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The disintegration of lean manufacturing and lean management

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Abstract Lean management—in manufacturing, supply chains, healthcare, services—has lost its way. Telling evidence of lean's dissolution shows up for inventory-intensive organizations in the form of worsening inventory numbers. My research of financial records of more than 1,500 global companies over 15 years shows growing inventories since the turn of the 21st century. Reduction of inventory is a concrete and visual marker of leanness and quicker customer response, while inventory growth is one of the more salient factors that degrades financial health. As to what has gone wrong with lean, the answer is nearly everything: ambiguous terms and concepts, trivializing the essence, botching the basics, going through the motions, analysis paralysis, puffery masking action, abetting organizational silos, discontinuity, and losing interest. This article addresses these in more specific terms with reference to key outcome measures, especially those most customer-relevant.

1. Lean's mission

Lean's foremost purpose should be serving customers with a quicker, more flexible, higher-quality response—all in the mode of customer-pull. Reducing inventory is an important contributor in services as well as goods. As Thomas (2016, p. 45) put it: "Inventory is people." Any item that sits in inventory lengthens waiting times and waiting lines and invites mix-ups and mishaps. In many services, the main party to (i.e., the victim of) those waits is the customer: client, user, shopper, or patient. At the same time, the causes of customer waits, whether for goods or services, are resident in the greater organization as waits for documents, supplies, tools, equipment, approvals, credit checks, makers, and servers.

Here is an example of lean at its best. In 1992 at Seattle's Northwest Hospital, Debby, a surgical nurse, told me how she brought about a fix to a chronic problem: No one, she said, could remember

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a surgery starting on time. Armed with process-improvement tools taught by a local-area expert in the quality sciences, she had cleared out a small room adjacent to the surgical suites and put up a whiteboard that she would use thereafter as a who-was-late chart. Then, in what came to be called Debby's Dugout, for each scheduled surgery she listed the names of all who were to be involved, followed by marking an X next to the name of any who were late. The effect, she explained, was nearly instantaneous: no more late surgeries (Schonberger, 2018a, p. 18):

> The shame and opprobrium from being singled out for bad behavior can have that effect . . . when . . . more than inconvenience [was] at stake. In this case, the rippling effects of one late surgery pushed back others, with patients the worse for it—to say nothing of the costs of poor usage of valued resources.

Debby applied one of the simplest of lean's kit bag of concepts: visual management. But that simplicity is often smothered by the management of lean management. Lean or lean/six-sigma offices keep busy not on process improvement, but in such activities as certifying green-belts and black-belts, drawing value-stream maps, and running training sessions that bring the belts, managers, and workforces up to speed in lean lingo, which does take time as the Lean Lexicon (Lean Enterprise Institute, 2014) includes 207 terms from A3 to Yokoten with Japanese words liberally sprinkled in.

Much of the cause of lean's downslide would seem to be owed to this tendency to spend more effort on peripheral pursuits—with accompanying outsized vocabulary—and less on actually changing processes for the better. Scholars and practitioners need to unite in a common cause (Ireland & Ketchen, 2008): that of transforming lean management from its present state of confusion and wheel spinning to proven customer-focused methodologies that directly affect the processes. Before getting into details on this, let us take a look at some of the detailed evidence of lean's decline.

2. Long-range inventory studies

I began my inventory research in the mid-1990s, digging into annual reports from publicly held U.S. manufacturers dating back many years; for some companies—IBM, Kroger, J.C. Penney, and L. S. Starrett Company—I went back as far as 1950. Gradually, I added manufacturers from the UK and France, then other countries. From the start, the object was to track long-range trends by industry sector and by global region in order to wash out biases of looking at single companies and short-term numbers. The active database includes only companies—now from 37 countries—for which I have 15 or more years of financial records, with trend analysis being based on the last 10 years.[1] Table 1 explains the importance of inventory in outcome management.

Table 1. Inventory and response times: Alter egos

Inventory is a thermometer that measures the fat and the lean in inventory-intensive organizations: manufacturers, retailers, distributors. By Little's Law (Little, 2011), as inventory decreases so do wait times—customer waits being of direct competitive importance, with inventory indirectly so.

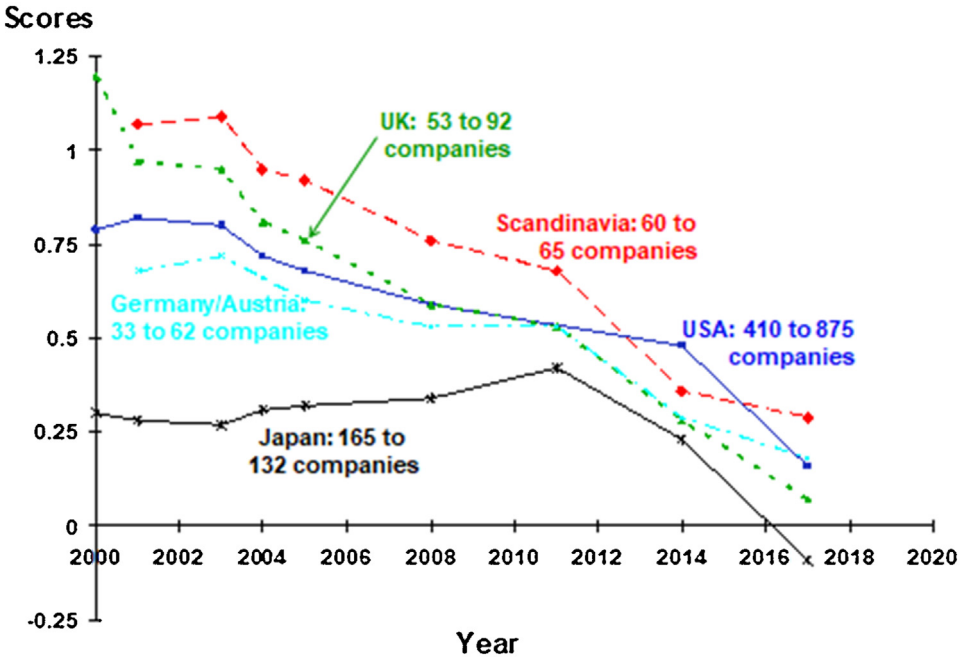
Key findings from the inventory research are reported in Schonberger (2016a, 2016b), which shows lean trends—based on yearly updates of company data—as a series of many-year down-up-down cycles. The cyclicity relates, in part, to such factors as WWII, post-war recovery, shifting the composition of executive suites, and the 90s lean phenomena and lean's show-the-way predecessor from the 1980s, just-in-time (JIT) manufacturing.

