ARC WHITE PAPER

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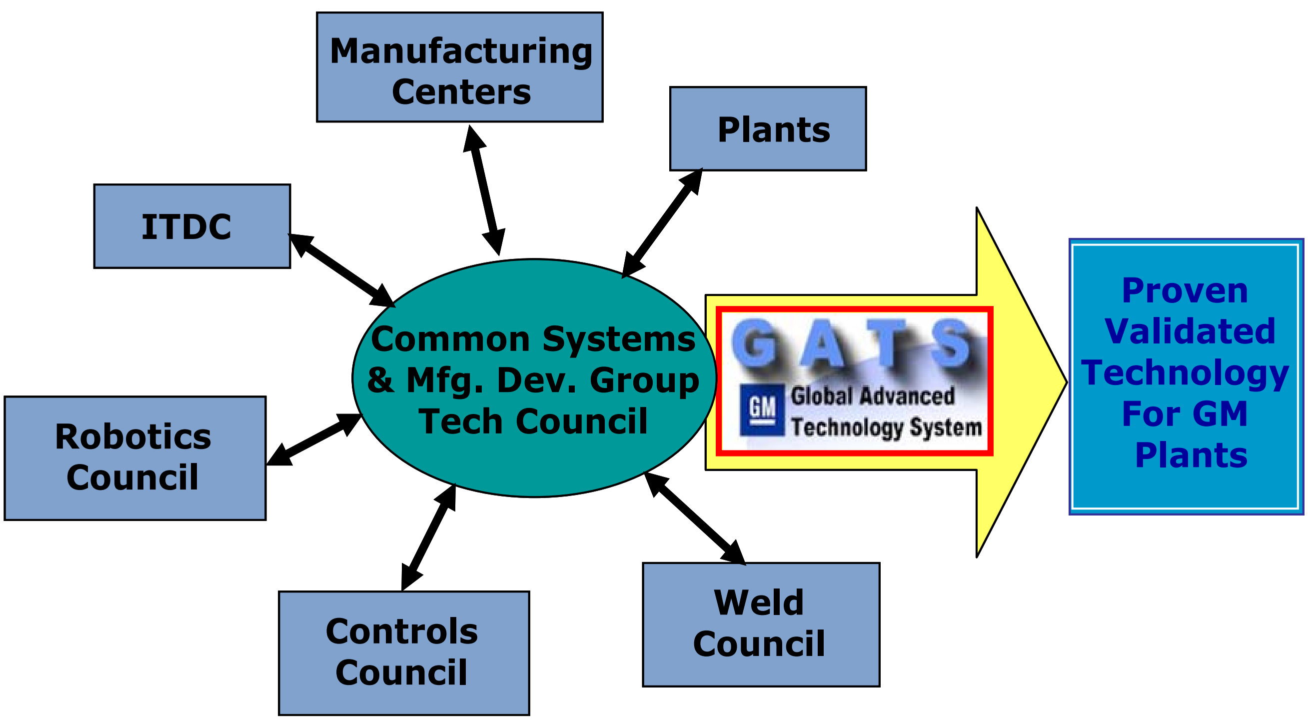
General Motors Drives Common Architecture for Global Operations

CCRW Drives Common Architecture for GM Global Operations



GM's Global Technical Council Manages & Validates Manufacturing Technology for All GM Operations

Executive Overview

Back in the mid 90s when former GM CEO Jack Smith issued the edict for GM to "Run Common, Run Lean & Fast, Grow, and Go Global" he was setting in place a plan to not only re-energize the company and lean out operations, but also to re-focus on one of GM's founding business principles: Globalization. Today, based on a long history of selling and operating overseas, GM sells their vehicles in nearly 200 countries.

For GM to operate and compete globally it was clear that "running common" would have to apply to everything from common vehicle platforms to architectures that define common production operations.

GM is responding to the global market and each regional market by offering a very diverse range of vehicles that will target a variety of consumer wants and needs. This strategy harkens back to one of GM's founders, Alfred Sloan, whose original concept was, "a car for every purse and purpose." Continuing in the vision of Sloan and Smith, GM North American Operations rolled out 12 new models in 2004 and will introduce 14 new vehicles in 2005. Launching this many new models, along with the associated production systems, tooling, assembly lines, and other factory systems required to support this manufacturing effort, would not be possible without GM's decision to establish common engineering, common processes, common manufacturing systems, and common components throughout its operations.

Rick Wagoner, the current GM CEO, is clearly following in the vision of his predecessors and adding his own stamp on GM's strategy of common, lean, and global. Under his watch GM is working to take advantage of its superior size by leveraging its business and operational functions around the world while "Acting as One Company."

