Hyperconnected Modular and Mobile Manufacturing

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Benoit Montreuil
Agenda

• Background
• Modular production within a Logistics Web
• Problem statement
• Presentation of the experts
• Discussion
  – Key questions
  – Issues
  – State of the art
  – Roadblock
  – Challenges
• Roadmap
  – Priorities
Background: Logistics Web

Montreuil et al. 2102
Background

• **Physical Internet**
  • Hyperconnected near point-of-use production of goods in a web of open multi-party fabs
  • Hyperconnected dynamic distributed deployment of modular containers in a web of open storage facilities
  • Hyperconnected multi-party multi-modal transportation of modular containers across a web of open hubs

• **Modular containerized production**
  • Process and technological innovations encapsulating production units in plug-and-play modular containers, enabling production capacity to be moved dynamically from site to site
Production Resources and Modules

- Performs some or all operations required for a finished product/service
- Can make different products
- Movable, reconfigurable
- Cost to install/uninstall/use/produce/move
- Requires installations
- Different sizes (requires space and or « plugs »)
Background

Proctor and Gamble (Germfree)

- Modular production
- Small footprint
- Require low investment
- Facility grows from two to three modules

(Germfree, illustrated in Sibomana 2015)
Background

Germfree

- Designing mobile laboratories
Background
Farber

• Designing mobile laboratories
Background

Bayer and Project F3 Factory

- Bayer Technology Services
- The F 3 (Flexible, Fast and Future) Factory project (www.f3factory.com)
- Plug-and-play modular containers
- Low to medium scale production
- Chemical industry
- Continuous production technology using novel, intensified equipment and processes in a standardized, container-based manufacturing environment
Background
Bayer and Project F3 Factory
Problem Statement

• How:
  – Design the realization web
  – To serve the distribution web
  – Use the mobility web
• Such to maximizes the profit from
  – Revenue: Selling the products to markets
  – Costs: Deployment of modules and resources
  – Costs: Supply, production and distribution of the products
• Production mode: assembly process under
  – Make-to-order
  – Make-to-stock
The Emerging Megaregions

http://www.america2050.org/images/2050_Map_Megaregions2008_150.png
Products Demand
Open Sites, Fabs, DC, Warehouse

- Production Module
- Storage module
- Available space for additional modules
- Stored module
Example of an assembly process and the links with the suppliers

Assembly process

Legend

- P.A: Process A
- P.B: Process B
- P.C: Process C
- P.D: Process D
- P.E: Process D
- External Supplier
- Production module
- Open Fab

Flow

- Dashed line: Part 1
- Dotted line: Main part
- Double line: Part 2
- Solid line: Supplier
Examples of open fabs, production modules, their resources through the production and assembly process
Hyperconnected modular and mobile manufacturing
Hyperconnected modular and mobile manufacturing

Make-to-order
Hyperconnected modular and mobile manufacturing

Make-to-stock

IPIC 2016 - 3rd International Physical Internet Conference
June 29-July 1, 2016 | Atlanta, GA USA
Conclusion

• Hyperconnected modular and mobile production
  – Multiple sites
  – Modules deployment (purchase, relocation)
  – Module types (capacity, capability, etc.)
• Formalized, described and modeled hyperconnected modular production and storage decisions
Supply Chain Optimization of Agroindustrial Residuals for Biofuel Production

3rd Physical Internet Conference 2016
June 29 – July 1, Atlanta, GA, USA

Dr. Yasel Costa Salas
Prof. Dr. Horst Treiblmaier
Biofuel Production

- Maize is the most widely grown crop in the Americas. (USA produces almost half of the world’s harvest, 42.5%, corresponding to over 220 million tons) (US-Department of Energy, 2011).
- Brazil is the world's 9th-largest producer of rice, generating around 2.9 million tons of rice husks annually (Gomes et al., 2013).
- Cassava (yucca) residues in Brazil exceed 60 million tons. Wheat residues production in Brazil is around 1.4 million tons (see in Ferreira-Leitão et al., 2010).
- Bagasse availability in Brazil exceeded 160 million tons during the period 2012/2013 (Hofsetz & Silva, 2012).
- In Colombia, the sugarcane feedstock availability is about 93 tons per hectare (but in the main producing regions it is about 120–140 tons / hectare) (Moncada et al., 2013).
- High availability of coffee cut stem in Colombia, the most productive country in coffee harvest, 32 tons per hectare-year (Triana et al., 2011).
- Sugarcane residuals in Cuba are estimated to be over 60 tons per hectare (Alonso Pippo et al., 2007).
Biofuel Production

- Agroindustrial Supply Chain Network Design (ASCND) implies various optimization problems:
  - number of crop residues suppliers
  - intermediate pre-processing facilities or warehouses,
  - number and location of places where processing facilities can be allocated
Proposed Supply Chain

Source: Duarte et al. (2016)
## Performance Indicators

<table>
<thead>
<tr>
<th>Category</th>
<th>Benefit</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ECONOMICAL</strong></td>
<td>Biofuel sales, Byproduct sales, SC Resilience</td>
<td>Residue acquisition, Plant construction, Plant operation, Transport, Unfulfilled demand, Financial risk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max</td>
</tr>
<tr>
<td><strong>ENVIRONMENTAL</strong></td>
<td>Emission credits, Waste utilization</td>
<td>Residue generation, Biomass pretreatment, Biomass transportation, Biofuel production</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max</td>
</tr>
<tr>
<td><strong>SOCIAL</strong></td>
<td>Source of employment, Government targets</td>
<td>Capture of agricultural land, Vulnerability of rural communities</td>
</tr>
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<td>Max</td>
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</tbody>
</table>
Project Goals

• Identify existing agroindustrial supply chains in order to determine their relevance for the research project.
• Conduct data collection and parameter analysis for the identified agroindustrial supply chains.
• Design optimization models for the agroindustrial supply chains.
• Develop, improve and apply optimization algorithms, in particular metaheuristics and hybrid strategies for biofuel SCND.
• Develop robust strategies (sensitivity analysis) based on inferential statistical techniques.
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