

Bespoke Analytics at Lie-Nielsen Toolworks

Teaching Case

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Abstract

Lie-Nielsen Toolworks (LNT) is a small, family-owned company manufacturing very high quality woodworking tools in coastal Maine. They face three major challenges: the sparse rural labor market makes it difficult to find and retain talent; their extreme quality standards lead to waste and rework; they struggle to forecast demand and schedule production due in part to offering a large number of SKUs in small quantities. Having reorganized the factory layout and upgraded its CNC machines over the past two years, LNT is now turning to information systems and analytics as tools for improvement. Advised by an internal IT staff of one, an external ERP partner, and an analytics consultant, Tom Lie-Nielsen must decide how to approach these information technologies, what benefits he can expect, and what organizational changes might be necessary to effectively leverage them.

Keywords: manufacturing analytics, small business, ERP, Lean production, APIs

An Heirloom-Quality Tool Maker

It might be fair to say that no other company in the world does what Lie-Nielsen Toolworks (LNT) is trying to do: manufacturing over 100 different products, while holding themselves to extreme quality standards, and doing it all with a labor force drawn from a sparsely populated rural area.

Here in a in a small factory on Route 1, the scenic highway along Maine’s coast, the world’s premier maker of woodworking hand tools brings long-vanished tools and techniques back to life. Now a veritable pilgrimage site for woodworkers, the company began with one man working in his backyard in nearby West Rockport to re-create a discontinued Stanley hand plane, the “no. 95”. In just over 35 years, Tom Lie-Nielsen’s company has grown to about 90 employees making a broad assortment of tools including planes, chisels, saws, and more.



Figure 1. A Lie-Nielsen no. 95 Bronze Edge Plane

Three issues in particular combine to make this small manufacturing business uniquely challenging:

- Because LNT offers over 100 tools that sell in relatively small (hence unpredictable) quantities, LNT struggles to forecast demand and schedule production of the right tools at the right times, resulting in stockouts and backorders.
- LNT’s uncompromising quality standards mean it must cope with waste and rework when raw materials or finished products don’t pass inspection; and re-orders of some parts, such as metal castings from the foundry, can create substantial delays in a production plan.
- The small-town setting means that experienced local talent is rare-to-unavailable, so LNT must work hard to find workers with potential, train them from scratch, and retain them once they’ve acquired marketable skills.

These challenges have increasingly been at the top of mind for Tom Lie-Nielsen and his management team. Over the past two years, Tom has made major changes to LNT’s manufacturing space, redesigning the shop layout, adding more square footage, and replacing aging Johnford CNC machines with a dozen new American-made CNCs from Haas Automation.

Now satisfied with improvements to the physical space, in 2016 LNT is increasingly focusing on information systems and analytics initiatives to try to achieve further strategic and operational improvements. With options advanced by an internal IT staff of one, an offshore ERP partner, and a local analytics consultant, Tom is working out how best to implement information technologies in his operations, what benefits he can expect from them, and how the business might have to change in order to leverage them effectively.

Struggling to get manufacturing working right over the past few years has dampened spirits in LNT’s management team, forcing them to divert precious attention away from what they’d really love to be doing: rediscovering classic hand tools, bringing them back to life for modern woodworkers, and sharing the art of hand tool woodworking with the world. Sitting for an interview in a classroom surrounded by antique tools, LNT’s marketing director, Robin Nolan, put it this way:

“Let’s just imagine that we live in a world where the shop just hums. Things go in, things come out, it’s the right thing, the right quantity, the right time. Customer orders are being filled in a timely

manner and there's no big hiccups. Let's just pretend, because that is a fantasy. Well, now, what should we do? ...

It would be really great to, number one, get back into the tool prototyping mode. Look around us! We've got all these treadle tools, all these human powered... works of art, basically. It's not like Tom's going to be making a pedal-powered scroll saw any time soon, but why not bring back to life a bunch of other cool, simple things? They just take the time and energy to produce. It's not difficult, it's the attention.

And then, the whole other side of that is, community building and reaching out to the people who use the tools, or who are interested in using the tools. A lot of children, a lot of women, people who maybe never had exposure while they were growing up to what this is all about. That's where I get really excited."



Figure 2. Lie-Nielsen Toolworks factory and employees

The Particulars

Legal name: Lie-Nielsen Toolworks, Inc.

Web address: <https://www.lie-nielsen.com/>

Founding date: 1981

Mission statement: "Our Mission is to design and create beautiful, heirloom quality, hand tools that inspire woodworkers and other artisans. Through exceptional support and education, our customers receive the same personal attention we put into our tools."

Ownership: privately owned by Tom Lie-Nielsen and family

Revenue: about \$9 million in 2015

Workforce: about 90

Main product lines: hand planes (several types), saws, chisels, other cutting and joinery tools, and workbenches, manufactured by Lie-Nielsen Toolworks; as well as carving tools, axes, sharpening supplies, books and DVDs made by other manufacturers. About 90% of revenues come from sales of Lie-Nielsen products and 10% from resale.

Sales channels: e-commerce website, hand tool events and workshops nationwide, storefront on Route 1 (a coastal highway with heavy summer tourist traffic), resale by authorized dealers (mostly outside the USA). Orders are about 80% retail to individuals, 20% wholesale.