GM's Controls, Conveyors, Robotics, and Welding systems (CCRW) automation and controls engineering group has been spearheading GM's common strategy from its inception. Today, CCRW is driving the globalization of Common Controls Architecture along with the development and deployment of emerging manufacturing technology through a step-by-step migration plan that is already impacting all GM operations worldwide. By partnering with one of their primary automation technology providers, Rockwell Automation, GM is able to establish their Common Controls Architecture across their global manufacturing operations and into new vehicle markets.

This common approach and technology migration plan has born significant results to date and promises substantial benefits for GM's production operations in the future.

CCRW Makes GM's Production Hum

GM's Controls, Conveyors, Robotics, and Welding systems (CCRW) group has had a singular mission since its original formation in 1997: provide GM North American operations with a competitive advantage in manufacturing. CCRW's goal, and the primary driver behind its formation, is to develop and rapidly deploy validated manufacturing systems that are efficient and cost-effective, work the first time, and are readily maintainable. CCRW embodies GM's core competency in controls hardware and software design and the integration of this technology into functioning manufacturing operations. Overall, CCRW enables GM's plants to become more flexible and agile, ultimately insuring production of high quality products that meet market demands.

Value to Internal Stakeholders

GM plant operations, including General Assembly (GA), Metal Forming, Body Shop, and Paint, are CCRW's primary customers. Today, this customer base is extending from the original North American operations base to all global operations. Internal GM manufacturing engineering groups associated with these operating groups have all become contributors to and stakeholders in CCRW's strategy of common processes, design, and standardization of controls and production system components. CCRW's value proposition to these stakeholders is comprehensive and straightforward: faster model launches and startups, systems that work the first time, accelerated time-to-market, significant cost savings, improved maintainability, and better training for plant support staff. CCRW strives to establish the optimum set of processes, control designs, and equipment, and then deliver them to these internal stakeholders via common controls designs and architectures that can be applied across GM's production operations. The benefits can be significant. For example, in

Maximize Agility & Flexibility
Minimize Capital Investment
Minimize Operating Costs
Enhance Safety
Maximize Uptime
Improve Product Quality
Execute Timely & Efficient Launches
Reduce Energy Consumption

Primary Objectives for CCRW

terms of start up time used for launches, CCRW has been able to reduce the amount of technical hours expended by their engineers and technicians by over 40 percent.

This approach enables CCRW engineers to support GM plants in any location worldwide. CCRW engineers are able to go into any GM plant supporting their architecture, quickly determine the controls or production systems issue, and resolve the problem. Even in expanding global markets such as China, where GM operations are often joint ventures with local Chinese manufacturers, plants have the option to use CCRW's common architecture and its associated support. Otherwise, they are on their own.

Timely and Efficient Model Launches Are the Goal

While an on-demand business model for the automotive companies has direct impact on many aspects of the product lifecycle from product design to manufacturing process optimization, the structure and approach to the model launch represents an activity that significantly affects success and profitability. The key metric is the amount of time it takes to deploy, install, and commission new production lines and bring all of these systems up to production rate. Additionally, engineering organizations have to be accountable for the engineering resources expended, whether in-house or outsourced, to accomplish the model launch. Since the goal is to reduce total cost for new model launches, both time and resources have to be controlled while still satisfying production and delivery.

CCRW has met this challenge head on and is enabling GM to increase the number of new model launches each successive model year. CCRW is even able to quantify their performance in terms of the key metrics of time, resources, and cost. In this way they are able to focus efforts for process improvement, validate the benefits of common architecture and standards, restructure their organization to fit architectural direction, and determine the right proportion of deployment outsourcing to in-house activity.

CCRW's Migration Plan Maps Deployment of Common Architecture

CCRW has delivered on their ability to provide GM production operations with a distinctive edge in getting their product to the market. From the beginning, the core technology enabler to this effort has been CCRW's Common Manufacturing Controls Architecture initiative that provides the defining blueprint of GM's global direction for automated production systems. This enabling architecture provides GM with a competitive advantage in vehicle production by increasing reusability, enhancing safety, and enabling more timely and efficient execution of new model launches.

> CCRW's task is to define, develop, validate, and deploy a common architecture that includes a common controls platform, common factory networking standards, and common automation components and equipment.

The technologies and production enhancements that comprise the current Step Function come into contact with multiple metric areas within the vehicle operations environment. CCRW refers to the metric areas that need to benefit from technology and process improvement as "SPQRCTE:" Safety, People, Quality, Responsiveness, Cost, Technology, and Environment. Each of the projects included in the current Step Function Plan addresses at least one or more of these major metric areas, if not all.

Deployment in Five Year Steps

In order to meet the challenging list of competitive requirements and provide deliverables that minimize disruption to vehicle launches, CCRW structured a technology migration plan that enabled technologies, platforms, equipment, and components to be implemented and deployed in five year sequences or "stair-step" functions. Each five year milestone represents the culmination of a set of technologies, production systems, and initiatives planned to be developed and implemented within that step function. The projects and technologies that comprise each five year step are maintained as the common architecture definition for that period of time. This enables CCRW to perform a thorough validation of each new technology before its integration into GM's manufacturing operations.

