Improving your R&D processes through application of lean thinking
— Dr Nick Scott

“In Method will help you to win time” — Goethe

In the previous two articles on lean thinking, we recognised that lean thinking is not exclusive to manufacturing operations, and looked at the value that could be achieved through application of lean principles within the product development process.

In the first article we reimagined product development as a process to reduce the uncertainty of creating a product to meet an unmet customer need. We also considered how to measure ourselves for this new type of success based on our understanding of the process we are running, rather than just the outcomes of the process.

Next, we solved problems to their root causes using Plan-Do-Check-Act experiments, and gained greater insights into how to challenge the constraints on the system for which we are developing better solutions (new products).

In this third instalment, we shall explore how to put these ideas, plus some new ones, together to create an improved product development process. Finally, we will leave the topic (for now) with some concrete things to put into action, so that we can start to realise some of the benefits of applying lean principles within R&D.

Introducing some new lean ideas

Understanding the characteristics of the product development process

It is valuable to recognise that the product development process is less complex than we often think, and lends itself to standardisation a lot more than we are prepared to admit.

Standardisation, the bedrock of lean, is simply the universal use of a “current best way”. We don’t have to (and must not) forego or reduce our ability to handle variety with rigid standards. We must pick our battles, however. We are going to ask you to suspend preconceptions as to what a standard has to be.

Also, it is useful to visualise product development as a process that can be usefully represented by a network of queues and process steps that serve the queues.

How is this useful? Firstly, we often have a single dimensional view of our projects considering them as being a series of steps progressing through a set of toll gates. Whilst toll gates are a great idea (see separate break-out box), they often allow us to miss the key details of the project in favour of externally imposed things we must do in order to move on.

We can also benefit from a resource-based view of progress on new products. We arrive at this queue and server (the processing step that serves a queue of work) structure by looking at the current flow and making what we call a Value Stream Map.

Value Stream Mapping (VSM)

Value stream mapping is an active, multi stakeholder team activity used to look end-to-end in a process, allowing you to establish “the view from the plane”. As we walk the flow (typically in reverse in order to challenge our thinking), we identify the essential capacity of the process, the process steps (which at the highest level of abstraction can be toll gates), the queues (inventory), the methods for controlling the flow, and where we see different problems and sources of waste. We’ll get to why we get these issues later - don’t forget we are still in the plane!
Finally, we draw a timeline showing all the time spent working on the project materials versus the total time those materials spend within the process (including time spent in queues and being worked on).

We can even derive the % of time we spend adding value.

Be prepared to be shocked — our experience shows that this “value add” time is often as little as 1-2% of the total time spent in the process!

This isn’t just tourism — it shows us all, as a team, how the process is typically behaving. After we make some improvements, that % figure will increase. That is the current state - we can now get on and build a future state.

Streamlining working practices

Lessons from lean manufacturing have already been applied, after a limited fashion, in the transactional parts of the engineering workplace.

For example, “5s” functional organisation in labs is a great introduction for engineers to the lean working that is so familiar in well-run factories. If done well, it can boost productivity (engineers can find their stuff more easily) and improve asset utilisation of test rigs etc. It can also motivate engineers and remind them that the business values their time.

Of course, it can be done badly! Simplifying the rummage-cupboards of passionate hoarders (lots of engineers, in our experience) can be a challenge, and efforts must be directed towards improving their ability to find and repurpose things to try and solve new problems. It is not just to force them to bin things they “don’t need”.

In another example, we can manage the bottleneck of engineering change requests (updating drawings and bills of material) with simple visual control systems like those used effectively by the operations teams next door. All of this is great and to be encouraged - it challenges teams to be the best at how they develop products. But it is only scratching the surface of the potential of lean thinking.

What should the future product development process be?

Stealing from the greats

In their landmark book, Lean Thinking, Womack and Jones introduced us to their framework for how lean manufacturers start and continue this journey. The lean breakthrough is achieved through following five simple steps:

1. Define value
2. Identify value
3. Create flow
4. Create pull
5. Pursue perfection

There are a couple of interesting things to note about these steps:

- How easy it is to use this process to get started and achieve real results.
- How universal it is. We have used this in factories, warehouses, hospitals, banks, utilities and now in design and development.

Most notably, these points indicate one key fact about the five-step lean process — it works.

Let’s now explore each of the five steps in turn.

A framework for development success

1. Define value

What is valuable to a customer? Depending on where we are in a development project, we need a “True North” compass bearing as to where we should heading. In product creation this is often difficult to define.

It is our opinion that value creation in product development is achieved by simply knowing that which we need to know in order to proceed to the next step in our process and taking the correct action at every step in the process.

Some examples

- Value is understanding the customers’ unmet needs.
- Value is understanding how much heat we need to dissipate within our product as a result of the power supply we think we are going to need.
- Value is understanding if the current moulding technology we use will achieve the tolerances this product may demand, and helping us challenge if we need a better moulding process or a more tolerant design.

If these examples sound like your job already then we are on the right track! Lean is about how we approach the questions these value statements pose, when will we approach them, and what we will do to answer them.

