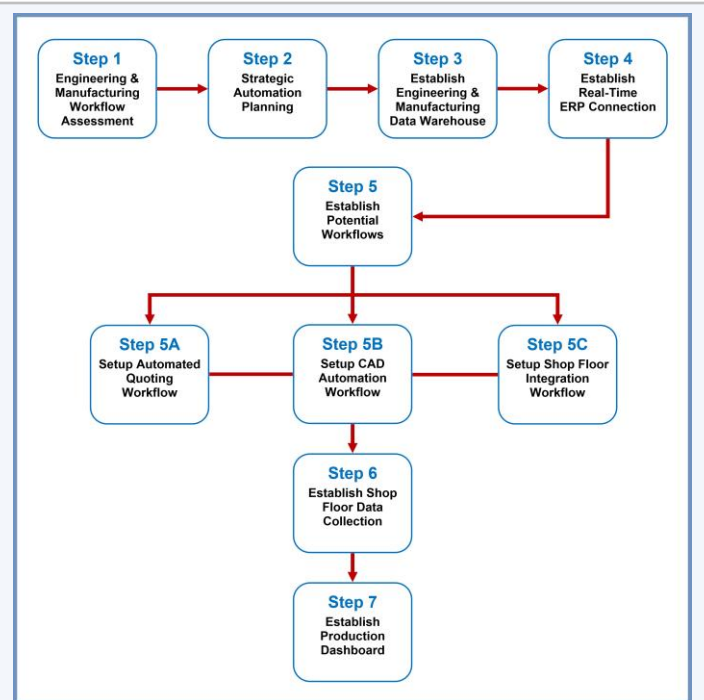




7 Practical Steps To Achieve An Integrated Factory

In today's global manufacturing marketplace, staying ahead of the competition is contingent on processing orders quickly and efficiently. This can be accomplished by providing the shop floor with accurate and timely information with an integrated factory. With engineered to order (ETO), configure to order (CTO), and custom products, the process of quoting and generating information for purchasing, engineering, manufacturing and the shop floor is generally a more involved, labor-intensive process. This article explores and explains seven practical steps your company can follow to achieve an integrated factory.

- 1) **Engineering & Manufacturing Workflow Assessment**
- 2) **Strategic Automation Planning**
- 3) **Establish Engineering & Manufacturing Data Warehouse**
- 4) **Establish Real-Time ERP Connection**
- 5) **Incorporating Automated Workflows**
- 6) **Shop Floor Data Collection**
- 7) **Production Dashboard**



**Our Proven Methodology &
Software Technology Can
Save Your Company
Thousands of Engineering
Hours Annually**



COOPER Power Systems

*"The marketplace for 100% automatic program generation (folding machines & press brakes) does not exist. **Global Edge** was the "missing link" that allowed us to expand our manufacturing technologies and capabilities. This has resulted in a savings of 1,000's of man hours per year in our Engineering & Programming departments."*

**Adam Popchock, Senior Manufacturing Engineer
Cooper Power Systems – Waukesha, Wisconsin**



1) Engineering & Manufacturing Workflow Assessment

The first step in coming up with an integrated factory environment starts with an **"Engineering & Manufacturing Workflow Assessment"**. This assessment identifies potential improvement areas and determines what is practical and cost-effective to automate.

Many manufacturing enterprises have numerous unconnected silos of information. These information silos include data in ERP and MES systems, 3D CAD models, spreadsheets and other engineering and manufacturing related documents. The separation of information into these silos is often the reason for inefficiencies that slow down the manufacturing workflow process. Integrating this information into an automated workflow has great potential for reducing engineering and manufacturing cycle times and boosting productivity.