It is important to note that CCRW takes the approach of selecting emerging technology within each Migration Step that will "reach" beyond current technology enough to prevent obsolescence before deployment is complete. At the same time they carefully evaluate and validate emerging technology to mitigate the risk of technology that doesn't work within the context of GM's production operations. The focus is on maintaining a standards-based approach to the selection of everything from next generation programmable automation control (PAC) platforms to standardized factory networking and safety systems.

The Value of Common Architecture

It was abundantly clear to CCRW that, in order to accomplish the formidable task of reducing manufacturing costs while reducing model launch times, a comprehensive common controls architecture based on industry standards, best-of-breed automation systems, and emerging technologies needed to be established. Developing an architecture that defines common control platforms, standardized factory networking and infrastructure, standardized control designs and reuse practices, common automation components and equipment, and a migration path that drives deployment would provide a common framework for GM factory automation engineering groups across all production facilities locally, regionally, and globally.

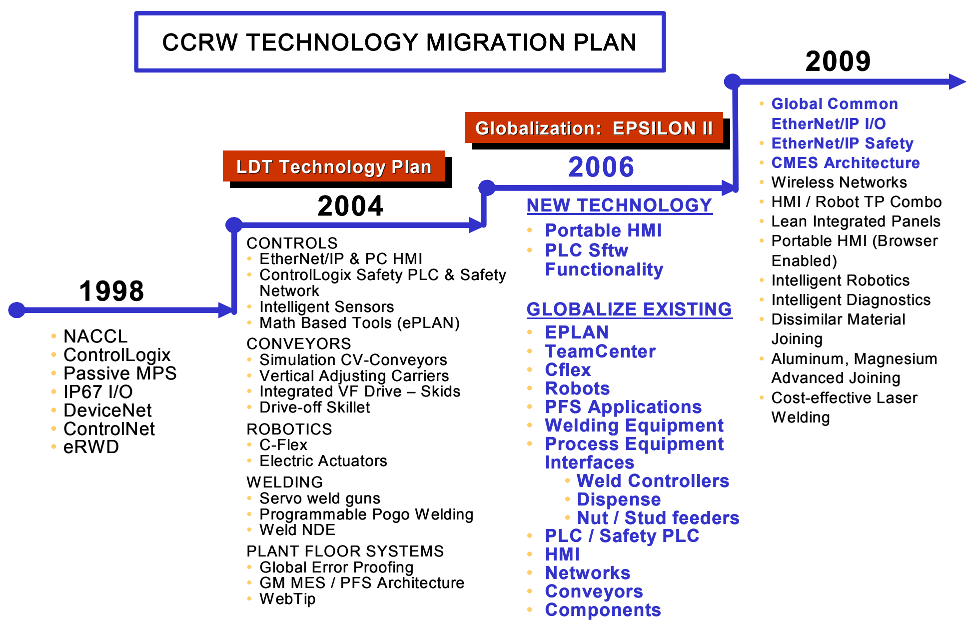
> Developing a common architecture will provide a common framework for factory automation engineering groups across local, regional, and global production facilities.

By validating design and components early on in each migration Step, much less validation is required for subsequent programs over the course of the Step. In the past each new production system went through a design, build, validate, install, debug, and startup process. Common Controls Architecture eliminates the iteration of design and validate with each new program, leaving only the need to build, install, debug, and startup, which represents a much faster process with significant cost savings. To put this in perspective, CCRW is able to realize a 60 percent reduction in direct engineering labor on controls design due to the adoption of reuse practices and common architecture.

ControlLogix as the Centerpiece

CCRW's Common Controls Architecture and technology plan is predicated on a number of key controls platforms, network standards, and manufacturing technologies. From the perspective of a common logic controls platform they have adopted ControlLogix from Rockwell Automation for use across all GM global operations. This decision is also a key factor driving the use of common controls software across all operations. Establishing ControlLogix as the common logic controls platform insures compatibility with GM's current factory network infrastructure based on DeviceNet and provides an open controls platform for future migration steps.

The intent was to drive down costs due to the high volume of common components, leverage their engineering knowledge base, and enable a common platform for manufacturing process applications. Standardizing on a common PLC platform along with the adoption of open factory networking standards establishes a common controls backplane for all of GM's global operations.



CCRW's Technology Migration Plan Maps GM Manufacturing Strategies for Near Term and Long Term

Once CCRW established ControlLogix as the logic controls standard across all GM global operations, the next step was to provide an associated industrial Ethernet factory networking standard that could connect the myriad of PLC's, robots, and weld controllers on the factory floor. CCRW settled on ODVA's Ethernet/IP (EIP) standard for the overall factory network, which is being put in place for the Lansing Delta Township (LDT) facility as part of the 2004 Step plan. EIP is replacing the ControlNet infrastructure layer currently in place and the PLC-controlled equipment and device tier currently serviced by DeviceNet.

