[The New York Infrastructure Observatory](#)
Session One: 2014.10.28
Location: Amazon's Middletown, Delaware fulfillment center
[560 Merrimac Ave, Middletown DE.](#)

Present:

- [Spencer Wright](#)
- [Rob Snowden](#)
- [Dan Suo](#)
- [Jason Spinell](#)

Arrived at 0945
Tour began at 1000
Tour completed at ~1115, and was quick almost to the point of being rushed.
Tour guide was named Evan
Notes taken retrospectively by everyone above.

This facility is 1.2 million square feet. The parking lot had somewhere around 2-3000 parking spots, and was mostly full. There was a sign saying "First Day Starts Here" in the front, and a number of what looked like brand new employees doing orientations. This is a "sort" facility, as opposed to a "non-sort" facility. The difference is that all of the items in a sort facility fit in a yellow bin (about 14"x14"x24").

There are two sides to the facility: Inbound and Outbound. Inbound receives stuff from suppliers and also from other Amazon facilities ("transfer"). They're doing a lot of transfer right now in prep for "peak season" (i.e. the holidays). Outbound ships orders to customers, and also presumably to other distribution facilities.

Most of the time, employees work 4x10hr days. There are two daily shifts, leaving the facility closed for a few hours a day. There are about 3000 people in normal employment at the facility. During peak season, they ramp up to 6x10hr days. I believe they also shift the schedules a bit, such that the facility is humming 24x7. They also increase their staff, up to about 6000 people.

At inbound, pallets come in and the bill of lading is checked. Then the boxes are loaded onto a conveyor. One team of associates *just* open the boxes. Then another team picks a box out, empties the items out, and checks quantities. Then (I think) they add an [ASIN](#) if the item doesn't have its own UPC.

They use random storage at the facility. There are cubbies everywhere, and each has a bar code. Inside each cubby is up to 6 unique SKUs. If a SKU is in one cubby, it CANNOT be in any adjacent cubby.

There are about 300 Pickers at this facility. They are managed by two managers. Pickers find the cubby they're assigned to look for, scan its barcode, and then find the item within that cubby that they're supposed to pick. They scan the item's barcode, and drop the item into their bin. If a picker finds a broken item, they put it in a red bin at the end of the aisle, where QC can find and fix/dispose of it. If a picker finds an item that's not in its proper cubby (e.g. on the ground), they put it in a blue "amnesty" bin, where QC can pick it up and return it to its proper location.

Once they get all the items on their current list (which does *not* correspond to a customer order), they put the bin on a conveyor, and it goes up to sort.

At sort, an associate has a bin (from the pickers) and an 8020 rack on casters that has a few dozen cubbies on it. They pick an item at random out of the bin, scan it, and then a monitor tells them which cubby to put it in. Here, the cubbies *do* correspond to customer orders. Once the rack's cubbies are all full, the rack gets wheeled over to the pack stations. Each cubby has a packing list in it.

There are about 100 Packers at this facility. They have one manager, and two or three assistant manager types. The packers take a packing list and its items out of the rack. They scan the packing list and it tells them which box to use. Different packers have boxes of different sizes; so one packer might have small/medium boxes, and another might have larger boxes.

They pack all the items into the box and fold it up, putting the packing list inside. They have a machine that wets water-activated shipping tape and cuts it to length automatically. All they have to do is press a green button and the machine already knows what kind of box they're using and spits out a piece of tape that's just the right length.

Each packer has a set of Andon lights above their station, which indicate their ability to perform their work. During normal operation, the Andon light is green. If the associate is running low on supplies, they turn it to blue; if they have a serious blockage or shortage problem, they turn it red. Andons are constantly monitored by support staff, who will come to assist if a packing associate is unable to do their job.

They seal the box up. Then they take a barcode sticker off of a reel, scan it, and put it on the box. At this point that barcode is assigned uniquely to the customer's order. The box goes on a conveyor. It is automatically scanned, and has a shipping label printed and slapped onto it by a machine (this was *cool*). A spot on the conveyor weighs the package, and if the weight is off then it goes into QC.

The packages are sorted roughly by size and go onto a long oval conveyor. At one point on the conveyor, a 360* scanner checks the barcode and figures out which truck (by shipping zone) the package needs to go on. Then, as it's going around the conveyor, little pushers kick the package off the conveyor at the right chute, and it's sent down to the truck to be loaded.

Humans load the trucks, creating big walls layer by layer. They try not to stack the same box size very high, because it'll become unstable unless the stack is interlocked at a lot of points.