2.1. Worsening multiyear inventory trends in five global regions

Figure 1 highlights lean's current regressive period by showing worsening inventory turnovers from about the year 2000 for the five global regions that are dominant in the research database: the U.S., Japan, Germany/Austria, Scandinavia, and the UK. The display is annotated with numbers of companies making up each trend line, changeable as companies are deleted from the database—via acquisitions, mergers, bankruptcies, etc.—or added. Some of the added companies had been in an inactive database and were activated when the required 15 years of data became available. That the U.S. contingent more than doubled in the 2000s may be owed in part to the dynamism of the U.S. economy in generating new businesses. Japan's reduced numbers may have a lot to do with "exiting . . . through joint venture or merger and acquisition" (Lehmberg, Dhanaraj, & Funai, 2013, p. 223) as a way of coping with 2 decades of stagnation in the Japanese economy.

[1] The *IndustryWeek* Best Plants Awards are based on just 3 years' data.

Figure 1. Long-term inventory turnover trends: Scores for five global regions
Beginning (year 2000) and ending (year 2017) numbers of companies are given for each of the five regions



The scoring, ranging from a high for the UK of 1.24 in 2000 to a low for Japan of minus 0.25, employs the following method:

- If a company's inventory turnover clearly shows an upward (improving) trend for as long as 10 years, score 2 points.
- The same but with a lapse in the latest 5—7 years, 1 point.
- No clear trend for 10 years, 0 points.
- Worsening 10-or-more years, minus 1 point.
- Five-or-more-year reversal of a long negative trend, plus $^{1}/_{2}$ point.

It was unexpected that the scoring would ever go below 0, which it does for Japan's 132 companies in 2017. Examples for selected companies follow.

2.2. Long-range up-down inventory patterns for four automakers

As a prominent example, Figure 2 shows sharply up-down trends in inventory turnovers for four of the largest global automakers. Three—Volkswagen, GM, and Toyota—clearly have worsening turns for at least 10 years (minus 1 point). Ford looks bad, too, but by the strict scoring method gets a grade of 0, because its worsening turns were confused by sharply down-up-down numbers since 2009, with the most recent downward trend being for less than 10 years.

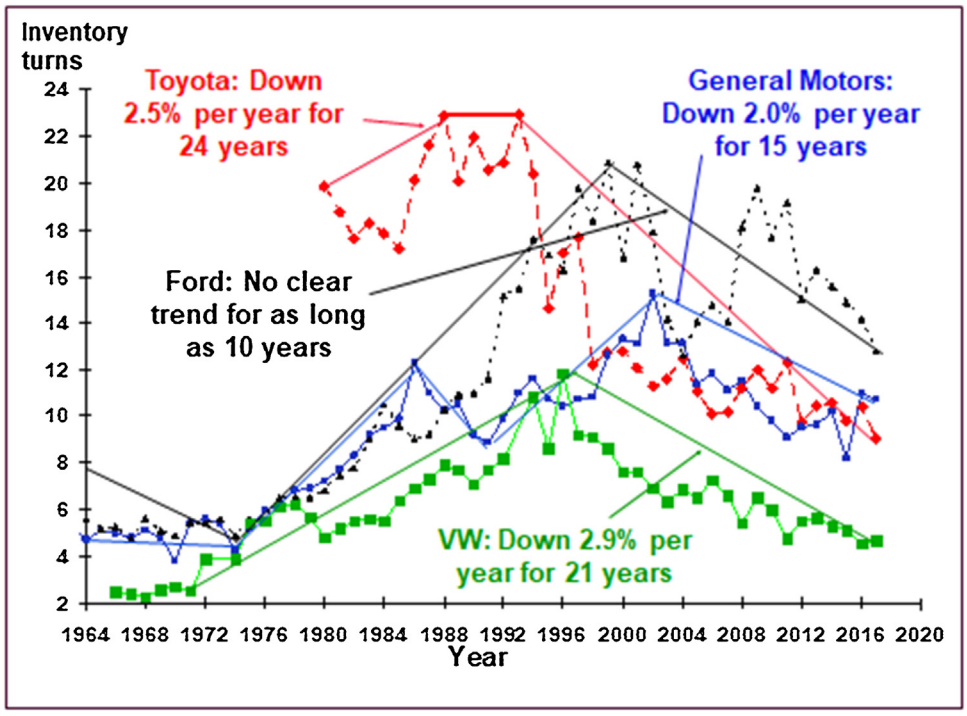
2.2.1. As major automakers go, so go many of their suppliers

Many of the automotive suppliers in the database echo the four majors—with sharply worsening inventory trends in the 2000s: Dana, Donaldson Co., Lear, and Timken (U.S.); GKN (UK); Aisin Seiki, Denso, Koito Manufacturing Co., KYB Corp., and Toyota Industries (Japan). Six other auto-parts makers have sharply improving trends, partially offsetting the 10 with bad trends (other producers showing no clear trend).

