

Getting the T's New Cars Back on Track¹

Overview

Vendors and buyers can fall into a trap that leads to cost overruns, under performance, and lateness with engineering and technology intensive projects. Having contracted for similar items previously, they imagine that the next round is routine enough to treat the work 'production-ready'—enough has been experienced and enough is known that the next increments are more of the same. Based on that, they tend towards agreeing to payments for units of production by milestone dates, maybe with cursory inspection at delivery.

Such an agreement offers the promise of letting both get underway with 'the real work' of production, delivery, installation, and use. It creates risk that they overlook elements of the new situation that merit being treated not as routine but as developmental, situations that are good but which still need experiments, trials, training, tests, debugging, mock-ups, pilots, etc. to become reliable. These novelties can include new technology, new configurations or applications of existing technology, new workforces, new worksites, etc. The downside of treating as developmental what is actually 'production-ready' is relatively minimal—the time and resources set aside can be repurposed for some other use. The downside of treating as production-ready what is still developmental can be enormous, forcing both parties to do the upstream work of creating and vetting ideas while also trying to maintain promised schedules. (In fact, the very best organizations treat products and processes, even those in production, as always developmental, a point that will be illustrated, below.)

Just such a mismatch between the structure of the contract and the novelty of the situation may be causing trouble with the Massachusetts Bay Transit Authority's (MBTA) purchase of new cars for its Orange and Red lines from Chinese rolling stock producer CRRC, and the MBTA-CRRC experience may be warning to other enterprises to build developmental time into contracts as a protective measure and to use developmental time as a recovery mechanism.

In contrast, what's apparent with the world's most successful engineering intensive organizations, is that they maintain a more intense experimental/developmental mindset during actual development and maintain such a mindset well into operations that most others would treat as ongoing and routine.

Table 1: developmental vs routine reality and treatment

		The situation <u>actually</u> is...	
		Developmental	Routine or Production Ready
We <u>treat</u> the situation as...	Develop-mental	We allocate time and resources to create capability, so build preparedness for operations.	No worries. Re allocate time and resources for some other purpose.
	Production ready (routine)	Disastrous costs trying to recover while operating.	Great! No time and other resources wasted.

¹ Dr. Steven Spear DBA MS MS, Principal HVE LLC and See to Solve LLC, Senior Lecturer MIT.

Off track and running behind

The Massachusetts Bay Transit Authority (MBTA) is experiencing delivery delays and operating problems with new cars for its Orange and Red lines, vehicles purchased from Chinese state-owned manufacturer CRRC and manufactured at a new CRRC facility in Springfield Mass.^{2 3 4 5 6}

To make a confident statement about the cause for underperformances, one would need in-depth access to operating issues. Nevertheless, it's possible to make a well-educated guess about how such a situation developed, how it can be remedied, and what can be done to avoid such disruption in the future. The logic behind such a "best guess" is not only applicable to the CRRC-MBTA relationship—it's relevant to other situations in which a customer is contracting for a large capital investment in engineering and technology intensive products, regardless of whether the parties are .com, .gov, or .mil.

Organizations—particularly those responsible for engineering-intensive, large scale projects—can fall into a trap that predictably causes underperformance (even failure) in terms of cost, quality, delivery time, product and process safety, etc.

They treat a situation that appears familiar as routine or 'production ready,' even though it is novel because of new science, technology, design, workforce, or context otherwise. In fact, the situation should really be treated as developmental. What's the difference? Developmental situations are ones in which we don't yet have an adequate understanding of what to do and how to do it. We're not yet prepared to succeed. So, to succeed, we build in time and resources to learn and otherwise build competency through experiments, tests, trials, and vetting.

Situations we treat as routine are those for which we've already accumulated sufficient understanding and developed adequate routines to succeed. We (think we) know well to what and how to do it.

² New Orange Line cars pulled from service due to 'a fault with the bolsters', March 3 2020, <https://www.boston.com/news/local-news/2020/03/03/new-orange-line-trains-removed-from-service>

³ MBTA says the new Orange Line cars — and the new Red Line cars — have been delayed, June 22, 2020, <https://www.boston.com/news/local-news/2020/06/22/mbta-new-orange-red-line-car-delays-coronavirus>

⁴ MBTA's new Orange, Red Line cars face another big delay, October 5, 2020, <https://www.bizjournals.com/boston/news/2020/10/05/mbta-orange-red-line-cars-face-another-big-delay.html>

⁵ MBTA warns of 15-month delay for Springfield-built CRRC Orange Line cars, October 5 2020, <https://www.masslive.com/coronavirus/2020/10/mbta-warns-of-15-month-delay-for-springfield-built-crrc-orange-line-cars.html>

⁶ Some new MBTA trains won't arrive until 2023, 2024, October 8, 2020, <https://www.dotnews.com/2020/some-new-mbta-trains-won-t-arrive-until-2023-2024>

Confuse what is really a developmental situation for a routine, production-ready one, and predictability an organization will fail.