We master the questions posed by the value statements above by reducing the uncertainty in every stage of our development process as soon as we possibly can, and by testing what we understand about the needs for which we are
developing products.

2. Identify value

Here we can benefit from standing on the shoulders of lean giants - having defined the value drivers of our development project, it is now easy to divide our efforts into one of two value buckets – *value added* and *waste*.

We can begin by sorting our efforts into those two buckets and exploring methods for elimination of the waste, as we discussed in the introduction. This might include minimising the time spent looking for a piece of measurement kit or a prototype part in the lab, avoiding rework and delays caused by engineering changes, or eliminating the need to reproduce CAD BOMs into spreadsheets and then again for our ERP system.

But there is an important further way to think about value and how we identify it. Not just *how* we perform the work, rather *what* that work should be.

Eric Reis talks about a “minimum viable product” (MVP) in our developments, that answers the fundamental question of what should be done (or gives us the knowledge we need at this stage of development), and does very little else.

His only rule – the MVP has to be well enough finished that a customer would part with their money for it, because it addresses a need of theirs.

If we now think about the development tasks that are required to achieve the MVP, we might come up with a very different view of the next phase of our development.

In general, when undertaking lean transformations, it is sufficient to start out with a phase of work that addresses each of these first two steps of defining and identifying value. However, in product development, we need to use these twin lenses for seeing value throughout the stages of our product development.

This might sound complicated but in fact we simplify and “cut to the chase” by working on root causes of problems, mapping the cause-effect relationships from the new knowledge we create (codified by drawings, lines of code, jigs and fixtures) as we progress through the steps of product creation.

3. Create flow

We define flow as continuous, unimpeded movement. In our case, this movement is the progress through the process steps of new product creation. When this flow stops, queues form.

If you've ever run a factory you will know that queues arise from mismatches between work arriving in a queue and the rate at which that work can be processed by the resource serving the queue (the server). The mismatches come from arrival rate exceeding processing rate, or the processing rate varying.

There is a natural tendency to manage the resource serving the queue, and since resources work best when they have plenty of work available, queues can be seen as a good thing.

We maintained this view in factories for years. However, the wisdom from lean is that we get more out of a system if we manage the queues rather than the resources. Define how large the queue needs to be at each stage in the process, and establish the flow to suit.

The implications of turning this view on its head are that:

- We no longer tolerate variations in processing time, so we fix our processes (in a factory, this is against a work standard, in product creation this is against what we thought we knew about the task). So, in a factory we improve the reliability of the process, in product creation we get better at driving out the uncertainty.

In the old-world order there was no reason to make this change. Driving out uncertainty builds on the core lean problem solving principle that spending more time understanding the problem reduces the time and effort required to create a good solution.

- We are no longer hostages to the traditional trade-off between being cost efficient versus the time it takes for projects to get through a network of queues and servers. We get more efficient as we reduce the delay time and minimise the need for multi-tasking (thereby reducing the costs of sharing resource between different projects).

It is also far easier to manage projects in this new model - you can visualise exactly where your work is in the product development network. It's also a lot easier to be a technical expert in an engineering group run on lean lines. Instead of constantly juggling the demands of different projects you now have a defined queue and a manageable set of live projects.

- If you can see exactly what work is in a queue, you can assign value to projects and costs to their delay. We thereby connect the delivery of project execution to the strategic product roadmaps and establish a means by which we can manage the conflicts of the contrasting timescales of maintaining current products, new product developments and blue-sky technology development.

So we have a created a more stable process that is no longer subject to trade-offs between key measures of success. It is also easier for a broader set of stakeholders to visualise the value created by the engineering team within an enterprise.
4. Create pull

In manufacturing or logistics, it is easy to see the difference and obvious advantages of pull (what we want, when we want it) versus push (what we thought we might need at some point).

In product development, we have typically created a plan based on our estimation of the resources required to complete future activities that are most likely unclearly defined. It is easy to think of ourselves as prisoners in a push world.

This is not the case if we have flow, or as close to a queue-and-server approximation as our process permits. Our queue-based view relies on making tasks less uncertain, and therefore more predictable, by limiting task size and performing the right experiments as soon as possible. This is the basis of well-designed development work.

Well-designed work is, of course, just another way of describing the standardisation of work. This is work that has been subject to study and improvement, again using experimentation and evaluation against objective measures.

With the correct pace or cadence within the development process, and the correctly defined work for teams and individuals, there is no reason why teams cannot pull their packets of work through the process steps in a predictable fashion.

5. Pursue perfection

Every viable system needs a control loop. In an earlier article we discussed how to perform this control loop using the Plan-Do-Check-Act (P-D-C-A) cycle. This can be applied at all levels throughout the development process.

- Every day, against each team member’s personal backlog of to-do’s.
- Every cycle when a team Pulls a well-defined, bitesize chunk of work from their queue, and reviews their progress on the last chunk.
- At every tollgate, against the requirements of established checklists and the specification or test plan against which this phase’s activity was drawn.
- At every board review, when the leadership of a company compares their model of the market to the actual customer activity rewarding the company’s efforts to provide products.

