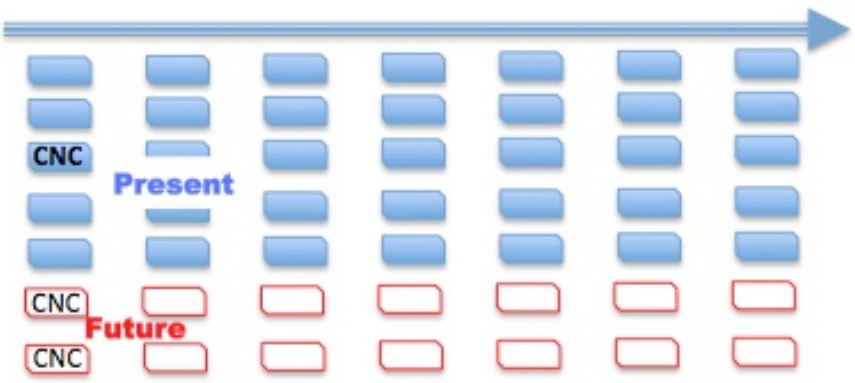
The Integration of Flexible, Reconfigurable Manufacturing with Quality

Roman Krygier

Group Vice-President for Global Manufacturing and Quality
Ford Motor Company

3rd CIRP International Conference on Reconfigurable Manufacturing,
Keynote Speech. May 10, 2005. Ann Arbor, Michigan, USA

I would like to talk today about our strategic decision of building flexible-reconfigurable manufacturing capacities in powertrain plants at Ford Motor Co. Building capacity in modular increments that can be scaled-up easily in the future to upgrade production when needed, is the economic solution in the age of uncertain demand.



Capacity built in Modular increments

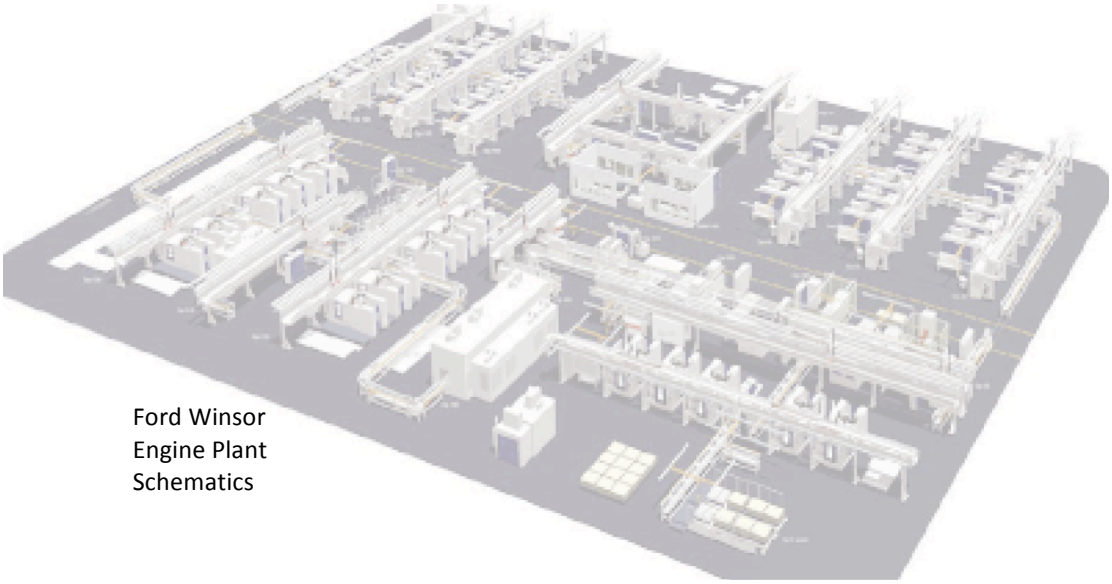
The strategic shift towards reconfigurable/flexible manufacturing systems in both vehicle and powertrain manufacturing is recognized as a competitive advantage that is required by the auto industry to stay ahead of the competition and the meet the changing demands of the market place. Plants are initially built just with the capacity needed, but with the option to add modular capacity if future demand surges.

This reconfigurable manufacturing architecture is a key enabler to address the strategic issues of excess capacity, shifting consumer trends, and future volume uncertainty. Flexible-Reconfigurable manufacturing lends to waste elimination, improves quality and efficiency, and rapid time to market.