Suppliers: metal castings (manganese bronze and ductile iron) from Enterprise Foundry in Lewiston, Maine; steel for blades ground and laser cut; wood from several sawyers in New England and Pennsylvania;

custom turned parts from three small family owned vendors; Swedish steel for saw blades. Tools for resale from, for example, S.A. Wetterlings (axes) and Forge de Saint Juery (carving tools).

Manufacturing activities: Metal castings fresh from the foundry are shaped first in computer-controlled Haas CNC machines. Machining is finished on manually-operated Bridgeport milling machines, and parts are hand-polished. Wooden parts such as handles and knobs are, similarly, machined then hand-finished. Tool blades are CNC machined but also heat-treated and cryogenically treated for hardness, then ground and honed to a sharp edge. Finished tools are assembled by hand. Saws and workbenches have their own distinct manufacturing processes not detailed here.

The Challenges

Human Resources

When asked what was the biggest challenge they faced, without exception LNT's managers mentioned human resources first. Tom said, "I think our biggest challenge at the moment is finding good people in mid-coast Maine. Because we're in a small population area, [where] the primary industry is tourism and fishing, there aren't a lot of people with the qualifications that we need, not only for the shop but more specifically for management." Robin answered that "the biggest challenge that we face, and maybe this is true of most organizations, is mobilizing the right people at the right place at the right time and getting them the tools to succeed and a clear set of expectations to fulfill, and if they don't, then have a measurable way of identifying that and doing something about it." Even the IT manager, Caleb Pusey, replied that the biggest challenge for the company is "finding qualified employees and retaining them" before saying anything about IT.



Figure 3. Skilled hand work in LNT's wood shop

As part of its commitment to quality, LNT is "stubbornly local" and relies on a local labor force rather than outsourcing. However, Maine is a sparsely-populated state with a relatively weak economy and a shrinking labor force¹, and like many rural states it suffers from "brain drain" as many of its best and brightest move south and west for higher-paying jobs. It is now the oldest state in the nation, narrowly beating Vermont and New Hampshire to have the highest median age according to the U.S. Census Bureau. For local businesses like Lie-Nielsen Toolworks, this means that they can't count on finding many skilled machinists hanging around unemployed in the area. (Or management, or IT talent, for that matter.) Instead, they must train skills and cultivate talent in the workers that mid-coast Maine provides. Tom said "I have always

¹ See, for example, Murphy, E.R. (2015, June 10). "Economic growth in Maine Stagnant, 47th in nation, report says". *Portland Press Herald*. <http://www.pressherald.com/2015/06/10/report-economic-growth-in-maine-stagnant-lowest-in-new-england/>

taken people who are inexperienced, who have some basic mechanical aptitude, and been able to train them to do good work in the shop.” LNT has sometimes been fortunate enough to recruit talented people from out of state, either attracted by his company’s reputation or by the geographic setting of coastal Maine. “If I can find people from away, I’m mostly looking for people with skills to bring to the table. ... We’re not looking for a *lot* of people, we’re looking for some *good* people.”

An additional challenge is that of retaining employees once they’ve been hired and trained. Once a worker becomes an experienced machinist or CNC operator, for example, he could then market those skills to obtain a job elsewhere, where salaries are higher than those typical in Maine. Thus, Lie-Nielsen continues to suffer a very high turnover rate in certain categories of employment, especially but not exclusively on the shop floor. Robin related that three years ago at Christmas (the busiest season for almost any retail company) the entire sales office was staffed by only one person. “So people gravitated toward that need and filled it as best they could.”

This company of only about 90 people has adapted to occasional human resources crises by taking an informal attitude toward job titles and pitching in to help with whatever needs to be done.

Planning and Factory Management

Although management believes that LNT has the capacity (in theory) to make all the tools its customers want to buy, its huge backlog of backorders (both wholesale and retail) testifies to the fact that it hasn’t been making the right tools at the right times. Robin explained:

“It’s always been apparent how much we can’t keep up with demand, so that if there were a place to really push on it would be production, to make sure that we can create tools of our quality standards and get them into customers’ hands when they ask for them. The situation has never quite been that way.”

Some of the reasons for this were an inefficient shop layout and aging, poorly maintained machines, but over the past two years Tom has made a major overhaul of the factory and purchased all new CNC machine tools² from Haas Automation. Now the main challenges are first, planning what to produce, and second, improving management in the factory.

One of the biggest challenges for production planning is that of manufacturing waste. With LNT’s exacting quality standards, a large percentage of work in process may be scrapped either due to casting defects discovered while machining, or from a manufacturing error. Even in cases where the problem is a defect in the metal casting that comes from the foundry, not LNT’s fault, it is often only after several man-hours of wasted effort that the defect is discovered. The critical effect of either type of waste is that it disrupts the company’s ability to forecast its own production. A typical example is that LNT might order 100 castings for a particular hand plane from the foundry and make its forecasts based on an expectation of having 95 finished tools in three weeks’ time, but a bad batch of castings or a new trainee in the shop might mean that, at the last minute, only 75 are finished and ready to sell. The store could find itself out of stock, and customers might cancel their orders or buy something else. In response, management often finds itself putting other plans aside in order to make new, emergency production plans to cover the shortfall.

Complicating the issue of production planning is the fact that some parts, such as tool blades, require a much greater lead time than others, and therefore must be started earlier. Not only does this require that forecasts of demand extend even farther ahead, it also makes production more complex to manage because different parts of the shop will be working on different tools. Machinists might be working on this month’s tool bodies while the blade shop is working on next month’s.