Other notes:
- The whole place was rather spartan.
- Our tour guide used an iPhone, but claimed he'd use a Fire if he wasn't locked into his carrier.
- Our tour guide is normally an Ops guy; tours are *not* his full time job.
- Their "___ Days since last workplace injury" sign was *not* filled out.
- They had Grainger vending machines with "free" PPE supplies inside - but they track employees use of those supplies.
- They were very excited about FBA (fulfillment by Amazon) and their MOS (make on site i.e. print books on site) programs. FBA packages get plain brown packing tape (as opposed to the Amazon branded tape), but otherwise the whole process seemed to be very similar to Amazon owned items.
- Our tour guide was very enthusiastic about a few TPS things. He mentioned Kaizen (literally "good change"), which to Amazon is a program where people from throughout the organization get together to propose and implement significant improvements in their processes. The Andon lights in the packaging department are also a derivative of a Toyota production feature.
- Amazon has a number of "etiquette" policies, which refer to the "nice" way of doing things. For example, heavy items shouldn't be stored on shelves above head height). It was unclear whether these guidelines were substantially different from rules, but with friendly names.
- The whole place was highly automated. The box & tape length selection systems were really interesting, and have the effect of

making the packers into just highly adaptable robots.
- When the tour was over, Evan (with some enthusiasm) gave us all Amazon branded cigarette lighter USB chargers.

Daniel's take on Amazon's random storage:

Grocery stores are arranged by category (e.g., dairy in the back, produce on the left, cat food in aisle 5). This makes searching and comparison easier for the typical consumer, but with a few assumptions and a counterintuitive adjustment, Amazon dramatically reduces the time and error for pickers (employees who pick things) to grab the items they need.

Instead of arranging inventory by category, Amazon arranges at random. Computers keep track of where everything is and choose both which items a picker will retrieve and an efficient path the picker needs to take. While it's near impossible to find the best solution (we don't know what orders we'll get ahead of time and even if we did, there are just too many possible paths), Amazon does better than the grocery shopper most of the time*. Why?

Many orders have items in wildly different categories, so to fulfill these orders under the grocery system, a picker with items in multiple categories is guaranteed to travel long distances to reach each category (and the facility is 1.2 million sf!). But by randomizing where items are, the picker has a much better chance of grabbing all the item she needs within a small area. Even better, because the items next to each other are so different, it is much less likely that a picker will pick something in error.

This isn't perfect, though. Surely there must be some orders where one item is far away or even in another fulfillment center. If we account for those, then why wouldn't we just arrange the fulfillment center by category, have pickers only pick items in their category, and assemble the specific orders later?

If I had to guess, Amazon is weighing the tradeoff between picking and packing efficiency. If pickers were category-specific, then packers would have to reorganize all the items from categories into orders. This is certainly doable (and could even be automated), but how much money and space would that take?

In fact, we see evidence of one such tradeoff: pickers don't necessarily pick items for a single or even complete order. For example, two or three pickers might grab the items necessary for a single order with the last item coming in from an outside vendor. The picking team roughly organizes the items by order and the packing team does the final organization. It must have been more efficient to have randomized inventory storage

plus some overhead on the packing team than to rely entirely on the packing team to build orders.

These are just some of the problems Amazon's logistics team wrestles with. Each fulfillment center is different depending on the problems they're trying to solve, but they all strive to improve.

* Our guide didn't disclose how randomization was done, so we can't say for sure

Rob's additional notes:

Receiving
- Pallets are taken off a truck, initially counted for qty, compared against the BOL, and immediately broken down into cartons (traditional receiving is at the pallet level).
- All cartons pass through a 360 scanner. Specific information is needed on each carton label. *(I'm having a hard time remembering what information was pulled by that scanner -- must be UPC / ASIN and qty? That sound right? But then what were the receivers counting and entering into the system later?)*
- Already noted, full-time associates cut open cartons for easier handling by those removing items.
- Items are transferred from cartons to yellow bins for locating. System dictates location for received items.

(My biggest confusion was on when the items are actually received into their system. I couldn't remember if that's what the scanner was doing, or if that's what the associates were doing who were physically transferring the items from the cartons to the yellow bins. also, I didn't fully grasp how the items moving from cartons to yellow bins were directed on where to go in the warehouse. Anyone know?)

Storage / Picking
- Already noted, items are *not* bulk-stored in one location. Instead, they are scattered throughout the pick floor for systematic pick-route-optimization.
- Pickers are not necessarily picking orders. They actually have no visibility into the order(s) they are picking for, and one pick list may be for several orders.
- An order doesn't actually come together until it reaches the "order pods" immediately before the packing table. I.E. one order is likely to be coming from many different bins.
- The associates separating bins into final orders simply scan items, and the system tells them which "order pod" to place the item in. This is color coded for simplicity. The order pod rack is then moved to the packing table for final packaging.

Packaging / Labeling

- System tells packing associate what box / envelope size to use for each order. *It's very important the associate use the proper packaging because the system is tallying up aggregate weight for the order, which will later reject if not a weight match.*
- Every single package is weighed immediately before the label is applied. If the actual weight does not match the predicted weight in the system (based on individual item weights + packaging), the package is kicked out for inspection.
- The flow racks leading to the scale and labelers orient the package for proper label application.
- Labels are printed and applied by a mobile, up-side-down printer.

Outbound

- Finished, labeled packages pass around a carousel until they are scanned for end destination. With the system knowing exactly where that package is on the carousel, since it has been scanned, the package is eventually auto-pushed down a chute to flow racks which accumulate and lead directly into the back of 53' trucks.
- Each truck pulls at a very specific time, regardless of or orders in process.
- Depending on package size, an estimated 14 - 18K packages would be on each truck.