2.2.2. Worsening component inventory trends

A separate data set, mostly of U.S. and Japanese companies, has total inventories subdivided into their components and is measured by production days of inventory rather than turnover. For example, Toyota's finished goods—mostly vehicles—grew from 10.5 days on hand in 1993 to 24.6 days in 2006, then fell and rose until it reached a new peak of 26 days in 2017. Meanwhile, its amount of purchased materials grew from 2 days' worth in 1988 to 8 days' in 2012, and its work-in-process went from 2.5 days in 1988 to 5.7 days average in 2004 before settling into a steady 5 days' worth from 2005—2017.

Figure 2. Lean in regression: Four automakers



2.2.3. Similar negative inventory trends in 32 industrial sectors: Worst-case examples

The stark evidence of un-lean trends in automotive is not an anomaly. Most of the 32 sectors making up the research database follow suit: Since 2000, more companies have scored minus than plus points.

Worst cases show up in Japan's large (19 companies) chemicals sector. Particularly acute up-down inventory-turnovers were found for eight of the companies: Asahi Kasei, Daicel, Kaneka, Mitsui Chemicals, Nagase, Shin-Etsu Chemical, Teijin Ltd., and Tosoh Corp. A composite plot of their data reveals improving inventory turns for 12 years, 1983—1995, at a rate of 2.8% per year, followed by worsening turns for the 22 years from 1995—2017 at a rate of 1.9% per year.

Another sector high in worst cases is furniture, a small sector that includes 12 U.S. manufacturers. Six of them—Bassett, Flexsteel, HNI, La-Z-Boy, Herman Miller, and Hill-Rom—have striking up-down inventory trends. A composite plot of their inventory data shows a steep 5.3% rate of improvement from 1976—2001 and then an even steeper downward trajectory ending at 11.9% in 2017.

Of those furniture companies, I became familiar and impressed with the office-furniture sub-sector in the 1980s and into the 1990s. In particular, from visits to HNI (nee, Hon Industries) and Steelcase, I had judged HNI/Hon as among global best examples of prowess in JIT/lean manufacturing. On the other hand, I saw Steelcase as rather the opposite, with many aspects of lean implementation floundering.[2] As for lean's fade at HNI, such discontinuity may be the norm. I am aware of—and have collections of articles and case studies on—many examples of companies once strong in JIT or lean (large reductions in flow times, inventories, scrap and rework, etc.) that lost it. Remarkably, there often seems to be no memory of having once been among JIT/lean's elite. For example, in an interview, Stan Asken—who became chair, president, and CEO of HNI Corp.—spoke of HNI's lean journey as having begun in 1992 but not having become a real effort until about 7 years later (Panchak, 2009). There was no awareness that it was actually roaring under the JIT rubric by the mid-1980s.

2.2.4. There are good examples, too

Still, there are plenty of companies—the minority, it seems—that have had their lean act together for some time. All of the following have upward trends in inventory turnover of at least 16 years (ZF Corp.) and up to 49 years (Sherwin-Williams):

- U.S.-based: Albany International, Burlington, CVS Health, Dean Foods, H.J. Heinz (before being acquired in 2014), Ingersoll Rand, Lancaster

[2] This was partially acknowledged by an insider, David Mann (2001).

Table 2. Lean methods, concepts, practices

1	2A	2B
Study/analyze/ document processes*	Act on/change/improve processes	Impacts (all also reducing costs while improving process flow)
Standard work Value-stream mapping Value-add/ non-value-add analysis Identifying wastes Going to "the place" A3	1. Visual workplace/5S	Reduces search times, misplaced and lost items, inventories.
	2. Queue limitation (*kanban*)	Acts as a formal, visual queue limiter, cutting throughput times and enabling pull systems; reduces scheduling and flow-control transactions.
	3. Cells and focused plants-in-a-plant	Reduces flow distances, flow times, floor space; catches mishaps while causal trail is fresh; enables balancing work among stations and operators; encourages/requires cross-training & operator-centered quality & maintenance; reduces transactions; enables the focusing of production units to families of customers or products.
	4. Quick setup/ changeover/readiness	Cuts lot sizes, throughput times; allows quick changes among alternate products.
	5. Smaller equipment in multiples (right-sizing)	Facilities making multiple products/filling multiple orders simultaneously.
	6. Cross-training/job rotation	Provides flexibility to handle variety of work with minimal delays; enables balancing workloads; fosters whole-process vision & process improvement.
	7. Fail-safing	Obviates mishaps; enables quality-at-the-source; reduces rework, scrap, and outgoing defects.
	8. Total productive maintenance (TPM)	Transfers much of maintenance to frontline operators for quick resolution of equipment problems; upgrades maintenance department's role while increasing operator capabilities and process vision.
	9. Supplier partnership	Improves incoming quality, reduces purchased inventories, fosters early involvement in product design.
	10. Design for manufacture and assembly (DFMA)	Reduces part counts and standardizes parts and end product configurations with potential to greatly reduce throughput times, flows, and defects.

* Conventional, historical, or general-management practices labeled/relabeled as "lean".

Colony, Lincoln Electric, McKesson, Ross Stores, Sherwin-Williams, Staples.

- Other: Freudenberg, ZF Corp. (Germany); Clarion Co., Hitachi Zosen (Japan); Unilever (UK/Holland); FEMSA (México); Novo Nordisk (Denmark); Atul Ltd. (India).