² A **machine tool** is a machine for cutting, grinding, or otherwise shaping metal or other materials (LNT also uses them for wood). CNC is **computer numerical control**, or automation. **CNC machines** are therefore computerized machines that shape metal and wood according to a computer program. At Lie-Nielsen Toolworks, they are used for the initial machining of plane bodies and other tool parts, before those parts are finished and polished by hand.



Figure 4. A machinist at work in the factory

In addition to planning, Lie-Nielsen has had trouble translating high-level plans into directions for its manufacturing workers. “Something that we have always talked about,” said Robin, “and not been able to hold on to over a long period of time, is good scheduling, and sticking to the schedule, and then disseminating the plan all the way down and having every step of the way work. It doesn’t do any good to look at the demand, set up a schedule, and then have the operator produce only a fraction of what you wanted because of whatever reason, either poor planning, or not enough advance notice, or nobody could find the setup sheet or the drawings or the actual program for the CNC.”

With so many different types of tools made on the same machines, it can be surprisingly difficult for factory workers to find out at the beginning of the day what they should be working on. These workers depend on instructions from a few department managers who have traditionally kept notes with pencil and paper, then entered production and scrap totals into a spreadsheet report at the end of the day. This takes time away from the work they need to be doing on the shop floor, and also means that the data is often entered late and inaccurately. As a result, Tom can’t fully trust the numbers and must visit the shop floor himself throughout the day to get an accurate picture of what’s happening on the machines.

It comes back to human resources, as does every aspect of this business. For Tom, “the most important decisions right now have to do with the production area, in the shop. Not the day to day scheduling, but the management of the production areas, which include machining, grinding, polishing, wood shop, assembly... and organizing that. Since we’ve reorganized the physical environment in the shop, workflow is a lot better, and now I’m trying to stabilize and organize the management structure in there so that we have a good group of lead people in each area. And I don’t have as many as I would like right now, because of the fact that we move around some, and we’ve lost a few people in the last couple of years who had those responsibilities previously.”

Robin also notes that “with the high turnover rate there’s not a lot of ownership and accountability.” As Tom has to become directly involved in solving problems on the shop floor, some workers have become overly dependent on him. “Tom has a very, very focused vision and he’s relentless in getting there. But I think that also creates this weakness, a dependency on ‘Well, what does Tom say?’ ... A lot of times people sit back, and they ask to be fed, they ask to be driven, which is something that Tom is very effective at doing, but it shouldn’t be his role to the degree that it is currently.”

If Tom is going to be able to free up his own time for more valuable work, he may need to both shore up factory management and make LNT’s production workers more self-directing.

LNT’s Search for Solutions

Solving the problems LNT hopes to solve may involve IT and analytics, but there isn’t one obvious best way to apply them. Moreover, other forms of organizational change are also on the table.

Lean Manufacturing

Since so many of Lie-Nielsen’s current problems have to do with not making the right tools at the right time, its management team has done a lot of thinking and talking about **lean manufacturing**. Also known as “just-in-time manufacturing” (JIT), or just **Lean**, this is a philosophy of manufacturing that views the system or process as a whole, and seeks to eliminate waste, thereby improving throughput, at individual steps in the process. Pioneered in Japan, and particularly at Toyota, lean manufacturing is actually a collection of different techniques that can be used to streamline a production process. One of its core ideas is that improving quality decreases cost; a counter-intuitive idea, but one that has generally proven to be true, as a lower rate of defects means less waste and rework.

One of the best known Lean tools for reducing inventory and smoothing out a production chain is called **kanban**, from the Japanese word for a signboard. In a kanban system, when a product is consumed “downstream” from a work center, that event sends a signal (traditionally, a paper card) “upstream” to tell the work center to produce an additional unit. In an ideal scenario, such a production line would require no “push” in the form of a production plan, but instead would trigger production in response to demand. In such an ideal example, if a finished product was sold from the retail store, the store would pick up one more unit from the warehouse. The warehouse would be one unit short of its usual inventory, so it would request one new unit from the assembly workstation. The assembly station would pick up parts from a finished parts stockpile to make one more unit, the machinist would pick up raw materials to make new parts, and so on. Thus kanban is known as a **pull production** system.