Treating everything always as developmental

Toyota is a positive example of an organization that has habitually treated situations as 'developmental,' all the way through operations that most others would consider 'on going' or routine. The rewards are gigantic. Heralded for its world-standard setting performance for manufacturing efficiency and product reliability in the 1980s and early 1990s, the company demonstrated tremendous accomplishment in converting itself from a foreign importer of vehicles, when it first entered the US market, to a bona fide 'domestic,' based on the amount of its business that is designed and built in North America. It's profits per unit sold are multiples of the world standard, and while other companies dabbled in the hybridization of gas engines and electric motors (think of the discontinued Chevy Volt), Toyota's hybrid drive system has gone through multiple evolutions, migrated from its introduction on the Prius to its presence on dozens of models, and has racked sales approaching 20 million vehicles.

Developmental mindset during development

The commitment to maintaining an approach richer in feedback and experimental attitude starts in the far upstream phases of product development, has continued through the introduction of new manufacturing facilities, and continues into day to day operations, that others would treat as routine but for which Toyota still demand continuous feedback and improvement.

Durward Sobek, Peter Ward, and Jeffrey Liker, in "The Second Toyota Paradox,"⁷ wondered how in the hyper competitive aspect of new product development, Toyota could achieve better designs (in terms of manufacturability ease, product reliability, product cost) engineering labor-content (about half the world standard), and time to market (two years for a major model upgrade versus the more typical four). What they found was that an apparent contradiction—a far later commitment to design decisions relative to its rivals was actually a source of advantage.

The apparent paradox that Ward, Liker, and Sobek found was Toyota staying in the clay-model phase of design longer than was typical and maintaining up to five alternatives of a design at that stage, when other companies would have narrowed down to a single variant and started to move on to more detailed design. How, they wondered, did Toyota catch up and get ahead if it was waiting so long to 'finish' that phase? The answer was that Toyota was respectful of the myriad questions that had to be explored experimentally, iteratively, and (maybe most important) collaboratively across functional silos, before they had sufficient confidence to move

⁷ *Sloan Management Review*, Spring 1995.

to the next phases. Their rivals were in such a rush to “get going,” that they left way too many questions unasked, let alone unanswered. The consequence? They had to keep coming back to them in an unproductive point-by-point search for a solution.

Developmental mindset during expansion

The maintenance of an experimental/developmental mindset has been evident in Toyota’s expansion of its USA-based production since the 1980s, transitioning from a pure importer to now being one of North America’s top producers (with top seller Camry leading in domestic content), and the company ranked as the most admired in its industry.⁸

When Toyota opened its first American manufacturing site in the mid-1980s, in Fremont, CA, it was a joint venture with General Motors (called NUMMI) in a facility and with a workforce that had been making cars. The JV started with familiar products; Toyota had been making them in Japan and had been selling them successfully in the United States.

Nevertheless, Toyota treated the situation as developmental, not routine or otherwise ‘production ready,’ because the existing workforce had not operated within the Toyota management system, this car hadn’t been made in the NUMMI facility, Toyota leaders hadn’t yet managed an American workforce, etc. So, hundreds of Americans were brought to Japan to immerse (think Karate Kid) in Toyota’s environment, and when the plant was (gradually) started up, hundreds of Japanese employees were brought to Fremont to act as ‘coordinators,’ essentially one-on-one shadows, giving real-time coaching on how to operate in this new fashion. Even when up and running, the systems (technical and people) were treated as ‘developmental,’ so when a problem was encountered an associate could (and should) have called immediate attention to it to be contained, investigated, and corrected enough to prevent recurrence.⁹

When Toyota opened its second plant in the USA, a Greenfield site in Georgetown, KY, it could have treated that as routine—known car and market (Camry), they’d already had experience with an American workforce at NUMMI, they’d been building their North American supply network, and veterans of NUMMI were on hand. Nevertheless, Georgetown was also treated as developmental, with the same attention to acculturating employees to the management system and technology particular to the Camry at its sister plant in Japan. Georgetown people were deployed to Japan to experience first-hand the environment, ‘coordinators’ followed them back

⁸ <https://pressroom.toyota.com/toyota-named-number-1-motor-vehicle-company-on-fortune-magazines-2020-worlds-most-admired-list/>

⁹ Akio Toyoda, now chairman of Toyota spent time at NUMMI as part of his developmental experience. Just because the Toyota company had international experience, it didn’t necessarily convey to the Toyoda family.

Getting the T Back on Track

to Kentucky, production was ramped to allow developing a new workforce, and ongoing operations were run as always developmental, with everyone having opportunity and responsibility for calling out problems of any type when and where they were first seen, so that problems could be contained once seen, and investigated and solved to prevent recurrence.

When the Princeton, Indiana plant was opened, treating the situation as developmental still held, despite previous Greenfield experience in. When the Tundra was relocated to a new facility in El Paso, TX, that too was treated as developmental—transplanted product, but new workforce, new logistics (even for existing suppliers), etc.