There is a caveat. In some cases, impressive inventory trends will be a concomitant of divestments, mergers, acquisitions, key competitor(s) dropping out, lucky market timing, and so on; a bad long-term trend could arise from opposites. The focus of the inventory research—on groups and long-term trends—aims at minimizing such biases.

The ills of lean could be carried on to completion in this article just by pulling further data from the multiple inventory research databases and analyzing their ramifications. However, the intent is to keep the hard data in mind while pressing on with lean's extensive conceptual and methodological deficiencies and the mismanagement of lean management.

3. Lean dichotomy: Study or do?

The matter of over-management versus high-impact implementation of lean can be addressed via a close look at primary methods and concepts that make up lean practices, many of which are listed in Table 2.

The principle message of Table 2 is that the items in Column 1 have only indirect effects, their modus operandi lying in studying, analyzing, and documenting processes. In contrast, the Column 2A activities directly act on, change, and improve target processes and thus achieve lean's

high-impact, customer-serving objectives given in Column 2B. The first two columns might be characterized—in the dichotomy of Miller, Hartwick, and Le Breton-Miller (2004)—as *fads* (Column 1) in contrast to *classics* (Column 2B); see, also, Ketchen and Short (2011). The hope implicit in the Column 1 items is that they will serve an enabling purpose, spurring the activities of Column 2A and generating the outcomes of 2B.

Years ago, such enabling may have taken place regularly. Over time, however—based on my reading of many published reports on companies' lean efforts—it appears that the study/analyze/document activities are overshadowing the act-on/change/improve methodologies to the competitive detriment of those companies. To the extent that this is true, it would help explain why lean seems to have fallen into, at best, a water-treading phase, and at worst—indicated by the widespread downslide of long-term inventory turnovers—pursuits that may actually worsen competitiveness by lengthening lead times and cycle times, reducing flexibility to meet ever-changing customer orders and filling retail and wholesale shelves with what is currently in demand, degrading responses to product nonconformities, and raising costs.

4. Study, analyze, document

Generally, the Column 1 items are add-ons and not a part of the lean equation when the lean term came into use, circa 1990, nor among the methodologies of lean's proximate predecessor, just-in-time (JIT) production. Moreover, most may be seen as warmed-over, usually renamed methodologies that date from well before the onset of lean or JIT. Each warrants some discussion because they are so entrenched in practice and in the vocabularies of managers, who may see fit to modify tendencies to toss them around.

4.1. Standard work

Standard work is a good idea, long admired under the acronym SOP: standard operating procedure. A related term, *one best way*, dates back to the work of Frederick W. Taylor in the early 1900s. One best way (OBW) has been advanced at Walmart in compendia of training information for employees. Scarce in JIT writings of the 1980s, standard work began to hit its stride in the publication of *Lean Thinking*, the glossary of which offered that standard work is "a precise description of each work activity" (Womack & Jones, 1996, p. 310).

It is good to have process documentation, although there is an unfortunate tendency—in specifying cycle time, work sequence, etc.—to lock in and thus subvert activities to improve processes continually. The best way to overcome such tendencies is through trend charts, prominent in workplaces, that show trajectories of cycle times, setup times, kanban quantities, flow distances, rework and scrap, employee cross-training, supplier certifications, dock-to-line deliveries, and the like (Schonberger, 2018b).

Standard work is, by now, treated as a fixture in the lean narrative. One book in the hospital context devotes a chapter, "Standardized Work as a Foundation of Lean," to the concept (Graban, 2012)—a thorough chapter (32 references) in a widely sold book. An irony is that so much is made of standardized work in the hospital setting. One can imagine the reaction, at least initially, of the typical nurse or physician at the idea of standardizing their helter-skelter, crisis-mode work lives. Furthermore, some nurses are sure to point out that medical protocols are already in place and deeply ingrained in clinical medicine.

A standout example of lean in health care, written up as a case study (Rachna Shah, Goldstein, Unger, & Henry, 2008), is employed by the Minneapolis Heart Institute (MHI) in processing heart-attack patients from correspondent hospitals throughout Minnesota. The study's authors maintained that the successes boil down to just one lean methodology, standard work. In a rebuttal, I pointed out that a careful read of the case study turns up five lean methodologies that were intensively applied throughout the MHI system that played key roles in MHI's remarkable record of saving patients' lives. The five, in wide use along circuitous routes from remote healthcare facilities to and through MHI, are quick setup, visual management, queue limitation,[3] cross-training/job rotation, and value-stream organization and layout (Schonberger, 2018a).

In sum, too much is made of standard work to the point in which it takes away from a greater emphasis on classic JIT/lean methodologies, including most of the items in Table 2, Column 2A.

4.2. Value-stream mapping (VSM)

VSM may be even more widely acclaimed and applied in the lean community than standard work. VSM is a version of process flow-charting originating

[3] Rather than the Japanese word, *kanban*, this article prefers the term, *queue limitation*, which is precisely what kanban does.

in the works of Frank and Lillian Gilbreth in the early 1900s—a method that employs five flow-charting symbols. *O* operation, *I* inspection, *T* transport, *D* delay, and an upside-down triangle for storage. Those symbols, standardized in 1947 by the American Society of Mechanical Engineers, are stalwarts of process improvement studies in the industrial engineering profession.

Over the years, flowcharting has taken many forms, from PERT (program evaluation and review technique) in R&D to systems-analysis charts in designing infosystems. Innumerable companies and consultancies have invented their own special versions, with or without time scales or reference to capacity and bottlenecks. The VSM version, developed by Rother and Shook (1999), calls for a present-state map of a process (the conventional flow chart) and—a distinguishing feature—a future-state map for the same basic flow group.