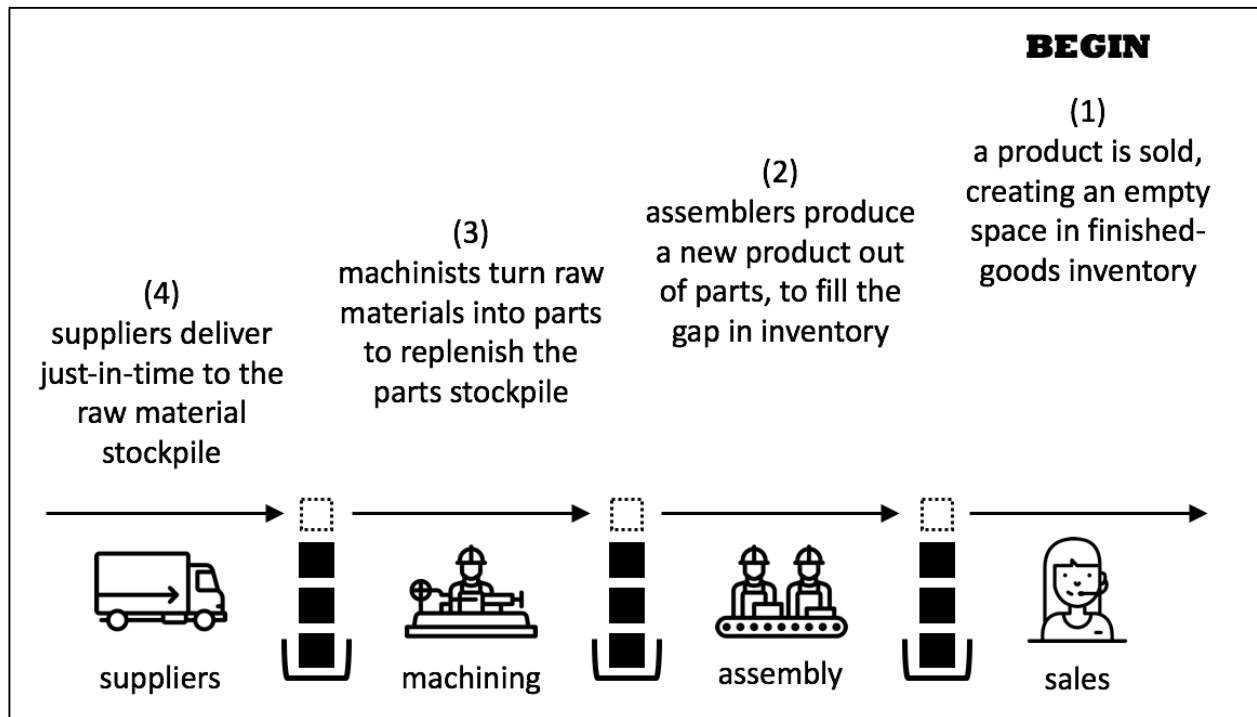


Figure 5. An idealized pull production system.

It is sometimes said that lean manufacturing doesn’t solve manufacturing problems so much as it makes them visible. With a pull production system, if limits are placed on the inventory that may be kept in each **work-in-process** (WIP) stockpile, it quickly becomes apparent which stations work faster than which others – the ones that are idle, waiting for work. In theory, managers can tune the sizes of the WIP stockpiles to the amount of lead time required at each step of the process, and can focus their investments

on the bottlenecks. In practice, Lean may be a relative term, as no business implements all of the ideas grouped under this umbrella.³



Figure 6. Foundry workers casting tool parts for LNT

Tom told me that not all parts of his production process are equally suited to Lean:

“Some time in the mid-nineties I made a big effort with Lean with respect to inventory and on-time delivery of raw materials. And that took about fifty percent of the value of inventory out in a year and a half, which was really, really good. And I taught my managers Lean, perhaps too well, because we were for a period... not what I would call just-in-time, we were ‘almost-in-time’. We were right on the edge, and I think that for the kind of work that we do, and the difficulties that we encounter, with castings in particular, we need to have some buffers of stock.”

Once again, a human resources challenge has shaped the direction LNT could take.

“So this year, not only have I been building up inventory a bit more, but I’ve been working a lot with batch size. Which is a very interesting thing to play with, related to the real world and how it effects the real world. One of the constraints you have with machining is the setup time it takes to set up a new job. And with a fairly inexperienced setup crew right now, I have found that I’ve been forced to do larger batches, to not have to have so many setups done every day.”

Larger batch sizes are usually frowned upon in the lean production world, but Tom has seen some benefits from it that are more in line with the traditional economic idea of economies of scale.

“That was a decision forced on me, but at the same time, I have found benefits to that. Because we are making enough tools in some cases to last us three or four months, which means we don’t have to make that batch again for three or four months, so I would consider that within the just-in-time umbrella. But certain operations, particularly machining, if you can do it in a larger batch it’s more efficient. As long as the batch isn’t too big. So I’ve been playing with what’s ‘too big’.

And our most popular tools, instead of making them every month, which is what we generally have done for a long time, I would prefer to make them once every two months, and have the opportunity for a longer run but also to really debug it, get it working great, spend a lot of time on that batch to

³ For more on lean manufacturing, several Wikipedia articles are helpful: “Lean manufacturing”, “Kanban”, “Just-in-time manufacturing”, and “Toyota Production System” all contain good material. Also recommended is *Out of the Crisis* (1982) by W. E. Deming. Deming was an American management theorist who helped introduce Lean principles to Japan after World War II, and later to re-introduce them to the United States in the 1980s.

make it easier and easier next time, so, that's I think working pretty well. I think I'm headed in the right direction."