Reconfigurable Manufacturing

- Waste Elimination
- Improved Quality
- Rapid Time to Market

Modeling and analysis confirmed that flexible/reconfigurable manufacturing does not cost more than traditional manufacturing. This was confirmed by the University of Michigan's **ERC-RMS Lifecycle Cost Model** software package. The ERC Lifecycle cost software was utilized during the simultaneous engineering phase for the 3V Valve program at the **Ford Windsor Engine plant** annex, and it confirmed from a total cost standpoint that the flexible/reconfigurable manufacturing system designed by Ford offers **better investment and operational efficiency** for initial programs (and second cycle changes) over the life of the product, or adding new products through the lifetime of the manufacturing system.



Ford Winsor Engine Plant Schematics

The ERC-RMS Life Cycle Economic software confirmed the cost-effectiveness of this architecture.

Standard design and operations methods at different plants across the globe

Another feature of the Flexible, Reconfigurable Manufacturing strategy is the ability to develop a standard solution for multiple locations across the globe using standard methods and standard building blocks of the process.

From a machining standpoint take the leading edge, yet proven manufacturing technologies like the CNC's to build them into modular manufacturing systems with standard equipment, standardized processes and plant layouts. Arrangement of these CNC's as the building blocks allows ranging the capacity from 300,000 to 4000,000 with the ability to plug and play machines as needed. This architecture (that is shown in the sketch above) enables rapid process rebalance and on-the-fly minor product changes.

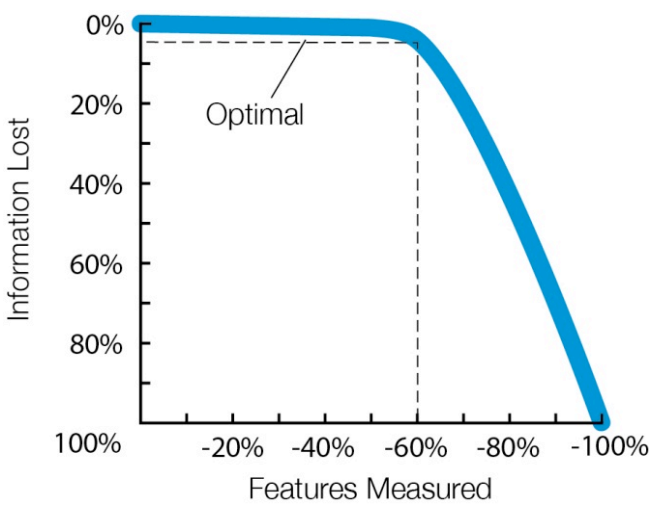
With this strategy we can replicate common layouts, process methods for different powertrain architectures across the globe; plants in Lima, Ohio to Dagenham, UK share similar layouts, suppliers, equipment and process methods and tooling. Enabling thereby rapid launch and sharing of lessons learned across teams programs in real time.

Building Quality within the manufacturing process with minimal post inspection

When planning the Ford Windsor engine plant in 1998 professor Koren indicated to me that because of the parallel machining operations the product can flow through the system in a huge number of paths, which cause different "streams-of-variations" in the dimensions of the final product. Therefore, we paid special attention to quality when designing and building our complex manufacturing system (that includes more than 120 CNCs). I am glad to report that Ford systems have delivered **consistently high levels of product quality**, with Six-Sigma levels of quality being achieved in production.

At the Ford plant we had many CMM measuring stations throughout the process. We knew that we are measuring more than it is needed, but we did not have a method to reduce the number of measurements. Working with the University of Michigan Engineering Research Center we were able to apply the Streams of Variation methodology.

This research helped us to understand and confirm linkage of product features and characteristics correlation. Based on feature linkage and the ERC analysis results, we have changed our coordinate measuring machine (CMM) gauging strategy to only measure representative features. We were able to achieve **a 60% reduction in measurements** through the first three operations with only 4% loss of data.



The Sustainable Advantage of Reconfigurable Manufacturing

With traditional dedicated manufacturing systems, an entire system has to be replaced by a new manufacturing system when we launch new engine architecture. When implementing reconfigurable manufacturing systems, the system can be reconfigured for the new engines by reconfiguring hardware and software so that the values of the manufacturing system are maintained for generations of products. **The reconfiguration approach enhances sustainability of manufacturing.**