ISYE 6202 Supply Chain Facilities

Caseworks 2.1, 2.2, and 2.3

CityFeed's Open Peri-Urban Fulfillment Center Design

Caseworks 2.1, 2.2, and 2.3 are respectively due on 10/25, 11/01, and 11/08 at 23h55, and are respectively weighing of 15, 25, and 35 points.

The caseworks may be realized solo or in teams of up to 3 students, with team size having no impact on grading.

CityFeed explores a novel business model inspired by the Physical Internet and its enabled hyperconnected city logistics and hyperconnected omnichannel supply chain concepts. The key idea is for CityFeed to be a complement to the last-mile delivery services that are growing in urban megacities and metropolises around the world, by offering open peri-urban fulfillment center services. The peri-urban fulfillers would offer clients (retailers, etailers, manufacturers, etc.) to store items meant to fulfill urban demand, usually for a one-day up to one-week prepositioning for fast urban fulfillment. The peri-urban fulfillers would usually be located near to urban gateway hubs (e.g. refer to casework 3) to facilitate getting the demanded items to the urban deliverers.

CityFeed is to exploit a digital platform to allow its clients to contract fulfillment services for their products encapsulated in smart modular reusable handling containers. In all cases, CityFeed is to receive only such containers from its clients, each being uniquely identified (e.g. Global Returnable Asset Identifier (GRAI), https://www.gs1.org/id-keys), with easy-to-scan code tags on each container.

There are to be essentially three types of offering, each with distinct pricing structure:

(1) CityFeed receives, stores and ships client-provided containers.

(2) For standard products sold by many clients, CityFeed receives these products from participating clients in client-provided containers, stores the containers, picks upon request from a client in one of the available containers (independent of the source), and ships the picked product units as specified by the client. For a specific product, the cumulative number of requested unit picks from a client is always restricted to be no greater than the cumulative number of product units received from that client.

(3) For products that specific clients do not want to put in the shared mode (2), CityFeed receives and stores these products encapsulated in client-provided containers, and ships them as specified by the client.

In offering (1), CityFeed does not need to know the products in the containers. For offerings (2) and (3), the client has to specify the number of products in each inbound container (validated during operations), to provide CityFeed with a unique product code (e.g. Global Trade Item Identifier GTIN, https://www.gs1.org/id-keys), and to insure that each product unit has a easy-to-scan code tag on each unit.

Never is a product unit to move by itself in CityFeed's centers: it always moves in a container. When a product unit is picked up from a container, it is to be immediately transferred to another container.

Clients are responsible for indicating to *CityFeed* what is to be shipped to whom when. There are three types of shipment requests from a client X through the digital platform:

(1) Ship an entire client-X container;
(2) Ship a container encapsulating client-X product units picked from specified client-X containers (offering 3) or shared containers (offering 2), aimed for the same final destination or the same intermediary urban logistic hub;
(3) Ship client-X product units picked from specified client-X or shared containers, aimed for the same final destination or the same intermediary urban logistic hub, to be encapsulated in a container of a urban deliverer specified by client X.

CityFeed is to use modular reusable handling containers that are to be industry-sturdy versions of collapsible utility crates currently on the market: CleverMade Clever Crates and GreenMade InstaCrate (www.clevermade.com, https://www.youtube.com/watch?v=OZOcsTLTsCw, https://www.youtube.com/watch?v=IzMY2SGz7KQ). Small containers are to have modular dimensions 28 (Height, Length, Width) and 14 inches (H, L, W) while large containers are to have modular dimensions of 60 inches (H, L) and 45 inches (H, L & W). Small containers are to fit nicely into the large ones.

The reusable modular containers are to be equipped with digital devices enabling them to be smart active agents, with memory, communication and processing capabilities. Communication is achievable in a vehicle with its master agent, or in a center with the digital platform. The smart containers can be digitally controlled to lock and unlock. They can transmit their current location on demand within a center or within a vehicle. They log their journey as well as the hand-off operations and transactions from one party or equipment to another.

On the inbound side, CityFeed may receive from its clients small or large inbound containers on their own, or small containers in larger containers. Large inbound containers are restricted to (L=W=H= 45 inches) while small containers are to have modular dimensions 28 (H, L, W) and 14 inches (H, L, W).

On the outbound side, containers are grouped by combination of deliverer and destination as much as possible, with small containers embedded in larger ones as critical mass permits. Modular sets of dimensions for large outbound containers are not allowed to exceed 90 inches.

Inbound containers of a client may come from four types of sources:

(1) A distribution center of the (commercial) client;
(2) A mixing center, or warehouse of the (industrial) client;
(3) An open multiple-party distribution center or warehouse where the client has previously stored the products in the container;
(4) A factory of the (industrial) client or one of its partners/contractors/supplier.

The latter case is when the products are shipped direct from production while for the three first cases, inbound products have been earlier stored in regional centers a few days or weeks to several months.

The centers are to be open for inbound and outbound flow all year long, 24 hours a day, 7 days a week, 52 weeks a year.