In its use of the future-state map, VSM follows Nadler's (1967) IDEALS concept—design for the ideal state. When I first heard about VSM I liked the idea, not for its mapping but for its term *value stream*. I presumed that meant a chain of processes tied to value in the eyes of end customers; also, that value stream would feature focused factories, plants-in-a-plant, and cellular organization (à la Shafer and Oswald, 1996), each focused on families of products or of customers. Those presumptions were incorrect. Instead, VSM generally takes place lower in the chain, largely within operations, perhaps extending to suppliers. As for future-state goals, they are set mostly by management with little input from those who should know the most about processes and issues thereof. Static goals set by managers are the norm in most organizations (Carson & Carson, 1993) but better results lie in the dynamics of visual trend charts, which provide positive reinforcement when trends are improving and scolds when good trends turn bad.

4.3. Value-add/non-value-add analysis

It is common in lean management circles to spend time early in a process-improvement cycle to examine the process flow(s) in detail thus to label segments as value-adding (VA) or non-value-adding (NVA). The purpose is to be able to prioritize process-improvement projects in reducing/eliminating NVA elements. It is a sensible-seeming approach but it tends to delay process improvement itself, and usually such prioritization is unneeded. Bottlenecks are natural targets, and are generally known to all, especially those on the front lines. Moreover, the best answer as to where to begin is . . . everywhere! All employees always engaged in some aspect of process improvement. Good examples are in plants liberally sprinkled with informal meeting areas: a few chairs and a whiteboard where area production associates meet perhaps every day to address mishaps and frustrations (e.g., BMW's plant in Spartanburg, SC).

4.4. Wastes

Waste reduction has come to be seen, widely, as lean's essence and defining pursuit. Here, we label it as *identifying* wastes—more specifically, the seven wastes of transport, inventory, motion, waiting, over-processing, over production, and defects. Actual reduction of wastes, however, takes place via the JIT-cum-lean methodologies of Column 2A, Table 2.

The prominence of waste-centered lean is owed in part to its being easily taught and activated at the lowest levels in an organization: Operators, assemblers, clerks, stock handlers, schedulers, servers, and so on can relate to it well and their awareness of wastes helps keep them engaged in process improvement. On the other hand, from high in the organization waste elimination looks like just another of the many cost-reduction programs that every organization has gone through over the years (Shields & Young, 1992). The busy CEO is likely to bless the effort, delegate it, and put it aside in favor of matters of more strategic import.

As for executives in marketing, the very idea that inventories should be seen as waste is likely to render them anti-lean. That is a great shame since the primary aims of enlightened lean are to attack root causes of inventory accumulations and concomitant delays, thereby to attain quicker, more flexible, higher quality customer responsiveness—keys to customer retention, greater sales, and overall competitiveness. Turning marketing from anti- to pro-lean, while also pulling CEOs in, is a matter of reframing lean as a strategic and competitive necessity (Pangarkar, 2015; Slater, Olson, & Hult, 2010). Waste reduction continues with its valued work at lower levels in the organization—with lean itself enjoying elevated stature in the organization, inasmuch as its reduction of transport, inventory, and waiting is seen as customer-serving effectiveness and not just operational efficiency.

4.5. Going to 'the place'[4]

This lean concept has senior people getting out of their offices to observe and study operational

[4] Dubiously, lean adherents have persistently called it going to the *gemba*; some, seeing the folly of parsing in a foreign tongue, call it going to the *place*.

processes (Bicheno & Holweg, 2016, p. 231). It is a push for this to be advanced as a lean concept inasmuch as management by walking around (MBWA) was a primary takeaway from Peters and Waterman's (1982) mega-seller, *In Search of Excellence*. Going to the place—not mentioned in the early books on lean (e.g., Womack & Jones, 1996; Womack et al., 1990)—caught fire as a lean pursuit in the 2000s but it is now overdone. It surely is good for executives to do the rounds in that they become conversant about the value-adding, cost-consuming operational parts of the business for which they are responsible. But, in terms of yielding valuable process improvements, executives and managers are the wrong ones taking these operational process walks. Instead, companies should develop systematic procedures in which experienced operative people leave their regular jobs for a few hours or a day to observe intensively, taking notes on clipboards, gaining whole-process insights, and taking germs of ideas with them back to process-improvement meetings with relevant parties such as teammates, engineers, buyers, and maintenance people. Let the place be owned by those who live there.

4.6. A3

Another bolted-on lean concept involves A3-sized paper—about twice the size of the 8 $^{1}/_{2}$ x 11-inch standard U.S. sheet—on which problem-solving steps are recorded, written, and diagramed. The A3 methodology is fine looking but so are many other process-focused methods, especially those that take place not in offline analysis but by frontline employees (e.g., Deming's statistical process control, Shainin's pre-control, and the ten lean/JIT methods listed in Column 2A, Table 2). Where did A3 come from? The same place as most of the other study/analyze/document items: Toyota used it—which is specious provenance.

Years ago when I was enrolled in a graduate-level course, one of my classmates expressed admiration for a certain proposition found in homework readings and waited for the professor's reaction. With a wry smile the professor said: "I know what you're talking about; I'd say that sort of thing passes the gee-whiz test, but we aren't sure it passes the so-what test."