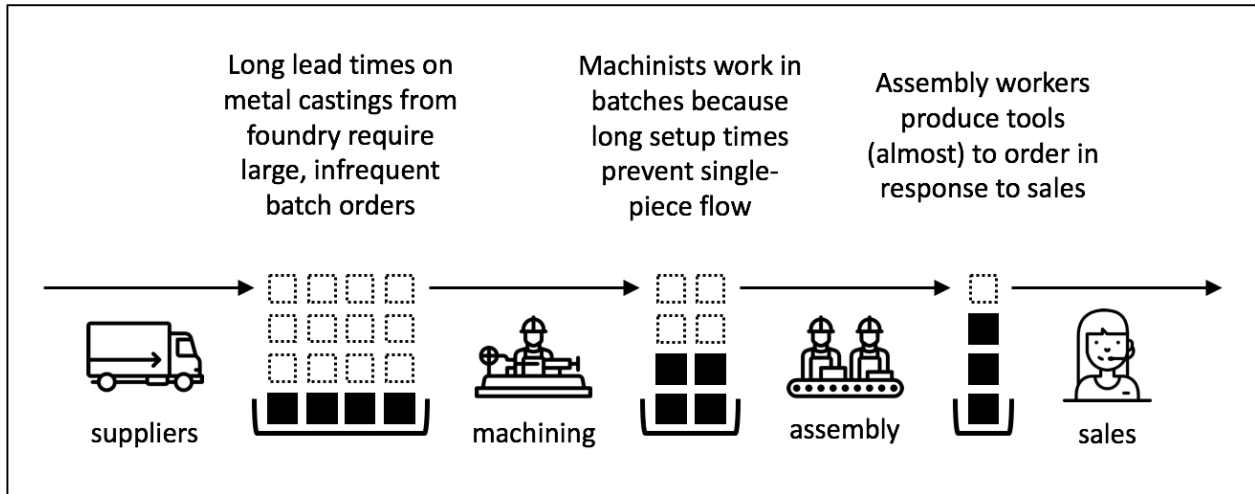


Figure 7. Push and pull production at LNT. LNT is just-in-time only at the assembly stage.

This raises a point that may be particularly relevant to a business that relies on a substantial amount of human knowledge in its processes. LNT is almost always training new production workers, and this year in particular, it's also getting familiar with a new brand of CNC machines, so "debugging" in this case may refer to training its people or to learning and adapting to the quirks of the machines. Thus, a case is made for larger batch sizes not based on economies of scale, but also as an investment in knowledge.



Figure 8. A skilled worker in LNT's saw shop

Finally, Tom explained that some of the post-machining processes are much easier to adapt to Lean.

"Now, finishing is different from machining. 'Finishing' would be grinding and polishing, assembly, and that can be done just-in-time very easily. Even to order, if we have things queued up that are 'ready to finish'. And that's another idea I'm playing with: some tools, where I might only sell a few hundred a year, I might [machine] enough for six months and put half of that batch back in the warehouse to finish it later. And that actually is extremely nice, to have that flexibility. I can grind and polish and assemble a large variety of tools in a given day, where I cannot do that with the machining. So once it's machined, I have the opportunity to do things a little differently."

Information Technology: ERP and Analytics

Caleb Pusey has been on the IT staff at LNT off and on since 2009, sometimes solo, as was the case in the early summer of 2016. Asked what it was like to do IT at Lie-Nielsen, he replied, “Well it’s only me, so you get everything possible from... my printer won’t work this morning, to [developing] web apps, or whatever comes along. It can be a wide range of things, like yesterday, the power was out so I had to reboot servers and figure out why DNS wasn’t working. So it’s a good job to keep all your skills!” As with every job title at a company this size, one has to be willing to wear multiple hats depending on what the company needs.

Caleb related the history of major IT systems at LNT. About the time he arrived, the company was outgrowing a simple accounting system called MYOB, and had decided to purchase an **enterprise resource planning** (ERP) system. ERP systems are large systems that encompass diverse business applications such as sales, shipping, inventory, manufacturing, accounting, and finance, and tightly integrate all of these applications so that they can work together. For example, employees using the sales application or customers using an e-commerce website can also see which products are in stock, because sales is integrated with inventory, and can get accurate estimates of shipping costs, because it’s also integrated with shipping. ERP systems are major investments that affect the whole business, and are believed to convey significant advantages for decision making and management... if done right.

LNT decided to go with SYSPRO, an ERP stalwart, about the time Caleb began working there in 2009.

“I interviewed here just as they were going to implement it ... I was hired just to be desktop support and light app support. They said, you won’t have to do anything with SYSPRO because we have the SYSPRO guy... The first day I got here I said ‘Hey, where’s the ERP guy?’. He got fired, so then I kind of had to learn it, just read the books, and I didn’t know anything about manufacturing or anything. So it was just, learn it from scratch.”

SYSPRO was a very expensive system designed for a huge enterprise, and proved to be too much for LNT’s needs. As a proprietary system, it couldn’t be modified or adapted, so just getting help with technical problems required expensive service calls.

“And of course people ask them in a company this size, ‘Can it do this?’ ... ‘Oh yeah, it can do that. It can do everything you ask for and more’. In fact it can do way too much, but they don’t tell you that because they just want to sell it. So basically selling a little company a *huge* ERP system. SYSPRO was made to run a giant company, multi-location warehouses, goods in transit, landed cost tracking, everything. And for us, all these modules would pop up and we’d use three or four of them. And the price was very expensive. And they were going to upgrade but they wanted, you know, a quarter of a million dollars just to upgrade—not talking annual fees.”

In response, LNT eventually switched to a new ERP system called Fishbowl, which by all accounts they regretted immediately. The new ERP provider was very much the opposite of SYSPRO: a small company, targeting small businesses. Its product was inexpensive and had an attractive user interface, appearing to be easy to use. But as soon as it was plugged in, the new system was a disaster, creating a number of serious problems such as sending out shipments unpaid-for and storing customer data without encryption.