CityFeed's business development and supply chain engineering teams provide you with the following design assumptions:

a) Relative to offering (1), each peri-urban fulfiller is expected to be capable of supporting a yearly outbound throughput of up to 3,000,000 containers;
b) Relative to offering (2), each peri-urban fulfiller is expected to be capable of supporting a shared portfolio of 60,000 standard products, globally inducing a multi-client throughput of 60,000,000 product units, with client orders ranging from 1 to 20 multi-product units;
c) Relative to offering (3), each peri-urban fulfiller is expected to be capable of supporting a client-specific portfolio of 50,000 standard client-products, globally inducing a multi-client throughput of 25,000,000 product units, with client orders ranging from 1 to 20 multi-product units;
d) Global daily throughput peaks for each type of offering are expected to be as high as five-time the annual average daily throughput;
e) The estimated inbound flow share of each type of container is as follows, with a coefficient of variation of 10%:

Container dimensions			Inbound flow
L	W	H	% of containers
14	14	14	20%
28	14	14	25%
28	14	28	15%
28	28	14	15%
28	28	28	15%
45	45	45	10%
45	45	90	5%
90	45	45	3%
90	45	90	2%

- The product portfolio for offerings (2) and (3) is estimated to be structured according to the following distributions:

Product Percentile	Demand Share	Cumulative Share
5%	40.00%	40.00%
10%	20.00%	60.00%
15%	10.00%	70.00%
20%	6.00%	76.00%
25%	4.00%	80.00%
30%	3.00%	83.00%
35%	2.00%	85.00%
40%	1.50%	86.50%
45%	1.30%	87.80%
50%	1.20%	89.00%
55%	1.20%	90.20%
60%	1.20%	91.40%
65%	1.15%	92.55%
70%	1.15%	93.70%
75%	1.15%	94.85%
80%	1.15%	96.00%
85%	1.00%	97.00%
90%	1.00%	98.00%
95%	1.00%	99.00%
100%	1.00%	100.00%
100.00%		

Product unit size Cubic inches	Demand Share
100-250	30.0%
251-500	30.0%
501-1000	20.0%
1001-5000	10.0%
5001-10000	5.0%
10001-20000	2.0%
20001-90000	1.5%
90001-180000	1.0%
180001-360000	0.5%
Total:	100.0%

- Clients are to a priori inform CityFeed of the order-to-shipping time they are prone to request for each container/product stored in the peri-urban center, CityFeed charging the clients more for faster request potential. For containers, options are expected to be 1, 2, 4 and 8 hours, respectively accounting for 20%, 30%, 30% and 20% of the requests. For product units, options are expected to be 2, 4 and 8 hours, respectively accounting for 40%, 40% and 20% of the requests.
- Due to the uncertainty of demand evolution (overall demand, market share), the team aims for you to provide modular peri-urban fulfiller designs that can be gradually be scaled up (or down), with clear depiction of how this could unfold.

Design tasks

For each task, you have to clearly describe your overall methodology, as well as your approach and outcomes relative to each of the models according to the Systemic Facilities Design Modeling Network Architecture:

1. Strategic model
2. Demand model
3. Product model
4. Process model
5. Performance model
   - *Must notably include investment and cost estimates*
6. Organization model
7. Operation model
8. Capacity model
9. Layout model
   - *Must notably include 2D center layout-s, and 3D layouts of key parts of the center*
10. Technology model
11. Simulation model *(valuable yet optional)*

Task 1. Mandatory for all caseworks

Provide CityFeed with a low-open peri-urban fulfillment center design.

For example, it may:

- Store the containers on racking,
- Rely on human pickers for picking from containers on racks,
- Rely on combination of forklifts (or similar) and/or conveyors for unloading from trucks, storing into racks, moving through the center and loading into trucks.

Task 2. Mandatory for Casework 2.1

Provide CityFeed with a significantly different alternative low-tech open peri-urban fulfillment center design. Contrast it rigorously with your design of task 1.

Task 3. Mandatory for Caseworks 2.2 and 2.3

Provide CityFeed with a high-tech open peri-urban fulfillment center design, then contrast it rigorously with your design of task 1.

Your design must leverage fundamental concepts and technologies of one of the systems below, potentially with some low-tech parts and/or parts from other high-tech systems:

- Shuttle-ASRS systems https://www.dematic.com/en-us/multishuttle/, https://www.bastiansolutions.com/solutions/technology/asrs/mini-load/knapp-osr-shuttle, http://www.invata.com/warehouse-automation/automated-storage-and-retrieval-systems-asrs/shuttle-asrs/
- Shelving-on-robots systems (http://www.businessinsider.com/kiva-robots-save-money-for-amazon-2016-6, https://vimeo.com/113374910, https://www.amazonrobotics.com/)
- Robot-swarm-grid systems (https://www.fastcodesign.com/90150368/this-online-supermarkets-robots-put-your-order-together-in-minutes; https://www.youtube.com/watch?v=b3X3r5UVtEM)

Task 4. Mandatory for Caseworks 2.3

Provide CityFeed with an alternative high-tech open peri-urban fulfillment center design, leveraging fundamental concepts and technologies from a distinct high-tech system among those listed above, then contrast it rigorously with your designs of tasks 1 and 3.

Task 5. Mandatory for all Caseworks

Synthesize your key learnings from the casework you tackled.

I hope this proves to be a challenging, stimulating, and fruitful learning experience,

Prof. Benoit Montreuil