The same goes for concepts that emerged from claims that Toyota did it. So what? Decades ago, Toyota was an innovator of now-bedrock methodologies. But, as with any company, many of Toyota's practices are/were unremarkable, and no more effective than hundreds of unsung management or operational routines that are constantly being devised and put to use elsewhere. At one company, I learned that, for management meetings, every attendee was expected to show up with one 5 × 7-inch index card on which a pressing issue was to be summarized. The purpose was to keep the meeting moving, give everyone a say, and not get bogged down by long-windedness. A3 might be more effective than that. Or not.

5. Pursuit of lean in the processes

The 10 methodologies of Column 2A, Table 2, are well known and tend to be self-explanatory in what they do, their customer-serving impacts explained with little need for elaboration in the adjacent boxes of Column 2B. Though they are the most essential of lean's concepts, it will suffice just to present their interwoven effects.

5.1. Interactive effects of ten methodologies

To a considerable extent, the methodologies listed in Table 2 Column 2A are mutually reinforcing. In the following examples, the numbers in parenthesis label each of the 10 methodologies:

- Visual workplace/5S (1) resides within the more general category of visual management (Galsworth, 2005) and visual management is enhanced by and an element of the other nine Column 2A/2B items. As Delisle and Freiberg (2014) claimed: "Everything is 5S."

- Queue limitation (2) relies considerably on visualization. When a limit is set on the number of people in a queue awaiting service or a number of widgets awaiting assembly, their physical placement needs to be easy to monitor visually. A key method is *space denial*: collapse the wait area through re-layout so that everything is easy to see, which, in turn, is what occurs in conversions to cells and focused plants-in-a-plant (3).

- Quick setup/changeover (4) relies heavily on moving setup materials—documents, tools, dies, molds, containers, handling carts, etc.—physically close to where the changeover takes place, so that there is little or no search time. To eliminate search time, 5S efforts (1) can/should work hand-in-glove with quick setup/changeover.

- Smaller equipment in multiples (5), valued in its own right, becomes a necessary part of queue limitation (2) because it shrinks space

and distance, as in cells and focused plants-in-a-plant (3), and an enabler of quick setup/changeover/readiness (4)—all interlaced with visual workplace (1).

- Cross-training/job rotation (6) generally calls for visual displays (1) that list each employee and tasks in which each has been certified.

- Fail-safing (7) is the insertion into a process of devices or procedures that prevent doing a task incorrectly. Often, it is an attachment to a piece of equipment, rigged so it always does the task correctly—and a valued take-over of work difficult for a human to do right every time. A computer program that disallows a payment or expenditure above a certain limit is another kind of fail-safe. In a sense, a fail-safe device incorporates its own checking routines as part of a visual workplace (1).[5]

- Total productive maintenance (8) encompasses the 5S (1) process and routines (Nakajima, 1984).

- Supplier partnerships (9) should and often do include purchased materials being delivered in queue-limited (2) returnable containers, which are often sectioned off so that, at a glance, the recipient can see (1) that exactly the right quantity of items is present.

- Design for manufacture and assembly (10) reduces the number of parts and the spaces they take up, thus facilitating all the other act-on/change/improve methodologies, (1—9).[6]

Besides their interlinkages, each of these methods can do well on its own. For example, when a lean pursuit is focused mostly on 5S, it can achieve impressive reductions in processing time. In hospitals, 5S attacks the chronic problem of frantic searches for an essential device, medication, or supply item while the ailing patient lies in wait.

5.2. Miscellaneous other lean procedures

This story of how lean got fat would be incomplete without considering six further lean-related items in three groups: one-piece flow, organized process improvement, and product costing.

5.2.1. One-piece flow

One-piece flow is sometimes held up as lean's most elemental concept, particularly when presented as the opposite of batch-and-queue processing—the norm in manufacturing, until being discredited under JIT and lean. Common evidence of one-piece flow is factories employing workload leveling/smoothing, takt time scheduling, and mixed-model sequencing; In the name of one-piece flow, "manufacturers proudly display factories that have been cleared of targeted wastes and are marvels of short flow times, low work-in-process (WIP) inventories, and high capacity utilization" (Schonberger & Brown, 2017, p. 83). But here's the rub: In most of those factories, enlarged company- and enterprise-wide finished goods inventories (FGI) more than offset the lowered WIP.[7]

The FGI that populates distribution channels is caused, in part, by production being out of sync with the highly variable patterns of downstream demand and usage, resulting in back-orders of hot items and gluts of those in lower demand. When a factory chases takt times and smooths production, it enlarges finished goods and lengthens customer lead times. Manufacturing manages to overlook those negatives, measuring itself on the false god of high utilization and other inward-looking performance indicators. It is left to marketers and distribution-chain managers to deal with customers who bear the burdens of the gluts and back orders—not to mention stockouts, which were a chronic problem 50 years ago (Neilsen, 1968a, 1968b) and not much has improved in this age of high emphasis on supply chain management.

What should manufacturers do to modify their flawed lean production processes? The answer centers on de-emphasizing leveled production and placing high priority on the flexibility to match up-and-down customer demand patterns (Raturi & Jack, 1994). In many cases, this can be done most particularly through re-equipping factories with multiple units of production so that many products or orders can be produced simultaneously—a mode called concurrent production (Schonberger & Brown, 2017). A well-known lean concept for moving in that direction—one that far too many manufacturers are violating—is seeking slower, simpler,

[5] *Fail-safe* has come into use in some quarters as a far better term than the widely used *mistake-proof*, with its negative connotations. The original Japanese term, *bakayoke*, came to be rejected—because it meant *fool*-proof—in favor of *pokayoke*, which translates roughly to fail-safe (Schonberger, 1990).

[6] DFMA is postulated as a third-way lean methodology in Schonberger (2014).