Fishbowl, like SYSPRO, was a proprietary system that LNT couldn’t modify, and in the process of considering a replacement, Caleb advocated for an open-source ERP option called Tryton (<http://www.tryton.org/>). That it is **open-source software** means that anyone can inspect the code to understand how the software works, and more importantly, that customers like Lie-Nielsen Toolworks can modify the code to enhance or customize it for their specific needs.⁴ Open-source software is free, in both senses of the word: “free” as in “free beer” and “free” as in “free speech”.

To “buy” an open-source solution, though, is a bit different from the traditional purchasing process. The code itself is free, but setting it up and customizing it can be difficult. Private companies can be found to offer consulting services, and may even add their own proprietary features to the free software.⁵

⁴ Tryton’s source code can be seen at <https://github.com/tryton/>

⁵ Surprisingly, there’s money to be made selling a product with no cost that can be copied by anyone!

“There’s the product and then there’s the implementers. Tryton, stock, out of the box, is... like I was trying to explain to Tom, with a SYSPRO you pay up front for everything, whether you need it or not. Tryton is this blob of clay, and you pay people to form it into exactly what you want.

A tool that’s honed for you.”

In 2014, LNT settled on a Tryton implementer that eventually became known as Fulfil.io (<https://www.fulfil.io/>). Their product, also called Fulfil, builds on the Tryton code with some features of their own, and over the past two years LNT and Fulfil have worked together to develop the ERP system they need. One of the reasons LNT likes Fulfil so much is that, as Fulfil’s first large customer, they enjoy a close working relationship with Fulfil’s creator, Sharoon Thomas. Despite being based in Bangalore, with offices in Silicon Valley, Sharoon is a frequent visitor to his flagship customer and in August 2016, could be found working from a borrowed office next to Caleb’s.

Sharoon describes Fulfil as “a cloud-based tool that small and mid-sized businesses can use to manage all of their operations, from manufacturing to managing their inventory, selling across multiple channels, and keeping track of all of this from one point. Instead of using a set of different tools or spreadsheets, it’s one tool to manage your entire retail and wholesale operations.” This elevator pitch notably omits the term “ERP”, and when pressed on it, Sharoon explained, “I feel that ERP systems represent... first of all, the word ‘enterprise’ really assumes that these are big companies, and usually ERP patterns are anti-patterns⁶ for small and mid-sized businesses. I feel that ERP systems should die. Which is exactly why I don’t like to term it an ERP”.

Tom praises the partnership with Fulfil as “a really strong relationship ... that’s given us access to some expertise that we would not have had otherwise. And experience.” The first phase of implementation, which focused mainly on retail sales and e-commerce applications, yielded some significant and quantifiable gains. Sharoon reported:

“We’ve seen some interesting stats, including the revenue numbers going up by around twenty percent. Most of that happened on the web side of things, which is also powered by Fulfil. The e-commerce site... That kind of indicates that having all information in one place makes the overall visibility of products better for customers. We get more orders.

Another interesting area is the trade shows and events that Lie-Nielsen participates in, where the gross revenue numbers of every single show have gone up. This is something that was done using paper or through remote desktop. Now these orders are accepted right there, people get an order confirmation on their e-mails before they leave the show, and products get shipped the same day, if it’s a working day.”

When asked how he could know that Fulfil was the reason people were ordering more at the shows, Sharoon replied that LNT had been losing orders...

“...both due to loss of orders due to cancellations, incorrect orders, and most importantly I feel it’s human factors, too. If you have taken orders with pen and paper, the customer placing the order with you hesitates to make a change. The salesperson hesitates to make a change even if it means adding a product into the basket. An interesting stat, if you compare orders from the past before Fulfil, and after Fulfil, especially with trade shows you will see *the number of order line items have gone up.*” [emphasis author’s]

⁶ The term **design pattern**, or just ‘pattern’, is Silicon Valley lingo for a formalized “best practice”. An **anti-pattern** is a bad practice that is nonetheless common and, therefore, ought to be unlearned.

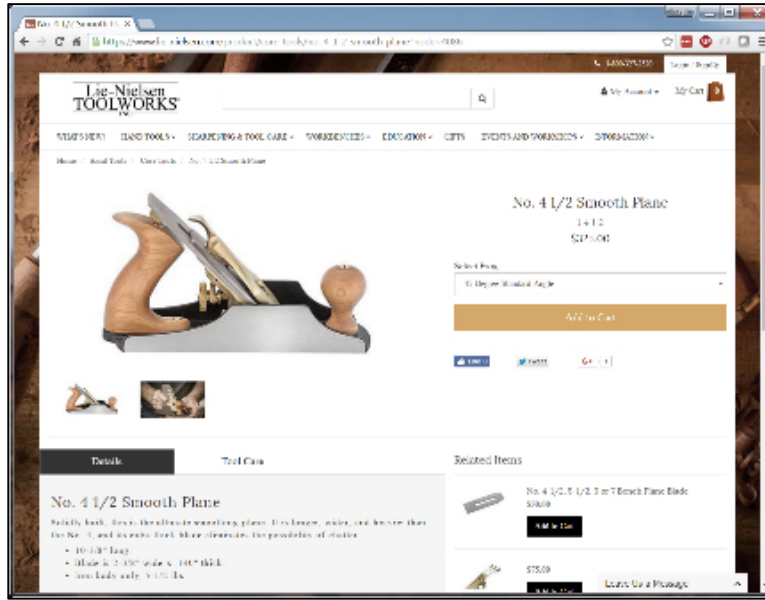


Figure 9. Screenshot of Lie-Nielsen’s e-commerce website, powered by Fulfil

Sharoon related that the next phase of implementation of Fulfil at LNT will focus on manufacturing, and noted that LNT is different from other companies particularly because of its size and its knowledge-intensive manufacturing processes.