But for our control system to perform correctly we need a good set of measures.

In the first article we explained how leading measures, derived from our deep understanding of the root causes of undesirable outcomes, gave us the edge both in terms of time, and in selecting the actions needed to truly solve those problems.

Throughout this pursuit of perfection, we are trying to improve knowledge of our process, make problems obvious, and ensure we are getting the right data to allow us to confront those problems together as a team.

Once again, we are using lean problem solving (P-D-C-A) to address root causes. We will now talk about how to put this to work.

Putting this to work

A list of hypotheses

Hypotheses drive the lean system. They are our plan – a list of uncertainties on one hand and a list of assumptions about how we think the world works on the other.

It’s important to note that these aren’t just useful at the product requirement “fuzzy front end” stage. Rather, they are important at every step of the way as we use our knowledge and experiments to transform requirements into a set of process controls that ensure successful outcomes at the end of our process.

Visual control of our tasks

We need measures that reflect the performance of the leading factors that influence good outcomes, and that cover all of our bases – team safety and wellbeing, the quality of their work, the timeliness of its completion, and the costs of delivery.

We also need visibility of our process steps (with their associated resource queues). The work packages in our managed queues needs to be defined in terms of the “current best” working practices of the team to make them predictable and productive.

Finally, if you can’t visualise all of these things in the workplace, you can’t really expect to control them. We are going to need whiteboards or big screens (if you must).

Short interval control

We typically work on three nested PDCA cycles with different clock speeds. We think in terms of the daily execution of an engineer’s work, the weekly, fortnightly or monthly cycle of agile queue management, and the quarterly or annual cycle of product strategy and roadmap review.

Figure 1 shows a representation of how the work we do serves the queues in our workflow, which in turn translates into delivery of the products we want to supply to our customers.
The PDCA cycles within each gear of this mechanism ensure control throughout the process and allow us to monitor progress against our development and delivery plans.

And remember, when we are talking about the actual process of project delivery, the drive for the other two gears comes from turning the little gear at the bottom!

Note that I’ve left the tollgate reviews out of this process. This is because, as soon as a project is ready for its next tollgate review, we should conduct that review, rather than wait for the next cycle.

To turn the gears then of our nested P-D-C-A’s, we have to do some marketing-engineering-manufacturing work! And we need to meet regularly to review our progress, raise our issues, and check our other performance measures.

We can also ask for help! This is the crucible of improvement, where we work our three cycles, based on what results from the actual work tells us about how we are doing. The sincerity, openness and drive of how the teams work these P-D-C-A loops will be the acid test of everyone’s commitment to lean breakthrough.

**A method of tying it all together**

Have you ever heard of Quality Function Deployment (QFD)?

In our experience, a great deal of the uncertainty, complexity and wasted effort within the product creation process comes from not only how we transform the uncertainties into knowledge, but also how we use knowledge to inform the next step of the process.

If the whole team can map and understand the flow of knowledge, using their individual expertise at each step, then we go a long way to addressing this wasted effort.

QFD is the ideal tool for this. It sets up a family of relational matrices that link, item by item, the customer to the production operative who will make the product, and everyone in between. Because of the rationality of the matrix, it helps us be disciplined with those cause-effect linkages, and we can all see the implications of the choices we make (user need, function, design detail, process selection) as we perform our parts in the overall process.

It’s thirty years since Hauser and Clausing³ wrote about QFD in Harvard Business Review and their explanation has not been bettered.
Conclusion

In this article, we have continued to explain how lean thinking applies to the complex and exciting world of new product creation.

There is almost nothing new in this article. You can see this in the dates of the references below. Rather, our hope is that we have provided a fresh way to think about some great ideas that started out in manufacturing but can be thoughtfully applied to our work in product development.

Also, our intention is that product creation should be joined-up from first lean principle to last. As you have seen, these principles keep occurring and can be re-used in lean product development.

Finally, we wanted to ensure that you can act on these principles with the best practices we have developed, because in our experience, lean product development success starts with pragmatic, bottom-up action, helped by clarity and a willingness to remove obstacles from the top down.

Good luck!

Toll Great

What’s great about tollgates (or phase gates, or maybe just gates), if properly used, is that they effectively reduce the appropriate risks at each stage in the life of a development project.

They also provide (via checklists) a place to codify the “current best way” to pass the toll gate (by carrying out the relevant checks).

However, tollgates can also set up batching or checklist driven behaviour, delaying decisions. And when incomplete activities are allowed to be carried over into the next phase, then we miss the opportunity to ensure we have reduced the appropriate uncertainty.

Finally, by anchoring a project within a tollgate process, do we burden teams with a model that doesn’t support their rapid knowledge-building mission in favour of a set-piece process? Is this why we do not tend to find tollgate processes at the “fuzzy front end” of new product innovation?

1. Lean Thinking, Jim Womack and Dan Jones, 1996
2. The Lean Start Up, Eric Reis, 2011
3. The House of Quality, Hauser and Clausing, HBR May 1988

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