WHAT IS A WORLD CLASS FACTORY?

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Manufacturing enterprises aiming for competitiveness through excellence would want to build and upgrade their plants and factories to "world class" status. But what is a world class factory (WCF) ? What is world class manufacturing? There are many literatures and research trying to grapple with this concept. There are a lot of substance in these, but unfortunately these descriptions are not useful in grading or self-evaluating one's factory or one's competitor as to what stage or state of "world class" it is in. At present, there is no standard way of grading and benchmarking factories globally. While there are awards and certification programs that rate and categorize company performance, these are focused on one performance indicator, too broad to be useful in rating factories, or very industry-specific. Moreover, many of these rate companies rather than factories. For instance, ISO 9000, Deming, Juran and Malcolm Baldrige Awards, Six Sigma just focus on quality management systems, ISO 14000 on environment management systems, and TPM (Total Production Maintenance) Award on maintenance, housekeeping, and overall equipment efficiency or OEE. These programs are open to all industries - primary processing, manufacturing as well as service- and have practically the same criteria and standards regardless of the industry of the applicant or nominee. In others words, they miss, by intent or design, the very essence and uniqueness of manufacturing operations. The GMP (Good Manufacturing Practices) standard seems to be the closest to rating manufacturing performance. However, again, this standard was essentially designed for the food and drug industries and their packaging suppliers, to ensure safe and quality products and processes. GMP does not stress productivity, yield, cycle time reduction and other non-quality and non-safety related indicators of excellent factory performance. QS 9000 is another integrated manufacturing standard, but it is somewhat industry specific and designed more for accrediting parts makers and suppliers of car manufacturers, particularly in the area of quality.

Before we start defining "world class factory", let us first define a factory. This paper will focus on factories of manufacturing industries. The manufacturing industry is also known as secondary industry which gets and processes raw materials from the primary industry. Primary industries are those that process extracted materials from nature and Mother Earth; their outputs are called primary materials or products like steel and other metals, glass, rubber, plastic, fuels, cement, flour, and wood pulp. The factories of primary industries usually run continuously. Nowadays they are highly automated and produce to stock. In contrast, manufacturing factories produce discrete products like cars and TV sets out of primary raw materials or parts from other manufacturers; they may produce discontinuously and have to option to make to stock or forecast or to make to order. Another difference is that inventories in

primary industries may be necessary and not indicators of "fat", while in secondary industries "leanness" in terms of inventory is usually a sign of efficiency. Also, low output variety in the primary industries is a given, while in secondary industries is it now considered a weakness. While we could also define WCF's in the primary industries and they do in fact exist, this paper will only attempt to define a WCF in manufacturing, where there are much more factories globally in numbers and much more intense competition and race to become excellent.

Factory operations essentially consists of raw materials or parts procurement, parts manufacturing or processing, assembly – subassembly and final assembly, packaging, and shipping. This last stage - shipping that includes finished goods storage and outbound logistics - may or may not be controlled by factory management. The same can be said with procurement. There may be several quality checks inside and between these operations. Some factories have parts and product design capabilities. But most of the time, R&D is separate from factory management and this unit receives instructions from the Marketing and Market Research groups, which are also independent from the factory. Thus in defining "world class factory", we assume that the factory is producing a saleable product, designed to satisfy the end-user or buyer. In other words, we assume that the R&D and Marketing units of the company have done or are doing their jobs accordingly and that the ball in now in the hands of the factory management to produce the right products the right way.

If all the factory operations (procurement to shipping) described above occur inside the factory or a plant compound, we have a "physical factory". This paper will focus on "world class physical factories". In this day and age of outsourcing and reengineering, in an effort to cut costs or convert them from fixed to variable, many factory processes are now jobbed out or contracted out to third parties known as subcontractors, contractors, or even to raw material suppliers. By further linking this network of companies with information technology, we can have a "virtual factory", running as if it were one factory under one roof and one management. So what happened to the original factory that outsourced, became emasculated in the process, and reduced to just a thinking (design) and marketing entity? Can it be rated as a "world class factory"? No, but its subcontractors can, for they remain physical. We still need physical factories to make the widgets and widget parts. Somebody has still got to do the dirty but lucrative job at end of the day, in spite of this outsourcing fever. And these widget contractors would all have to be world class factories in order for any virtual factory or supply chain to achieve operational excellence and global competitiveness.

In summary, what we are about to define as "world class factory" is a physical factory in the manufacturing industry making saleable products. The reader may later realize that many if not all of the description of a world class factory may be useful in describing world class manufacturing supply chains and other integrated network of physical factories.

