32,000)
- Cost-Benefit analysis conducted
Simio Processing Throughput for GT Library Books

### Cost/Book

<table>
<thead>
<tr>
<th>Cost/Book</th>
<th>8 weeks</th>
<th>9 weeks</th>
<th>10 weeks</th>
<th>11 weeks</th>
<th>12 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Lines (1 vac)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>$0.47</td>
</tr>
<tr>
<td>4 Lines (1 vac)</td>
<td>N/A</td>
<td>N/A</td>
<td>$0.47</td>
<td>$0.51</td>
<td>$0.55</td>
</tr>
<tr>
<td>3 Lines (2 vac)</td>
<td>$0.37</td>
<td>$0.40</td>
<td>$0.44</td>
<td>$0.48</td>
<td>$0.52</td>
</tr>
<tr>
<td>4 Lines (2 vac)</td>
<td>$0.43</td>
<td>$0.47</td>
<td>$0.52</td>
<td>$0.56</td>
<td>$0.61</td>
</tr>
</tbody>
</table>

**INTEGRATION OF COM AND SIMIO**
## MODEL VALIDATION

<table>
<thead>
<tr>
<th>Task</th>
<th>Library Consultant’s Plan (Labor Hours)</th>
<th>Senior Design’s Plan (Labor Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fetching</td>
<td>4528</td>
<td>3152</td>
</tr>
<tr>
<td>Transporting</td>
<td>1232</td>
<td>2384</td>
</tr>
<tr>
<td>Support, Size, &amp; Tray</td>
<td>5160</td>
<td>6304</td>
</tr>
<tr>
<td>Accession</td>
<td>5160</td>
<td>3200</td>
</tr>
<tr>
<td>Verify &amp; Shelve</td>
<td>5560</td>
<td>5488</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>21640</strong></td>
<td><strong>20528</strong></td>
</tr>
</tbody>
</table>

Our estimate is within **5%** of the Library Consultant’s Plan
# WORKFORCE PLAN - BOOKS

<table>
<thead>
<tr>
<th></th>
<th>Emory High Museum</th>
<th>Georgia Tech Library</th>
<th>Emory Woodruff Library</th>
<th>Georgia Tech LRC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Work Schedule:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of workdays</td>
<td>8</td>
<td>48</td>
<td>54</td>
<td>18</td>
</tr>
<tr>
<td><strong>Processing per shift:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of lines</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td># of laborers</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td># of support staff</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><strong>Shelving per shift:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of laborers</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Fetching per shift:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of laborers</td>
<td>N/A</td>
<td>2</td>
<td>N/A</td>
<td>5</td>
</tr>
<tr>
<td><strong>Transporting per shift:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of laborers</td>
<td>N/A</td>
<td>2</td>
<td>N/A</td>
<td>2</td>
</tr>
<tr>
<td># of trips</td>
<td>N/A</td>
<td>3</td>
<td>N/A</td>
<td>3</td>
</tr>
<tr>
<td># of carts/trip</td>
<td>N/A</td>
<td>22</td>
<td>N/A</td>
<td>22</td>
</tr>
<tr>
<td><strong>Cost:</strong></td>
<td>$26,959</td>
<td>$347,050</td>
<td>$244,565</td>
<td>$91,649</td>
</tr>
</tbody>
</table>

**Total Cost for GT:** $438,701  **Total Cost for Emory:** $271,524  **Total Cost:** $710,224
# WORKFORCE PLAN - OTHER MATERIALS

<table>
<thead>
<tr>
<th></th>
<th>Georgia Tech Micro-Docs</th>
<th>Georgia Tech Maps</th>
<th>Georgia Tech Archival Boxes</th>
<th>Emory Archival Boxes</th>
<th>Georgia Tech LRC Maps</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Work Schedule:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of workdays</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td><strong>Processing per shift:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of lines</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td># of laborers</td>
<td>8</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td># of support staff</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><strong>Shelving per shift:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of laborers</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>Fetching per shift:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of laborers</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>N/A</td>
<td>2</td>
</tr>
<tr>
<td><strong>Transporting per shift:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of laborers</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>N/A</td>
<td>1</td>
</tr>
<tr>
<td># of trips</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>N/A</td>
<td>3</td>
</tr>
<tr>
<td># of units/trip</td>
<td>16 carts</td>
<td>60 drawers</td>
<td>18 carts</td>
<td>N/A</td>
<td>60 drawers</td>
</tr>
<tr>
<td><strong>Cost:</strong></td>
<td>$21,391</td>
<td>$4,724</td>
<td>$4,259</td>
<td>$4,168</td>
<td>$2,974</td>
</tr>
</tbody>
</table>

**Total Cost for GT:** $33,346  
**Total Cost for Emory:** $4,168  
**Total Cost:** $37,514
### Equipment Purchasing Plan

#### Purchasing Assumptions (considered already purchased)

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Gryphon Carts</th>
<th>Vacuum tables</th>
<th>Workstations</th>
<th>Raymond Pickers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>25</td>
<td>6</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>

#### Equipment To Be Purchased

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Gryphon Carts</th>
<th>26’ Box Truck Rental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number Needed</td>
<td>54</td>
<td>1</td>
</tr>
<tr>
<td>Per Unit Cost</td>
<td>$1,025</td>
<td>$86.60/day, $0.29/mile</td>
</tr>
<tr>
<td>Cost</td>
<td>$55,350</td>
<td>$9,043</td>
</tr>
<tr>
<td>Total Cost</td>
<td></td>
<td>$64,393</td>
</tr>
</tbody>
</table>
Unwrapped carts are staged for vacuuming.

Books are processed.

Processed books are shelved.

Carts of books are unloaded and unwrapped.

Delivery trucks enter garage.
COST OUTCOME SUMMARY

Georgia Tech
- Library*: $347,051, 22,560 labor hours
- Library Record Center*: $91,650, 8,416 labor hours

Emory
- High Museum*: $26,960, 1,920 labor hours
- Woodruff Library*: $244,566, 14,240 labor hours

* includes equipment costs
* processing & shelving only
49% less time than Library Consultant

66% less cost than Library Consultant

Both cost estimates account for fetching, transporting, processing (excluding vacuuming), and shelving.
### Savings Insight:

<table>
<thead>
<tr>
<th>Employee Type</th>
<th>Georgia Tech Hourly Rate</th>
<th>Library Consultant Hourly Rate</th>
<th>% Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fetching</td>
<td>$11.06</td>
<td>$27</td>
<td>144%</td>
</tr>
<tr>
<td>Transporting</td>
<td>$15</td>
<td>$88</td>
<td>487%</td>
</tr>
<tr>
<td>Processing</td>
<td>$11.06</td>
<td>$35</td>
<td>216%</td>
</tr>
<tr>
<td>Technical</td>
<td>$17.02</td>
<td>$27</td>
<td>59%</td>
</tr>
<tr>
<td>Shelving</td>
<td>$21.50</td>
<td>$28</td>
<td>30%</td>
</tr>
</tbody>
</table>

**Labor Savings:** $350,279

Management Savings: $249,920

58% of our savings come from lower labor rates
100% of books expected to meet 24 hour turnover time.
THANK YOU