Development and validation of the 2004 Technology Step function was accomplished in 2002 and 2003, culminating with a series of six month pilot programs before being deployed in a production environment at LDT in 2005. Driven primarily by GM's focus on globalization, both in terms of gaining new vehicle markets and the proliferation of common manufacturing processes, CCRW has established an interim technology Step for 2006. Just as the 1998 Step was tied to the Moraine platform, and the 2004 Step tied to the LDT platform, the 2006 technology Step will support the Epsilon II platform and associated production facilities.

Elements of this technology Step will include new technologies such as Portable HMI and PLC software functionality. However, the primary aim is to globalize existing and implemented projects that were part of the 2004 technology Step: C-Flex, ePLAN, robot and welding equipment standards, Plant Floor Systems, and factory networking standards like EIP and DeviceNet.

Systems architecture validation continues in 2005 with planned validation pilots for the LDT platform along with support deployment. CCRW's plan is to link their projects with GM manufacturing R&D innovation programs and to link Math-based technologies to standard CCRW business processes. CCRW will also continue to pursue Global Technology Advanced Systems (GATS) process improvements as a part of the 2005 objectives. These objectives include 1) Complete deployment of the '98 architecture prior to LDT, 2) complete LDT architecture, 3) continue 2006 globalization plan, and 4) begin 2009 architecture deployment.

The short term plan is to have DeviceNet replace PROFIbus in GM's European operations, with plant floor devices communication migrating to EIP as it becomes cost effective to do so. The long term plan is for EIP to represent a standardized backplane that will extend to real-time control for production processes opening the door to more data access with shop floor devices. A factory network based on EIP allows for a more open environment in terms of connecting the array of production equipment, controls, I/O, and common components.

Common Component Model Consolidates Supply Chain

The current Common Architecture initiative was formally kicked off in 1998, only a year after CCRW was formed as an organization, but the groundwork had been established by other engineering groups who had developed common electrical panel designs, modular controls logic, and common HMI panels. After CCRW had examined GM's manufacturing processes, developed standardized hardware design templates, and factory networking architecture, they began to look at a way to commonize a method of component selection and competitive bidding based on standards-based components of their emerging architecture. What grew out of this was a system to 1) identify potential suppliers, 2) pre-qualify them, 3) bid the components competitively, and 4) validate the components of the selected supplier. CCRW's North American Common Components List (NACCL) was the basis for an entire set of component purchasing strategies that became the Common Components Procurement Model (CCPM) that includes a consolidated supply chain, a GM-defined supplier service model, and GM validation and support strategies. The principal objective in this North American-wide initiative was to address the high cost of automation components.

Competitively bid automation components across multiple GM NA vehicle programs, leveraging GM's total volume purchasing power
Utilize smaller niche component manufacturers only for specific items when this approach is clearly the best choice for cost, safety, and compatibility
Achieve the lowest possible automation component cost and effective parts control management through competitive bidding of supplier bundled automation packages
Consolidate the supply chain: GM has actually reduced its number of suppliers from 400 to 92 and worked consolidate sourcing of numerous components to one common distributor

Key Elements of the Common Components Procurement Model

The CCRW strategy was to test and validate the components used in production systems to increase reliability and quality while driving down the cost through volume procurement. Not only did this approach provide significant cost savings for GM, it was an opportunity for suppliers to be included on the NACCL for minimum of three years based on periodic reviews. The 3 to 5 year commitment that GM provides suppliers allows them to maximize their competencies and work to lower their costs. GM views this as a win-win situation. Moreover, the CCPM consolidated CCRW's automation components supply chain significantly, reducing the number of suppliers while consolidating sourcing of many required components to a common distributor.

Since the inception of CCPM around 2000, GM has realized roughly 30 percent cost savings, with projections through 2007 pushing 50 percent overall. This represents both panel and field controls components and spare parts where the average cost savings is around 60 percent overall. The NACCL strategy is now being globalized, starting with robotics suppliers and then conveyors.

Common Panel Design Evolves To Common Workcell Panel

Based on quantification of specific projects within the overall Common Controls Architecture initiative, CCRW has been successful in meeting their primary goals along with almost all of the technology initiatives and production systems included in the technology migration plan. One area that CCRW has focused on from the beginning is the concept of a common controls panel. This panel represents the physical enclosure that houses the various PLCs, controllers, safety relays, and other electrical components required to run the multitude of work stations, conveyor systems, robotic welding cells, and other production systems in their factories. Their original goal was to create a modular standard for an identical control panel that would come in four standard sizes and incorporate common control panels throughout their production lines. What CCRW has accomplished to date is to significantly reduce the size and complexity of the panel by incorporating common electrical components and controls, and overall optimize the space and efficiency of the panel. The immediate benefits were lower design costs due to reuse of a common panel design from program to program; simplified logistics in obtaining panels for planned implementations or on short notice, and the ability to bid out large quantity build contracts leading to significant cost reduction per panel.