“Now, there are two approaches you could take. One, you could, like the traditional ERP systems... bring in a lot of routing processes, and a lot of different steps into a manufacturing workflow. Which works great for large companies, but it requires a ton of discipline. It requires extremely organized processes and most of them kind of ignore the human aspect of the whole process. That’s something that would be really, really hard for Lie-Nielsen to pull off.”

Which is where you need something that’s lighter on processes, more around insights and analytics. To drive this process but still not make it a very robotic thing that happens in routine. Finding that balance is the toughest job at Lie-Nielsen, and once you have that balance, it’s even going to vary. That balance is going to vary by product lines. That’s going to be the sweet spot where this company can operate efficiently.”

Although rigid processes may work in large enterprises with extensive automation, Tom, Sharoon, and Caleb all argue that LNT needs to allow its workers the flexibility to apply their knowledge in what can be highly variable work. Therefore, instead of imposing rigid processes, their current thrust is to increase visibility: for factory workers to see what they need to be working on, for managers to know what’s getting done, and for Tom to visualize his future supply and demand. Given better visibility, workers and managers can use their own ingenuity to decide how to do the work.

To accomplish “visibility”, LNT is trying to build up an internal IT staff that will develop reports and dashboards suited to their needs, but populate the reports with data from Fulfil. Fulfil holds all the data that LNT needs, but its presentation will be customized to the way LNT likes to consume it.

An API-based partnership

Sharoon is a strong advocate of a collaboration between Fulfil and an in-house IT department based on **application programming interfaces (APIs)**.⁷ An API is a set of instructions for accessing an information system’s functions and data from the outside, in this case to “plug in” to Fulfil without having to know how it works under the hood. Using Fulfil’s API, an in-house IT staff at Lie-Nielsen can develop reports that show just the data Tom and his managers need. Caleb summarizes, “just a million different

⁷ In fact, Fulfil.io is billed to developers as “ERP as an API”; cf. <http://www.fulfil.io/developers>

views of the data... they'll say it's all in there [in Tryton], but really presentation is everything when it comes to data. That's why dashboards are the hottest thing. People need actionable data in a good format." Because the API defines a standard interface, Sharoon's team and the LNT team can work independently with software development tools of their choice, without disrupting each other. Sharoon sees the internal IT team at LNT as a key partner, not a competitor to Fulfil:

"If you look at software built from, all the way from 2000 to 2010, 2012, software products were either designed to be 'off the shelf' or they were designed to be customized and deployed, hence the open-source movement and all that. In 2016 and beyond, I believe that customization is dead, and APIs are the future. So you build products which have complete open access to APIs, and then you build tools that work for you around that. And *that* requires people in-house. Those 'tools around that' could be simple reports and insights into information the way you are used to looking at it; it could be tools which make you more efficient like faster input methods on a mobile phone or being able to scan something in, which is specific to your business process, or it could even be printing a bar code label because your business needs that. It's possible with APIs."

In July and August 2016, LNT took on a new IT hire and worked with an analytics consultant (the author), to develop the first of these customized, but Fulfil-based, reports. The first few reports were designed to replicate the structure of spreadsheets that LNT has previously used for communication and planning, with one key difference: they plug in to Fulfil.io and draw accurate data from its API at the time a viewer clicks on the report. By contrast, the spreadsheets they replaced were usually only updated at the end of the day and could have been inaccurate even then due to manual data entry errors. The new reports could be accessed at any time during the day, via an internal website, so Tom and his managers could see the progress of production jobs and changes in inventory throughout the day.

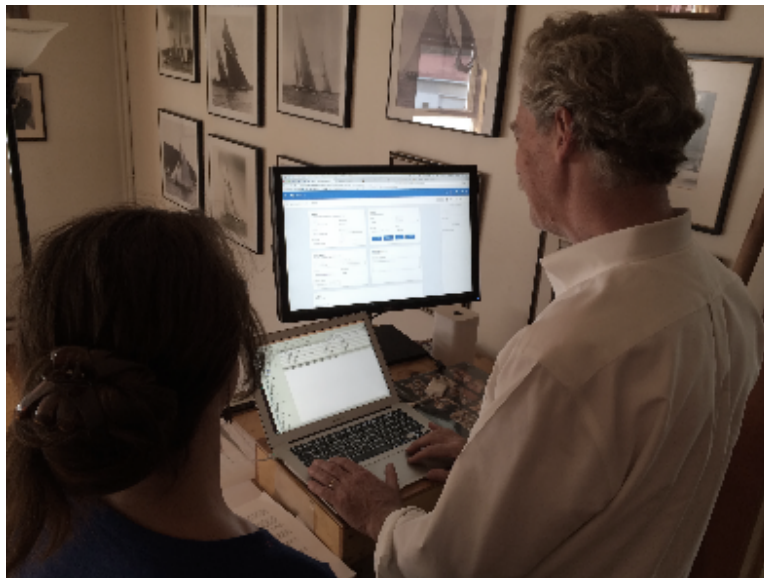


Figure 10. Tom and Robin have desktop access to data in Fulfil

Time will tell whether these new, custom-made analytical tools lead to tangible benefits, whether in strategic matters like production planning or tactical decision-making on the shop floor. One thing that is clear is that Tom is committed to growing an internal IT department to partner with Fulfil.