All indicators of excellence in factory operations can be conveniently grouped into five: defect-free, fast, flexible, lean, and environment-friendly. With 5 as the magic number, a useful analogy that comes to mind would be the 5-star rating of hotels and restaurants. But the analogy ends there, for the 5-star rating of these establishments is inaccurate and nothing but gauges of their "priceyness" rather than of their excellence in operations. I have received sloppy, inconsistent and unreliable services from 5-star

rated hotels, and excellent service from 3-star ones. While avoiding the pitfalls of the hotel star rating that confuse travel agents and travelers alike, I propose the accumulation of all the five indicators described below or "stars" to achieve "5-star" or "world class" factory status. The five stars - defect-free, fast, flexible, lean, and environment-friendly – are not mutually exclusive, and they may influence one another positively or negatively. But the degree of interaction, interdependence, or correlation is not that strong such that it is possible for a factory to have only some, say three or four of the five. I have witnessed such 3-4 star factories. It is not an all-or-nothing proposition. A factory can accumulate these stars during its continuous improvement journey. The sequence of stars acquisition is not important; all I believe are equally difficult and important. The sequence - defect-free, fast, flexible, lean, and environment-friendly – is just my personal suggestion for those who wish to clear the hurdles one at a time.

Note that I did not purposely include any specific management programs in any of the 5-star ratings. The five - defect-free, fast, flexible, lean, and environment-friendly – are intended to be the results or deliverables, the "what's", of any or all programs the factory or company chooses to employ. All management philosophies or schools of thought or "how's", are welcome, but do not garner points unless they achieve any of these five indicators of excellence. For example, a factory, in trying to achieve the 5 stars, may employ programs such as Total Quality Management (TQM), ISO 9000, Six-Sigma Program, Total Productive Maintenance (TPM), Kaizen or continuous improvement, Quality Circles, Business Process Reengineering, Just-in-Time, Total Quality Environmental Management (TQEM), ISO 14000, Single Minute Exchange of Die (SMED), 5S-Houskeeping, Supply Chain Management, Activity Based Costing, etc. These are means to an end. They are not ends in themselves.

Star # 1 : Defect-free

A world class factory must have high quality outputs, inputs and processes. It must have both low external failure (defects that escape the factory undetected), and low internal failure (defects discovered and fixed inside the factory). Defect free sales is not enough if there are extensive rework and repair operations are going on inside. Inspection between stations should be nil or minimal. A WCF eliminates most incoming inspection as they partner only with reliable suppliers. At any stage or process, a WCF does not do100% inspection. 100% inspection is evidence of inadequate quality at the source. In lieu of inspection, a WCF employs extensively fool-proofing devices to prevent defects. These machines and processes are made robust against their operator's inattention and even carelessness. After sensing any defect produced or received or any abnormality for that matter, these smart machines switch off themselves and attract attention to itself with bells and lights to seek help. Moreover to further prevent defects from flowing downstream, WCF workers, all extensively trained on quality, are empowered to stop any line, machine, or process that produce defects. The factory, in coordination with R&D, employs the concept of design for manufacturability (DFM), which ensures that products are not just designed for customer satisfaction, but also designed for easy, defect-free, waste-free processing and manufacturing. Finally, a WCF would use dpm (defects per million) or ppm (parts per million) are the metric of choice for quality levels. It avoids using defect rates in percentage since

this is too gross and limited (1-100 range) and hard to comprehend and track. Most factories produce a least a million units of products in a year or less time - drugs, toys, shirts, pens, TV sets, bullets, canned soup, condoms, cars. Even low volume but huge products like planes contain millions of parts. So one million should be more appropriate base rather than one hundred in measuring and tracking quality and its improvement. WCF's should achieve something like 300-1000 dpm (.03% -0.1%) defect rate, both externally and internally. In relative terms, assuming a conventional factory has 5% defect rates, a WCF should have 98% less defects or better. Six-sigma WCF's can achieve 3-4 dpm.

Star # 2 : Fast

WCF's produce "fast" not in terms of production cycle time or production rate, but in terms of manufacturing lead time or turnaround time, or order processing time for make-to-order factories. It is fast not because of fast machines and workers and high capacity, but because it does less activities than ordinary factories to produce the same widgets. A WCF with slower machines and lower capacity can process orders faster than one more endowed with production resources. How does a WCF achieve this high speed? It does so by eliminating wasteful, unnecessary processes, and then streamlining what remain as necessary. Through this approach, process cycle times (from procurement to shipping down to the sub-processes that make them up) are constantly examined and ruthlessly cut to the bare bones using world class benchmarks as a guide. Also, with much less inspection and rework activities due to its high quality described earlier, it further cuts its lead time. Further lead time reduction comes with less storage and inventories and less materials handling, as will be described in the section on "Lean". Support groups like procurement and maintenance also cut their lead times – finding and selecting suppliers, responding to repair calls and fixing broken equipment. WCF support groups can achieve breakthrough records in cutting their cycles times from days to hours, or from hours to seconds. For example, key suppliers of WCF's are just nearby either co-located inside the factory vicinity or at most 3 kilometers away from it, thus significantly cutting inbound logistics and transport time. A WCF is also noted for its extensive use of visual controls, devices embedded into all processes and equipment that emit lights and/or sounds to immediately alert operators and the factory management of any situation that could cause quality problems or production delays. Response times to abnormal situations amount only to seconds. To further cut order processing time, a WCF may be directly linked to the point-of-sale (POS) - the cash register itself, the salesman taking orders, or the company storefront website. As a result of all these efforts and programs, a WCF can dramatically cut its over-all total manufacturing lead time (or order processing time for make-to-order factories) to 50% or less of that of conventional factories. This capability can give it a very short "time-to-market" and "first mover" advantages over competitors.