Panels can be mass produced
Panels are interchangeable between programs
Common panel design drives common software
Easier for skilled trades to troubleshoot
More efficient training
Auto-generation of hardware and software designs from standard templates

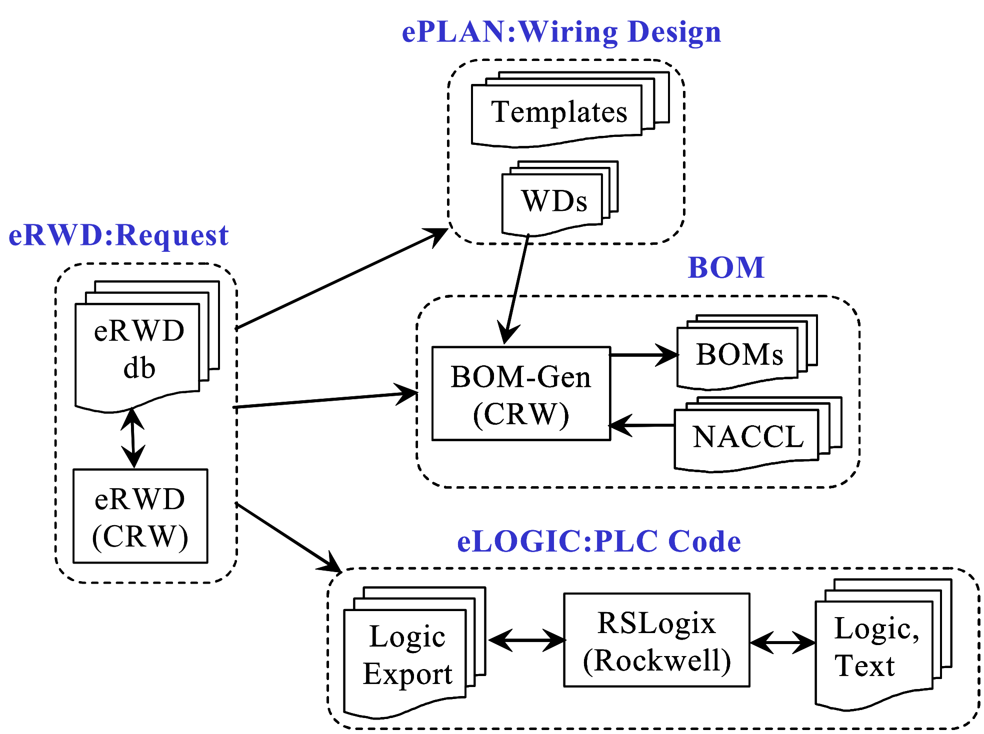
Benefits of Common Panel Design

Advanced Manufacturing Projects

CCRW is pushing technological innovation and production process enhancement well beyond the development and implementation of a Common Controls Architecture. While a common architecture based on industrial standards remains the core of their major initiatives, CCRW is pursuing a complete agenda of projects that include a fairly comprehensive list of projects that include everything from generative controls engineering to advanced assembly line equipment.

ePLAN and eLOGIC Shorten Systems Deployment Time

One of CCRW's initial efforts to introduce standardization to GM production processes was to standardize the process of controls design. This involved developing standard templates for hardware design drawings for everything from circuits and electrical panels to controls and infrastructure components. The result was hundreds of standard templates for hardware design. These templates enable maximum reuse of designs and enforce established CCRW standards.



CCRW's ePLAN and eLOGIC Automatically Generate H/W Design, BOM, and Control Code

CCRW's Math-Based tools ePLAN and eLOGIC effectively address the issues of hardware design and software design reusability respectively.

These hardware and software controls design generation and template tools are a clear demonstration that methods of reuse can extend well beyond production equipment, tooling, and plant floor hardware. The ePLAN and eLOGIC Math-Based strategy is applied to the controls design itself and is an integral part of GM's common controls architecture.

By utilizing standard templates for hardware design and reuse methods such as control code generation, CCRW can significantly reduce the cost of production system deployment and commissioning. This not only translates to shortening model launches, but can appreciably reduce engineering resources and subsequently generate substantial cost savings for manufacturing overall. Overall, CCRW's strategy is to generate 80 percent of any design from previous design templates. CCRW was also able to incorporate around 80 percent of their hardware and software design templates from the 1998 tier to the 2004 tier. Overall ePLAN has reduced hardware design costs by 40 to 60 percent to benchmarks.