[7] One indicator: Using a separate, ancillary data set of my inventory research, I found that, for a sample of 60 U.S. manufacturers from 2000 through 2017, finished goods were 41% of total inventories, dwarfing raw materials at 31% and WIP at 28%.

Table 3. High-flex manufacturing at Polaris

Polaris, Spirit Lake, Iowa, builds Indian motorcycles in two separate production lines and Victory bikes, being more complex, in four lines. The plant does not smooth customer demand. Rather it operates in a highly demand-responsive, build-to-order mode using a "retail flow management system that allows dealers to place orders daily": its order-to-deliver time was reduced from 120 to 15 days. Contributing to this flexibility, "All large equipment and monuments have been eliminated and replaced with smaller, more nimble and cheaper flexible equipment."

Source: Weber (2015)

easier-to-operate-and-maintain, less costly kinds of equipment in multiples, a conversion from *monument* to *right-sized* machinery; see the example in Table 3.

5.2.2. Organized process improvement

In many companies, kaizen and lean/six sigma events are the main pathways to what is commonly referred to as continuous process improvement. However, projects are, by definition, discontinuous. Moreover, in practice, they tend to be dominated by well-paid professional staff, with only token participation by frontline employees. Course correction calls for all employees to be engaged every day in recording and putting to use data on things not right or going wrong. This prescription fits with the process-data-driven formula handed down from Deming (1982), and Ishikawa's (1988) seven basic tools for plotting and categorizing nonconformities. When the workforce is recording mishaps and frustrations daily (e.g., simply, on whiteboards—either via check marks upon each occurrence or a brief written notation; Schonberger, 2018b), the storehouse of data has two beneficial effects. It generates process-improvement consciousness and draws operatives toward involvement. Further, it serves as primary data for project teams to hit the ground running instead of spending early time digging for necessary problem data. Worthington Industries, having invested heavily in kaizen-event-driven process improvement, admits this about its new kaizen approach: "Most of its time is spent conducting 'pre-work,' gathering information and generating theories to test" (Panchak, 2018, p. 35).

5.2.3. Product costing

Activity-based costing (ABC) emerged from the JIT production movement with business units of Hewlett-Packard as primary instigators. In 1982 at HP's Greeley Division, the reorganization of the factory into cells reduced flow times from many days to a few hours. One upshot: The plant's cost accountants realized that with many product cycles completed within a monthly cost cycle, their cost reports no longer had relevance. Before long, this and other divisions of HP were casting off conventional costing in favor of ABC (see, for example, Cooper and Turney, 1988). The involvement of academic accountants was spurred by the publication of *Relevance Lost: The Rise and Fall of Management Accounting* (Johnson & Kaplan, 1987; see also McIlhattan, 1987).

ABC calls for rejection of formulaic methods of allocating overhead to products (e.g., by direct-labor hours), which usually result in over-costing the simple, high-volume, quick-flow items and under-costing the long-flow-time dogs and cats of the product line (Hunt, Garrett, & Merz, 1985). Two of the managers responsible for HP Greeley's JIT successes later took positions at Zytec Corp., where they applied ABC innovatively: overhead allocated by flow times. Zytec went on to receive the U.S.'s Baldridge Prize in 1991.

One issue in the deployment of ABC is whether to use it in the conventional periodic cost reporting mode or on an as-needed basis, say, for re-pricing the product catalog, evaluating an expensive piece of capital equipment, bidding on a major contract with a high-value customer, or trying to make a major make-or-buy decision. An attendee at one of my presentations expressed doubts about how his company could even think about eliminating the cost reports. My response: "But do you have to re-cost the same operations again and again, day after day, all year long?" In full implementation the ABC audit-as-needed viewpoint would dismantle (lean-out) much of the conventional cost-accounting structure.

6. About lean's demons: What managers/companies need to do

The cures for lean's platter full of ills are themselves a full plate. Much of what is needed has been discussed in should-do and should-not-do form in this article—summarized here under five topics.

6.1. Organizational memory

It is astonishing that so many lean startups over the past 25-plus years are presented—in workshops, webinars, group tours, etc.—as entirely new ventures, when for there are published case studies detailing remarkable lean/JIT achievements that took place years earlier. One example, given earlier (see section 2.2.3), is that of HNI/Hon Industries. In

one of my books, I wrote about how Mars, the candy company, had systematically combatted "such institutional forgetting, and to avoid reinventing the wheel, especially the wobbly kind" (Schonberger, 2008, p. 150).

Managers should put their company or business-unit librarian in charge of developing and maintaining a compilation of major initiatives, naming names and dates, what was done, and what went right or wrong. Further, when a new initiative is in planning, the librarian serves as an influential member of the planning team, such that there is "learn-from-hindsight due diligence" of the kind that I had described in my book, also ensuring emphasis on "refresher training, not just the hot, new thing" (Schonberger, 2008, p. 150).

6.2. Lean tools, concepts, methodologies

There is no end to claims by consultants—then widely repeated—that lean is not/should not be about implementing a set of tools. Rather, we are told it must revolve around creating a lean or continuous-improvement culture, people-focused leaders, and raising lean literacy. One hospital, extolling its lean results, said: "Over a 10-month period, CCM [Center for Cooperative Medicine] was able to increase its lean knowledge by 19% with the workforce" (McCabe, 2018). The beware-of-lean-as-tools message helps explain why companies are expending high energy studying processes, but with little left over for substantive process improvement. One closely related issue is that, in application, lean has gotten so tied up in the study/analyze/document mode that lean's potent act on/change/improve methodologies (i.e., tools) get short shrift.