Star # 3 : Lean

A WCF is lean in the sense that its uses much less resources than its conventional counterpart in producing widgets of the same quality and quantity. With extremely high productivity and yield, it

dramatically reduces inventories, space, machines, and even people and suppliers required to achieve the production target. Most WCF's adopt the market driven or "pull" rather than the more conventional forecast/capacity driven "push" concept of production. The pull system ensures that only the needed products and parts are planned and produced at the right time at the right quantity. Ordinary factories produce based on capacity or forecast (which is always wrong), and they tend to be cluttered with inventories and other idle resources. WCF's avoid overproduction and overstocking, without incurring stock-outs, thanks to their short lead times described earlier. Much less raw materials, work-in-process (WIP), and finished goods mean reduced working capital investment, space and warehouse requirements. A WCF's total inventories may be as low as 10% of that of a conventional factory producing the same volume. A common observation inside a WCF is the absence of warehouses and storage spaces where we would normally expect them. A WCF's output-to-space ratio is orders of magnitude better than that of ordinary factories. Most WCF's production processes are balanced in terms of cycle times, thus eliminating the need for WIP between work stations. Set-up times are also reduced such that production batch sizes are greatly cut. They can achieve a batch size of one - through one-piece flow production, wherein there is only one unit in each station and between each station at any one time. A WCF is also lean in terms of manpower. It's multi skilled worker can operate several pieces of equipment at the same time, to as many as twenty. The WCF's very high machine-to-man ratio sets it visibly apart from run-of-the-mill plants. A less evident difference is its high direct labor-to-indirect labor ratio. A WCF finds less need for a large number of support groups and other indirect workers who manage inventories, warehouses, quality control, maintenance, and space. Finally, a WCF is lean even in terms of its business partners – the suppliers of parts and raw materials. They have few but highly reliable suppliers of key parts and materials – doing sole-sourcing (one supplier) in some cases for key supplies. Being lean, a WCF is outstanding in resource management.

Star # 4 : Flexible

Being flexible, a WCF is clearly a factory for the future, a factory with a future. With the global market's demand for more product variety and models, factories with highly flexible and adaptive manufacturing systems would have definite marketing and cost advantages. A WCF does not have to produce products in high variety; but it has the capability to do so in the short term as the need or market demand for them arises. The key for its flexibility is its very short set-up time, the amount of time to changeover from one model to another. In ordinary factories, this could take hours if not days. Long set-up times, in order to justify and recover their high downtime costs, translate to big production batches of one model, high minimum order quantities, and limited product offerings. A WCF has programs to continuously reduce all set-up times - streamlining, reengineering, and reinventing the set-up processes and procedures. WCF's set-up times just amount to a few minutes or seconds, instead of days and hours. The SMED (Single Minutes Exchange of Die) program, employed by many WCF's, aims to reduce set-ups of all equipment and production lines to just 60 seconds. The die is used as its prototype, because this jig typically takes the longest to replace when changing product models. With short set-ups, high variety and small batch or order sizes do not significantly increase unit production costs. This cost advantage translates to very competitive pricing opportunities. WCF's production lines employ the more flexible product layout rather than the process layout. Equipment are grouped and lined up in

sequence to produce a product or family of products. In conventional factories, equipment are usually grouped by type. This process layout is highly efficient in terms of equipment utilization, but very inflexible. The WCF's lines are typically multi-model lines, capable of producing a least two different models at the same time. This number can easily jump to 20 in some WCF's in the automotive industry. Capable of high volume high variety production, a WCF can do mass customization instead of the traditional mass production. When linked to the POS or point of sale, a flexible, multi-model line can do real time mass customization. Flexible lines means the WCF's have multi-skilled workers capable of multi-tasking. It also implies that their suppliers are capable of multi-model parts delivery in small batch sizes at frequent intervals.

Star # 5 : Environment-friendly

A WCF not only operates efficiently, but operates in a clean and safe environment. It processes are "brown", meaning they are waste and pollution free. A WCF produces only "green" products, products designed for the protection and preservation of the environment. Such products are usually re-cyclable, repairable, re-manufacturable, re-usable, or biodegradable. WCF's products have been designed with proper disposable in mind at the end of their useful lives. It also practices good housekeeping to keep the place orderly, clutter-free, and less accident prone. A dangerous and dirty factory, however productive, cannot be considered world class. A WCF practices good and thorough housekeeping . It is prepared and equipped to effectively deal with external and internal emergency situations, like fire, earthquake, explosion, and accidents. A WCF is a conducive place to work in. Its workers and the community it is in are proud of it. A WCF serves as a model corporate citizen in its community.

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