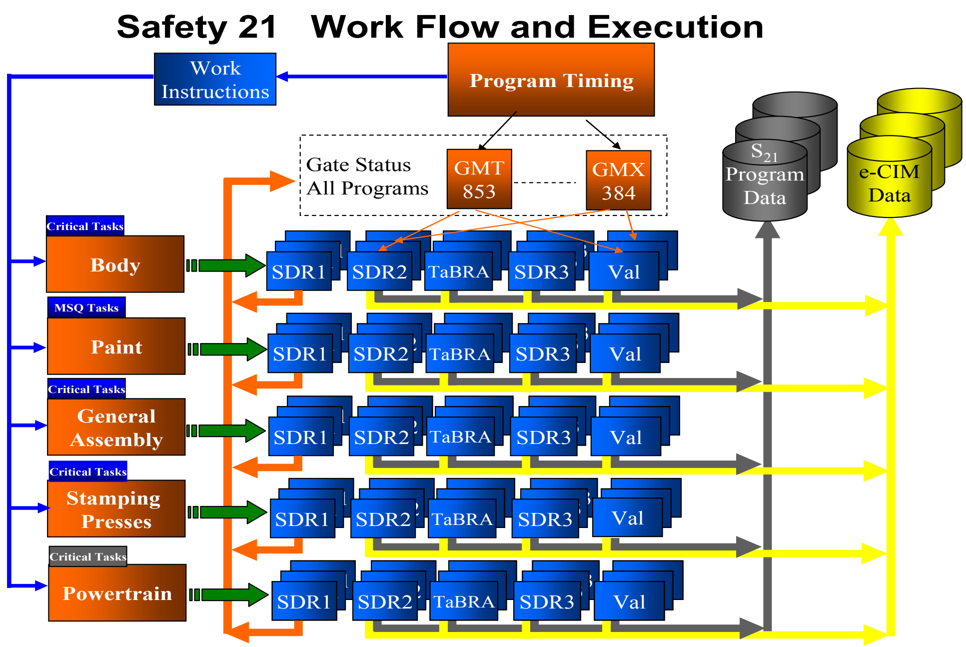
GM European operations also uses ePLAN, but a different version that is compatible with the equipment currently used in those plants. As GM moves toward establishing CCRW's Common Controls Architecture across global operations, compatibility issues will dissipate.

Next-Generation Machine Safety

In 1992 the GM Board of Directors made the decision to make health and safety their overriding priority. To that end the GM Automotive Strategy Board created GM's Health and Safety Policy from which emerged the two Safety Absolutes:

- Safety is our overriding priority
- All incidents can be prevented

Clearly, safety is taken very seriously at GM, and this is demonstrated by the inclusion and implementation of machine safety technology as a critical element of CCRW's technology migration plan. To address the safety of the workforce during production CCRW created Monitored Power Systems (MPS). During the early pilot installations UAW-GM created a Task Based Risk Assessment (TaBRA) process to give confidence around the application of this new technology. As a result MPS and TaBRA have helped GM improve their Lost Work Day case rate over the years and GM leads all automotive companies in this area.



By using risk assessment as its core GM created the Safety 21 process, which is an engineering-based closed loop communication process applied to safety. It consists of five short meetings on new manufacturing installations. All engineering execution teams and plant teams in each GM division participate in the Safety 21 meetings as the manufacturing system is designed, built, installed and brought up to production speed. Using the Task-Based risk assessment approach the timing of operator is captured, and maintenance then works along with recommendations from the operators. The implemented recommended technologies, like MPS are then verified to the actual savings when the final manufacturing systems are running.

In 1997 the productivity recommendations from UAW-GM personnel participating in the new truck programs increased productivity by an extra vehicle every 5 hours based on their recommendations captured during the Safety 21 meetings.

On production lines CCRW is eliminating the costly and complex safety relays in the common control panel and replacing them with small footprint rack-mounted safety PLCs from Rockwell Automation. Replacing safety relays with a dedicated safety PLC significantly reduces control panel "real estate" by eliminating cabling, freeing up space, and reducing the overall complexity of the panel. Moreover, since unique safety circuitry has been eliminated, this has resulted in a more common panel overall. This approach enhances the reliability and functionality of the panel and reduces maintenance costs by improving mean time between repairs (MTTR).

Agility, Reuse, and Flexible Tooling

The days of shuttering a plant to gut old "style-specific" tooling are gone. The marketplace has driven vehicle model proliferation with shorter product lifecycles and the GM Manufacturing system has changed to reflect those requirements. Leveraging a common, standardized product process plan – called the "Bill of Process" or BOP - GM uses common automation components that provide flexibility in an ever-changing marketplace.

C-Flex Multi-Model Flexible Tooling

GM has developed a proprietary tooling system – called "C-flex" – that uses high precision, programmable tooling fixtures. This system replaces the dedicated style-specific systems of the past, and combined with the common BOP, provides GM with the agility to change the vehicle build mix, and introduce new models with the same common equipment.