"Working with [Fulfil] has given us access to some expertise that we would not have had otherwise. And experience. That's been a really strong relationship, but I have felt that we were lacking what we needed in-house, having only one person here, whose responsibilities include fixing printers and network connections and hardware and all that; as well as software troubleshooting if you want to put it that way. And I would like to have a much more proactive IT department that would be able to spend more time training people, streamlining process, giving feedback to the software developers.

That whole part of things has become my job in the last year or two, for good reasons as well as bad reasons. Previously I was not as involved as I am now. I think that the whole program suffered as a result. People were struggling with things that I didn't really understand, what it was all about. Since we've been involved with [Fulfil], I decided that I needed to know what was going on in great detail, so I've been working in the system in various parts—sales, shipping, production, inventory, purchasing—just trying to learn the system, but also to give feedback to the developer in order to make it easier to use...

So I don't want to do that permanently, but I think it's very important for me to know. And I think we've gotten farther than we would have otherwise because of that."

Tom has also asked Robin to take a leading role in the IT arena, and praised her involvement as very valuable. Robin describes her contribution as that of an interpreter between management and IT:

"My role, as more of a lay person,... what I found was that the disconnect between the IT department and the end user is so huge it can be so greatly benefited by a translator: someone to say 'I hear what you're saying and what you need', and then to the developer 'I hear what you're saying and what you're building, but, do you understand that the end user has no use for what you think is important?'... unless you can convince [the end user] that the developments actually *do* have a use, because it's a different approach to solving problems that they have figured out how to solve in many steps... the technology offers them a more efficient way of doing their work."

Next Initiatives

Asked what might be the next big initiative for LNT's growing IT department, both Tom and Robin pointed to possible innovations for the shop floor:

Tom: "The next biggest project for us revolves around all of the shop-related computer systems: CAD systems, the generation of programs for the machines, centers, and most particularly the filing and organization of all that information. All of it really is intellectual property of tool making the way we do it. Documentation, photographs, drawings, programs, all of that information. So that's my next big project."

Robin: "Moving parts down the production line to produce a finished tool as high quality and hand-touched as our particular product may be, that's still something that I feel should be like clockwork... Like: what are we making? Pull out the file. It's been updated since the last time we made it. Hand it to the person. That person knows what to do. They know the machine. They know how to set it up. They know what their quota should be for the day, if all things go well... That would be a game changer for us, because it would allow us to focus on dialing in a lot more of the *interesting* problems that flare up and affect the routine problems."



Figure 11. A Lie-Nielsen no. 7^{1/2}, and other planes

Discussion

Lie-Nielsen Toolworks has a number of assets. Its reputation for beautiful, high-quality woodworking hand tools is untarnished, and it has few or no serious competitors in many of its product lines. Its customers are enthusiastic supporters who return again and again, and spread the word among fellow woodworkers, so sales are growing (about 10% from 2015 to 2016) with little paid advertising.

But LNT is having trouble making the right tools at the right times to serve those customers. It scrambles to fill backorders as the factory floor struggles with training inexperienced workers, unclear direction from management, and unpredictable rates of scrap. Production planning is often reactive, rather than proactive, and forecasting is limited. LNT's profit is close to zero. The weight of these challenges has forced Tom and his leadership team to turn their attention away from what they'd really like to be doing: reinventing hand tool woodworking and evangelizing this art to a new generation.

Information technology, and in particular analytics, is their tool of choice, but many options present themselves. How should they best take advantage of the possibilities?

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Questions for classroom discussion:

Overview of the business

1. LNT is a family-owned business dedicated to staying “stubbornly local”. How might those characteristics shape the way you analyze this case?
2. How does LNT’s commitment to quality create opportunities, and challenges? What other businesses would make good comparisons to LNT?
3. How might LNT address its challenges with regards to finding, developing, and keeping good employees? Do they have any advantages they could make use of?
4. In what ways do backorders and stock outs hurt a business like LNT?

Analytics

5. What should be the main KPIs (key performance indicators) for LNT?
6. What decisions are likely to be made on the basis of these KPIs?
7. How is this data (likely) collected? Could data collection be improved with technology?
8. How should this data be analyzed, modeled, or visualized for additional impact?

Information systems for the factory

9. Tom finds that he needs to intervene on the factory floor (pg. 6) both to get a current picture of what’s going on, and to redirect workers. What technologies or applications might help reduce the need for these interventions?
10. Exercise: design a user interface (a “screen”) to be used on the factory floor which would be used to impose a process-heavy workflow as in Sharoon’s first approach (see p. 12).
11. Exercise: design a user interface (a “screen”) that would support flexible decision making in the factory by providing “visibility” (see p. 12).
12. Which of these approaches to factory-floor information systems do you think would be better for LNT. Why so?
13. Can you come up with a hybrid design, somewhere in between the two approaches?

Organizational change

14. How might implementing Lean manufacturing change the need for, or design of, analytics?
15. At LNT, the decision to order castings from the foundry is different than the decision to assemble new finished tools. How would the decision making process be different in either case?
16. How can a small company like LNT build and keep an effective analytics team?
17. LNT has a small internal IT team as well as a strong partner in Fulfil.io. How should they get the most advantage out of both? How might this relationship evolve?
18. To what extent should Tom be personally involved in information systems development? Why?