An Engineering & Manufacturing Workflow Assessment can help identify your **"Current State"** to determine a practical **"Future State"** improved workflow process. A key part of this **"Current State"** is an estimate of the cost of each step in cycle time impact, labor and machine time. The following is the information that is typically gathered and discussed with an Engineering & Manufacturing Workflow Assessment:

Engineering & Manufacturing Workflow Assessment Outline

⊕ Define Software & Hardware Technologies Utilized

- ERP / Business System
- CAD / PDM System
- Quoting System / Spreadsheet
- MES / Scheduling System
- Custom Software Applications
- Legacy Systems
- Shop Floor Machine Tools

With each of these software and hardware technologies, it's important to understand the information generated with each and where it is currently being distributed to. This also includes determining if additional information needs to be made available to improve processes elsewhere in the enterprise in a timely fashion.

⊕ Document Existing Workflows

The process of documenting existing workflows is to help determine potential inefficiencies and potential improvement areas. Additionally, this includes identifying labor intensive workflow tasks that can be supplemented with software automation and data integration.

⊕ Current State Workflow Summary

At the end of this step, there will be an up-to-date workflow map that will show the strengths and weaknesses of current operations. This provides a foundation for the next step to plan for future improvements based on Industry 4.0 principles to create an effective path forward.

LDC has the expertise to identify and devise plans to drive significant results

 **TDK-Lambda**

*"Within one year of implementing **Global Edge** the time from order entry to shipment of custom power supplies decreased from four months to three weeks."*

*John Garcia, V.P. Engineering
Lambda Electronics, Inc. – Melville, New York*



2) Strategic Automation Planning

Strategic Automation Planning is the next step following the Engineering & Manufacturing Workflow Assessment. In this step an automation blueprint for a plan to achieve a **"Future State"** integrated factory environment will be developed. This stage of planning needs to determine not only what is possible, but also what is practical and cost-effective to implement.

Creating a fully integrated factory that automates every operation that guides and records every move may be theoretically possible, but it is not realistic or affordable. The best way forward is a step-by-step process with attainable goals and a return on investment at each step.

A Strategic Automation Plan developed during this process will provide a roadmap for integrating and improving the workflow potentially from quoting through final product shipment. Starting with the workflow documented in the previous step and focusing on identified costly bottlenecks; a step-by-step plan towards a new integrated and more productive workflow will be developed.

JCI Achieved Significant Results Starting with a Strategic Automation Plan



*"Without the **Global Edge** – Product Configurator, we would need to create hundreds of bills of materials (the list of damper components), which requires hundreds of engineering and clerical hours to create and maintain. Orders that once took up to four hours are now processed within 20 seconds."*

Steve Yoder, Damper Cell Manager
Johnson Controls – Watertown, Wisconsin

Each manufacturer is usually at their own unique starting point with procedural workflows developed over the history of the business. A Strategic Automation Plan needs to be developed that takes these unique requirements into account because one size does not fit all.

The **"Current State"** in the workflow assessment identifies the existing costs of workflow tasks that enable the selection of high priority tasks to integrate with software automation. Each of these workflow tasks needs a solid foundation to build upon. This includes identifying what data needs to be populated and when, to guarantee it is accurate and up to date.

To develop the Strategic Automation Plan, the information exchange capabilities of your various software and hardware technologies / components throughout the manufacturing enterprise needs to be assessed. This includes:

- ⊕ **Import / Export Capabilities of Existing Software**
- ⊕ **if Existing Software Needs to be Modified**
- ⊕ **if Custom Programming Required**
- ⊕ **Import / Export Capabilities of Machine Control Software**
- ⊕ **Machine Tools Network Accessibility**
- ⊕ **Machine Tool IoT (Internet of Things) Data Collection Capabilities**
- ⊕ **Required Data Formats**

Once these assessments are complete, the next step is to formulate a strategy of how this information should be exchanged, prioritized in the importance of positive impact to the flow of time critical information, including the potential return on investment. Logic Design Corporation provides the expertise to help guide manufacturers through this process.