C-flex allows multiple styles of vehicles to be assembled and welded with the same set of programmable tools and robots. Model-specific tooling is not required. C-flex minimizes the number of stations needed to manufacture a maximum number of styles, reducing floor space requirements and supporting infrastructure. C-flex is a Math-Based system that allows for new model introduction with a minimal amount of required programming, allowing for faster model changeover.

Many GM competitors already have the ability to run different vehicle platforms down one assembly line. But fixed body-shop tooling often is used. GM is transitioning from the same fixed body-shop tooling systems to the newer flexible manufacturing processes with a structured plan. This stepped plan considers the reuse of valuable capital assets, and implements new processes when there is the need for flexibility.

Electric Actuators Eliminate Need for Compressed Air

CCRW is leading the industry in the development and deployment of Electric Actuators. The benefits are based on the elimination of compressed air generation and distribution systems in plants and energy costs associated with them. Wide-scale distribution of compressed air is notoriously inefficient. Some GM studies show that poorly maintained compressed air systems use up to 40% of their generation capacity to supply leaks in the distribution system. Further, compressed air drying to minimize corrosion-causing condensation in the system can add up to 50% to operating costs. These compressors, dryers, and distribution systems are major capital investments that are expensive to maintain and must be renewed and updated every decade. The elimination of compressed air also makes it easier to shut down the body shop on the weekends.

GM-CCRW, in cooperation with GM Body Assembly and General Assembly Engineering, is currently piloting a variety of electric actuators in its vehicle assembly operations. The vision is to completely build body assemblies and final assemblies without any compressed air.

Assembly Line Technology

CCRW is currently introducing a number of technologies and manufacturing enhancements to the assembly process. One project within the scope of the current step function plan is the emulation of controls logic to validate control designs for production systems such as conveyor systems. This involves emulating the controls logic used for a conveyor line, and subsequently validating the controls and synchronization for the motors, drives, and other motion components of the conveyor system. This method of controls logic emulation enables validation of the conveyor system prior to the build process, and eliminates much of the time-consuming system debug process on the shop floor during model launch.

New welder control units are being developed that will use a standardized I/O interface as well as a direct industrial Ethernet IP interface in lieu of proprietary operator interfaces specific to weld controllers. This will enable the use of a Web browser operator interface that will provide enhanced factory networking capability and connect these welding controllers to upper tiered production management systems. Additionally, these incorporate enhanced safety features such as touch safe control components.

On the vehicle final assembly line CCRW is introducing multiple enhancements. One example is the drive-off skillet pad that is part of a flexible conveyor system that significantly reduces complexity. The vehicle is mounted on the pad in the final assembly stage allowing for much easier access to installation of final trim components. This is an example of production technology transfer from GM's European operations, and emphasizes the use of common processes across GM's global operations.

PC-Based HMI Connects Controls and Plant Floor Systems

CCRW plans for PC-based HMI applications to play a prominent role in the Common Controls Architecture. Again, this is an effort to deploy a common HMI user interface at the work cell and production systems level with one of the primary focuses being on reducing the total cost of user interface and visualization.

30% cost savings over current platform
Less complex software
Fewer workarounds
Significant increase in memory
Enhanced viewing capability
Better information sharing
Reduced number of HMI platforms
Portable HMI by 2006

Benefits of Windows CE-Based HMI

As a part of the 2004 Step Function of GM's Common Architecture, CCRW upgraded to CE-based VersaView terminals from Rockwell Automation. Wireless devices will come more into play as CCRW moves into the next five year Step plan and the implementation of more pervasive wireless networks throughout the production facilities.

As GM migrates to applications of PC-based HMI, this will translate into a common generic HMI workstation that will be able to host multiple production applications. But more importantly, GM is looking for a common HMI application to help integrate the production controls tier with the production management tier. PC-based HMI will integrate the visualization function between the Rockwell Automation ControlLogix platform and upper level Plant Floor Systems. This will provide a common HMI look and feel for across all production lines and a uniform control information presentation interface for any function, whether it's welding, painting, or general assembly.

GM's Global Factory of the Future

With about 95 percent of the 2004 Step function projects being either in final validation or implemented, CCRW is busy with the next phase of projects that represent the technology for their factories of the future. GM is expanding production facilities in several major global markets outside of their North American and European operations into areas such as Brazil, India, and South Korea, with China representing one of the regions where this expansion will be most extensive. Driving the Common Architecture across global operations will be critical to meeting scheduling milestones, cost projections, and the market demands of each global region.

EtherNet/IP as Backplane for Global Common Network

The current network architecture definition (2004) for GM's North American operations features ODVA's Ethernet/IP (EIP) at the intermediate tier. In line with GM's Global Common Architecture, their European operations will replace PROFIbus PMS with EIP at the controls tier. The 2009 plan is to deploy a common Ethernet/IP factory network architecture for all controls and safety, eventually driving Industrial Ethernet down to the device and sensor level.

