Human-Machine Interaction Design for Freight Planning Systems

Research Festival
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E51-372
Freight Planning System

Scale

Division of Labor

AUTOMATED V. MANUAL

Manual 45%

Automated 55%
Today’s Operating Environment
Research Question

What process augmentation will incrementally decrease costs, reduce manual load planning, permit a system retrofit, and improve the joint cognitive system iteratively?
Project Scope and Goals

1. Characterize System using HMI
2. Propose Conceptual System Design
3. Propose Pilot Design
4. Insights from Design Process
5. Academic Contributions and Managerial Takeaways
Joint Cognitive Systems

Human-Machine Interaction Design: Typical Applications
Hypothesis

Human-Machine Interaction Design : Pallets
Hypothesis

Human-machine interaction (HMI) design principles can be applied to retrofit a loosely coupled joint cognitive system, particularly a freight planning system, to iteratively improve the system.
HMI Application

Initial Framework

Scenario Modeling

Recursive Nested Behavior-Based Control

Displaced Transparency

Human Sensing

Task Batching

Architectural

Scenario Modeling

Task Batching*

Human Sensing

Displaced Transparency

Implementation

Interviews / Field Observation

Surveys (Level Setting)

Brainstorming (What > Why)

5 Whys

Ishikawa (Fishbone) and Process/Swim Lane Diagrams

Prediction Market*
Process Diagram of System HMI

Data Repository & Central Communication System

Roles:
- Data Repository
- Cross-System Communication
- Order Management
- Service Center Capacity and other data
- External Partner Management and Billing

Optimization System
[Load Sourcing & Assignment]

Sourcing Assignment Made (Y/N)?

Yes

Transportation Management System
[Carrier Assignment]

Cancellations & Changes

Customers

Service Centers

Carriers

External to Planning & Logistics

Loads

Optimization Failures
Late Cancellations & Changes
Optimization Rework
Load Balancing

Logistics Team
(Logistics Coordinators)

[Manual Load Interventions]

Work Sources:
1. Optimization Failures
2. Late Cancellations & Changes
3. Optimization Rework
4. * Load Balancing

Sufficient Load & Constraint Data (Y/N)?

Yes

No

Within 48 Hours* (Y/N)?

Yes

No

Customers

Service Centers

Carriers

External to Planning & Logistics

Loads

Dotted Lines Reflect Constant Bi-Directional Communications Between Systems

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Ishikawa Diagram of Cognitive System Gaps

**PSO System Capabilities**
- How often does it update?
- Prevent autobook restricted customers?
- Account for Labor at Service Centers?
- Live Load Restrictions?
- Incorporate Service Center Funnels?
- Is there a better system out there?
- Other system capabilities that could use?
- PSO account for missed loads in inventory calculation?

**Current Data Visibility**
- How is all feedback incorporated into system – limits/frequencies?
- How/When inventory balance updated/validated?
- How/When transportation costs updated to PSO?
- What is the best centralized repository of operational caps?

**Procedures**
- Can consider delivery windows in auto-booking?
- Does PSO consider 5 v. 7 day site openings?
- Can PSO split source; add P3, P4?
- How/When update expected damage ratios?
- How does customer raised volume impact automation process?
- How do PSO, Planning, & Logistics Communicate Information?
- How does lane level detail impact automation process?
- Facility Production Changes – How Communicated?

**Manual Process**
- How/When does it update?
- Account for Labor at Service Centers?
- Live Load Restrictions?
- Incorporate Service Center Funnels?
- Is there a better system out there?
- Other system capabilities that could use?
- PSO account for missed loads in inventory calculation?

**Questions**
- What factors drive logistics manual decision process?
- What does logistics consider in booking an open order?
- What is LC planning deviation process?
- Restrict to live unloads?
- How ensure better TPM volume data?
- What is LC planning deviation process?
- How prioritize customers?
- How/When update expected damage ratios?
- How does lane level detail impact automation process?
- Facility Production Changes – How Communicated?

*Questions may Cross Segments*
Ishikawa Diagram of Manual Intervention Causes

**Current Data Visibility**
- PSO account for missed loads in inventory calculation?
- What is the best centralized repository of operational caps?
- Prevent autobook restricted customers?
- Account for Labor at Service Centers?
- Live Load Restrictions?
- Incorporate Service Center Funnels?
- Is there a better system out there?
- Other system capabilities that could use?