Table 2: sequencing novelty in the Toyota system

	Product	Market	Facility	Workforce	Suppliers and Logistics
NUMMI	Known: Corolla--1985 (some sold as Novas)		Experienced but unfamiliar		New
Georgetown, KY	Known (Camry)		New		Familiar but always increasing... <ul style="list-style-type: none"> • USA based content • product variety, • production sites, & • production volumes.
	New (Sienna—1998, full sized minivan)		Experienced		
Princeton, IN	New: Full size pickups (Tundra-1999)		Inexperienced		
	Tundra		Experienced		
	New: full size SUV (Sequoia-2001)				
	Familiar: Tundra, Sequoia, New to TMMI: Sienna—2003		Experienced workforce. First time car and truck bodies on same line.		
El Paso, TX	Known: Tundra		New		

Routine Operations as Developmental

Studies of Toyota popularized the notion of ‘standard work’ as a way to reduce process variance. It was sometimes misunderstood as a Tayloristic imposition of required routines by overlording superiors. What was missing from the focus on the standards was that each standard was designed to have a “built in test” (or tests) that were giving fast and frequent feedback as to whether the people using the standard were able to, and even if they could, whether or not it was working. Those tests took myriad forms—from go/no-go gauges to see if parts were compliment, time trackers to see if work had inadvertently gotten ahead or behind of the expectation/prediction built into the standard. Regardless, the indication that something was amiss was a signal that in turn triggered an investigation of what was wrong with the doing and that in turn also triggered what was wrong in the thinking that proceeded the doing. In effect, standards within Toyota have been *temporary* standards, agreed upon choreography for completing tasks, but also subject to constant test. And once a test refuted the standard—too slow, too hard, too ineffective, too wasteful—it was investigated and improved. In effect, standards were hypotheses, uses were experiments, and the entire workforce (in the ideal) were part of “a community of scientists” treating everything as developmental/experimental.¹⁰

Discarding Developmental Mindset to Early—even in the contracting phase

In contrast, organizations that mischaracterize a developmental situation as a routine one, don’t allow themselves the time nor the mechanisms to build competency, trying to ramp to production levels for which they are unprepared. Failure in this regard goes to both the vendor and the buyer. One can imagine, particularly for governmental authorities, is that normal for them is contracting for materials in terms of units of production—a certain volume of physical product, delivered by particular milestones, at particular costs.

As for the train situation—we can construct a hypothesis—make a guess, that the MBTA’s relationship with its Chinese vendor fell into the ‘developmental being treated as a routine, production-ready’ situation. The MBTA needed new cars for its Orange and Red lines. The Chinese vendor had experience making subway cars—they’re one of the largest producers in the world. CRRC probably looked best among various competitors for the contract; so far so good and looking plenty routine. And, had the “T” agreed to buy copies of existing and proven models as export/import products from China, that might have fit the ‘routine’ model (well, except for transportation, distribution, service and maintenance).

¹⁰ “Decoding the DNA of the Toyota Production System,” Steve Spear and H. Kent Bowen, *Harvard Business Review*, 1999.

Getting the T Back on Track

However, we can guess is that it didn't order, as if from a catalog. More likely, there was customization to the product—refitting for the conditions in Boston vs elsewhere. Maybe HVAC and other accommodations for odd ball New England weather. Maybe other modifications for service and maintenance conditions different than those of previous users.

On top of everything else, thrown on top was pressure, no doubt, for a "Made in America" element that would have introduced more novelty. New production site (meaning new vendors of industrial equipment + new suppliers of parts, components, etc.), new workforce (new to the employer and new to making trains).

Table 3: CRRC-MBTA contract assumptions vs reality

	Product	Market	Facility	Workforce	Logistics
Reality...	Probably newish	New	New	New	New
Treated as...	Treated as routine	Treated as routine	Treated as routine (e.g. install the equipment, buy the tools.	Show them how to build trains, quick enough.	?

Yet, expectations on both sides—supplier and customer—probably didn't allow for developing the workforce, developing local suppliers, vetting vendors of the new production equipment, vetting the new product design, etc.

Long and short, if you want to point to when failure was baked in, the best guess was in the days running up to the contract signing, when the "been there, done that" mindset asserted itself.

Recovery By Reestablishing Developmental Approaches

So, how do you rescue such a situation? If, all the assumptions about novel/developmental being treated as routine are true, then the most important step is for both parties to acknowledge that they are still in a developmental condition and act accordingly.

Take a pause in trying to push production forward "according to schedule" (they've proven already they cannot hold to schedule), identify where exactly things are still most unresolved—product, process, workforce, vendors, suppliers, logistics, etc.—invest time to get those better understood and more capable. At that point, 'routine' production can commence.

A strong prediction, if the guess is true that novel was treated as routine, and if the guess is true that there is still a lot of unresolved 'developmental' issues, then taking pauses will actually get the program on track and able to run smoothly. And, if not, it'll be a headache going forward.