The deployment of safety bus will be based on ODVA's Common Industrial Protocol (CIP) as a common bus for safety and controls. This architecture could then be deployed across all GM production operations worldwide. The implications of deploying this common architecture are far reaching and vital to GM's global vision for establishing production in emerging markets. Additionally, migration to an Ethernet-based infrastructure will flatten out a factory architecture that was previously very hierarchical from the device bus level upward to control and business systems.

The ultimate effect of this networking strategy is a common global architecture that can be applied within any GM production facility worldwide. Coupled with GM's common vehicle platform strategy, flexible manufacturing methods and tools, and Common Controls Architecture, GM will enjoy a truly global production operations environment. While this remains an ambitious plan, once implemented and deployed, it will place GM in the unique position of playing from the same playbook, plant to plant, and provides GM with the opportunity to shift production from one plant to another in a relatively seamless, rapid, and cost effective way.

Wireless Network Technology Will Play Important Role

As part of the 2009 Step Function, wireless factory networks are being proposed that will support communications for devices, sensors, as well as production visualization and monitoring applications in production and assembly operations. Wireless sensor networks offer a number of benefits including low cost of installation due to the elimination of hard wiring and would enable an agile and adaptable production environment. Such a wireless sensor net would be capable of gathering information at low levels in production equipment and work cells, conveyor systems, even motors and drives. Machine condition monitoring and other asset management information can be accessed and exchanged over this wireless network, providing essential real-time information to performance and asset management systems.

Intelligent Robotic Work Cells Help Preserve Assets

One area that GM is focusing on to realize significant cost savings is preserving production equipment assets. An example is the use of intelligent sensors that enable production equipment such as conveyor systems, weld controllers, robots, and components such as motors and drives to perform self-diagnosis functions that report the current condition and state to predictive and preventative maintenance systems that enable preservation of production equipment assets.

CCRW plans to enable robotic welding work cells that will be able to predict drive, motor, and cable failures, and report this data to predictive maintenance systems. Additionally, condition monitoring functions will be applied to device nodes to monitor network voltages to gauge network health parameters. Motor drives will be monitored to sense excessive current draw, and motor bearings sensed for temperature and excessive vibration. All of this represents an effort to use embedded intelligent sensors at device levels to enable an environment of self reporting by production systems. The intent is to report abnormal conditions directly to production management and control systems, as well as to specific asset management monitoring and maintenance applications.

CCRW as Model for Automotive Industry

The business of automotive manufacturing is being driven by a set of factors that are re-defining strategies across the entire product lifecycle. Moreover, these factors are universal to all automotive manufacturers today. They include common vehicle platforms, shorter production runs, regionally focused production, modular product designs, outsourcing deployment, and more agile manufacturing systems.

Given that the manufacturing process has expanded to a global operation for most companies, the need has emerged to drive a common architecture that defines enterprise standards for production systems and equipment, control systems, and manufacturing processes across the manufacturing enterprise. CCRW, in addressing these needs has, in effect, established a model that can be successfully emulated across the automotive industry. By partnering with one of their primary automation technology providers, Rockwell Automation, GM is able to establish their Common Controls Architecture across their global manufacturing operations and into new vehicle markets.

Based on the business and manufacturing drivers and the trends across the industry, automotive manufacturers would be well served to examine CCRW's concept of common controls architecture and how it applies to their specific business and manufacturing processes.

Analyst: Dick Slansky

Editor: Chantal Polsonetti

GM CCRW Contributors: Phil Disch, Jim Caie, Dan King, Jay Schroeder, Marty Linn, Mike Douglas

Acronym Reference: For a complete list of industry acronyms, refer to our web page at www.arcweb.com/Community/terms/terms.html

AI	Artificial Intelligence
API	Application Program Interface
APS	Advanced Planning & Scheduling
B2B	Business-to-Business
BPM	Business Process Management
CAGR	Compound Annual Growth Rate
CAS	Collaborative Automation System
CMM	Collaborative Manufacturing Management
CNC	Computer Numeric Control
CPG	Consumer Packaged Goods
CPAS	Collaborative Process Automation System
CPM	Collaborative Production
EAM	Enterprise Asset Management
ERP	Enterprise Resource Planning
HMI	Human Machine Interface
IT	Information Technology
LAN	Local Area Network
MIS	Management Information System
MRP	Materials Resource Planning
OpX	Operational Excellence
OPC	OLE for Process Control
P2B	Production To Business
PAS	Process Automation System
PLC	Programmable Logic Controller
PLM	Product Lifecycle Management
SCE	Supply Chain Execution
WAH	Web Application Hosting
WMS	Warehouse Management System

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