High on the agenda for managers is leading a shift in time and attention away from getting organized and prepared for lean—which generally has a high cost-to-benefit ratio—and toward early and heavy use of lean's proven concepts and methodologies that act directly on and in the processes and should be the targets of continuous process improvement. In other words, put the first and highest energy into the practices (or tools) that count, including organizing work cells, cross-training the workforce, reducing changeover times, right-sizing equipment, and enterprise-wide queue limitation with resultant reduction of total inventories and customer response times.

6.3. Silos

Many of lean's woes are owed to siloing. There is a strong tendency for the locus of lean to reside in the operations function, with little recognition or concern about effects in the marketing-sales-customer realm even though lean's greatest competitive potential lies in realizing quicker, more flexible, higher-quality response to customer entities.

Course correction calls for managers to play down the view that lean is all about waste reduction and, through a large-scale campaign, play up lean's more important competitive/customer-side benefits. At the lowest levels in the organization, members' waste-reduction efforts continue but with full awareness that doing so increases sales revenue and customer allegiance, which accompanies potential for higher pay and better job security.

6.4. Ambiguity

A large part of the lean problem is that it has gone off in profuse directions characterized by a terminological jungle. All those terms, some seemingly vetted and embraced simply for being Japanese, make the very definition of lean problematic.

This confused state of lean calls for continually addressing it in many forums. Among the more promising is a budding movement toward abandonment of the term lean itself. At first, the term seemed to be a useful replacement for its shop-worn predecessor, just-in-time—lean being descriptive of losing the excesses (i.e., the fat) that go with slow response, poor quality, breakdowns, re-dos, and high reliance on just-in-case inventories. The suggestion that lean might mean shedding live bodies was roundly rejected by the lean community—as it was under JIT—in that it would be sure to kill off engagement by frontline and support people residing where lean was largely applied. Now, though, there are stories in the business press that are clearly referring to cutting head counts as the main thrust of lean management. Moreover, to the general public, lean refers to diets and body mass; and in web searches for the word lean, what often comes up relates to the mega-selling book *Lean In: Women, Work, and the Will to Lead* and its movement.

As a replacement for the term lean—along with the confusion over lean the concept—the best choice may be *flow management*. That term ties well to such lean elements as one-piece flow, flow chart, flow distance, flow time, and the common and appropriate analogy of flowing streams. At least two authors who could have used the lean term instead picked flow: Huntzinger's (2007) *Lean Cost Management: Accounting for Lean by Establishing Flow* and Hirano (1988), which includes a 27-page chapter entitled "Flow Management." As one more

example, an article on lean in healthcare is titled "Let my patients flow" (Jenkins & Gisler, 2012).

There need not be just one term. Other good ones are found in the titles of two books by Suri: *Quick Response Manufacturing* (Suri, 1998), the term adopted by the University of Wisconsin-Madison's Center for Quick Response Manufacturing. QRM strongly emphasizes what is usually missing from lean endeavors—a quick response all the way to final customers. The second is Suri's (2010) *It's About Time*. Speaking of time, there is room, as well, for industry-specific language: The UK's National Health Service chose to bypass terms such as lean and waste in favor of 'more time to care' (NHS, 2010).

My best advice to managers is to take the lead—in their own organization and with its stakeholders—in selecting and adopting replacements for problematic lean terminology. The best time to do so is now, in parallel with recommended fixes in regard to tools/concepts/methodologies and silos.

6.5. Lean as strategy

Another thing consultants and practitioners alike harp on is that, like most initiatives, successful lean requires strong backing in high places. Using the Delphi method, Lean Frontiers (2017) conducted a study indicating a general lack of such backing. To a question on lean value as seen by senior leaders, 44% responded pessimistically, saying "lean is a program," 28% that leaders are not personally engaged, and the remaining 28% that leaders are engaged. Second, in response to how long lean-as-strategy will last, 47% said a meager 1–2 years, 32% referred to leadership and external factors as obstacles, and 20% said long term. As to why lean support fades, a clue is offered by an article in *Quality Digest*, entitled "Bored by Lean" (Cutler, 2008)—that year being a midpoint of the period targeted in this article on the degradation of lean management.

Another story might have been written with the theme of "never excited by lean," referring to attitudes of senior executives and boards of directors. To probe the matter, in 2010 I did an internet survey of annual reports for 20 manufacturers—hand-picked companies whose financials showed impressive reductions in total inventory for at least 10 years (e.g., Heinz, SKF, Xerox). I consulted at least three and up to seven back issues of their annual reports, looking for any uses of lean/continuous-improvement-related terminology, both spelled out and as acronyms. They included lean, JIT, TPS, CPI, TPM, process improvement, quick setup, kaizen, kanban, total quality, scrap and rework, cross-training. Results: For 11 of the companies none of the terms was found and for most of the other nine the terms were rare. Upshot: Since their annual reports scarcely mentioned those terms, the executives surely did not consider them to be of strategic importance, nor that their boards, investors, and the financial community would either.

It may seem that there is nothing to be done about this state of disinterest. But there is—because lean by any other name surely *is* strategic, though neither those in executive ranks nor the lean mavens in operations have been made sufficiently aware of this. Lean, correctly espoused and carried forward, contributes significantly to the top line: Quicker, more flexible, more reliable delivery of goods and services generate increases in revenue through increased sales to existing customers, plus market-share growth through retention of existing customers and generation of new ones.

What needs doing is for managers and executives to swamp current, muddled mindsets (e.g., on lean being mainly about waste removal) through all-out campaigns (see Mazzei, Shock, & Ketchen, 2009) on lean's primary, customer-serving, quick-response essence and impacts on competitiveness. Stalk (1988) had the right idea in his much-quoted article, "Time—Next Source of Competitive Advantage."

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