**PSO System Capabilities**
- Can benchmarking rates be considered in auto-booking?
- Can consider length of haul in auto-booking?
- Does PSO consider 5 v. 7 day site openings?
- Can PSO split source; add P3, P4?
- Can consider delivery windows in auto-booking?
- Location selection criteria?

**Procedures**
- How LC Feedback Incorporated?
- How do PSO, Planning, & Logistics Communicate Information?
- How does customer raised volume impact automation process?
- How does lane level detail impact automation process?
- Facility Production Changes – How Communicated?

**Manual Process**
- How ensure better TPM volume data?
- What factors drive logistics manual decision process?
- Reduce transportation costs updated to PSO?
- How does logistics consider in booking an open order?
- What is LC planning deviation process?
- Restrict to live unloads?

**Questions**
- *Questions may Cross Segments*
- How/When update expected damage ratios?
- How prioritize customers?
- How/When update expected damage ratios?
- How/When inventory balance updated/validated?
- What does logistics consider in booking an open order?
- What is LC planning deviation process?
Self-Developed Data

MANUAL INTERVENTIONS (≈50 ENTRIES)

- Facility Restriction: 2%
- Data Correction: 10%
- Customer Restriction: 10%
- Carrier Correction: 76%
- Sourcing Correction: 76%

Questions

- How/When inventory balance updated/validated?
- How/When transportation costs updated to PSO?
- Prevent autobook restricted customers?
- Location selection criteria?
- How is all feedback incorporated into system – limits/frequencies?
- How prioritize customers?
- Does PSO consider 5 v. 7 day site openings?
- Can consider delivery windows in auto-booking?
- How does lane level detail impact automation process?
- Does PSO consider length of haul in auto-booking?
- Can consider delivery windows in auto-booking?
- How does customer raised volume impact automation process?
- Facility (Production Changes – How Communicated)?
- LC Feedback incorporated?
- How/When update expected damage ratios?
- How/When inventory balance updated/validated?
- What is LC planning deviation process?
- Pre-autobook data in inventory calculations?
- What factors drive logistics manual decision process?
- Pre-autobook data in inventory calculations?
- What is the best centralized repository of operational caps?
- What does logistics consider in booking an open order?
- Can consider length of haul in auto-booking?
- What LC feedback is incorporated?
- How long does it run?
- What does logistics consider in booking an open order?
- Does PSO consider length of haul in auto-booking?
- Can consider length of haul in auto-booking?
- Is there a better system out there?
- Can consider delivery windows in auto-booking?
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HMI Retrofit Implementation

**Comprehension Phase**

**HMI Architecture**
- Identify Relevant HMI Architectural Frameworks
  - Scenario Modeling
  - Task Batching
  - Human Sensing
  - Displaced Transparency

**Enabling Methods**
- Implement & Iterate
  - ID and Empower HMI Architect
  - Establish Human Sensing & System Update Process
  - Separate to Small (Action) & Large (Prediction) Teams
  - Stage HMI Framework Application
  - Iterate Across Stages (Closest = Fastest)

**Identify Relevant Facilitating Frameworks**
- 5 Whys Analysis
- Ishikawa and Swim Lane Diagramming
- Brainstorming Sessions
- Prediction Markets & Polling

**Identify Relevant HMI Architectural Frameworks**
- Stakeholder Interviews, Surveys, & Field Observations
- Systems Change Proposals → ID other Stakeholders
- Automated Systems Analysis
- Systems Conceptual Mapping
- Systems Data Analysis & Additional Data Gathering
HMI Retrofit Iteration Cycles

- **Comprehension Phase**
  - Daily
  - Monthly
  - Quarterly
  - Annually

- **HMI Architecture**
  - Enabling Methods Iteration
  - System Data Updates

- ** Iterate**
  - HMI Frameworks Iteration
  - Full System Comprehension Iteration
Research Contributions

- HMI → Loosely Coupled Freight Planning System

- Other Loosely Coupled Planning Systems
  - Freight, Customer Demand, Warehouse, Labor Planning

- Application to Total System Retrofits

- Iterative System Comprehension and Development Approach
Managerial Insights
Questions