3) Establish Engineering & Manufacturing Data Warehouse

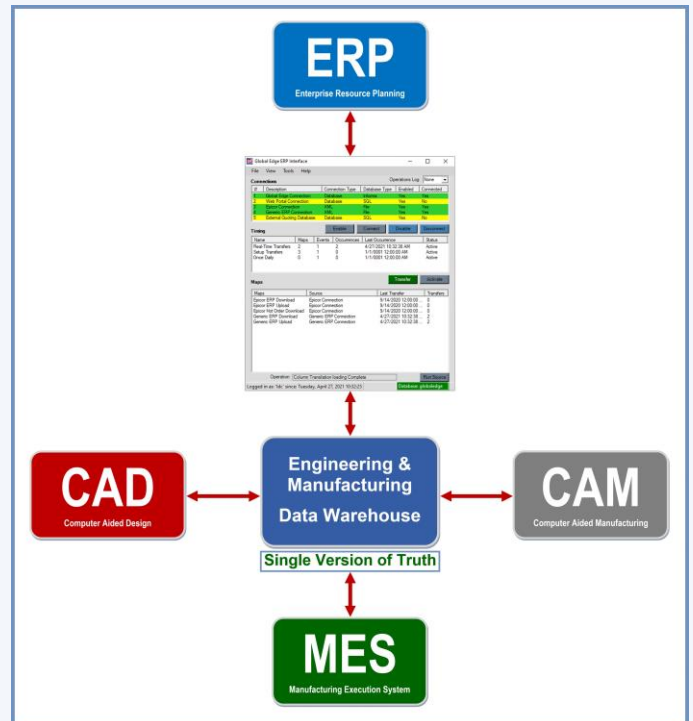
Once a Strategic Automation Plan has been formulated including a prioritization of incremental improvement steps, the most likely next step is to establish an **"Engineering & Manufacturing Data Warehouse"**. This provides a digital framework to serve as a centralized data warehouse that integrates your various software and hardware technologies.

A specialty of Logic Design Corporation, in addition to engineering and manufacturing workflow assessments and strategic automation planning, has been to help manufacturing companies establish a **"Single Version of Truth"** engineering and manufacturing data warehouse. This process is the culmination of working with hundreds of manufacturing companies for the past 30 years to devise an effective method to integrate ERP with CAD, CAM and MES.

This two-way exchange of information not only helps establish a single version of accurate and timely information, but it also provides effective filtering that eliminates duplicate information. Additionally, the direct integration between CAD, ERP and the data warehouse provides ERP with an accurate foundation for everything tied to bill of materials including routings, part parameters, vendors, and inventory and manufacturing transactions.

The **"Engineering & Manufacturing Data Warehouse"** capabilities can also incorporate direct integration with your various spreadsheets that are currently utilized for quoting, sales orders, inventory management, etc.

The following chart illustrates the potential flow of **"Real-Time"** information with the **"Engineering & Manufacturing Data Warehouse"**:



Logic Design Corporation in addition to development of the **"Engineering & Manufacturing Data Warehouse"** has developed a complete suite of software tools that makes the above type of integration both possible and practical.



4) Establish Real-Time ERP Connection

To integrate your various software and hardware technologies with the Engineering & Manufacturing Data Warehouse is made possible with an innovative ERP Interface that allows your company to define and map bi-directional data flows. These data flows can include the exchange of the following information with ERP and the enterprise:

- ⊕ Job / Work Orders
- ⊕ Production Schedules
- ⊕ Rush Orders / Hot Parts
- ⊕ Part Numbers / CAD Part Parameters
- ⊕ Inventory / Shipment Transactions
- ⊕ WIP / Scrap Transactions
- ⊕ Production Data Counts
- ⊕ Routings / Cost Rollups
- ⊕ Labor & Machine Hours

These are some of the types of data flows of information that can be exchanged with your ERP system bi-directionally. These data flows can also map, translate, and consolidate data as needed. Additionally, these data flows can automatically filter information to eliminate duplicate information such as duplicate part numbers throughout the enterprise. Information generated in engineering that needs to integrate directly with MES (Manufacturing Execution System) software and the shop floor can utilize multiple data transfer methods.

The screenshot displays the 'Global Edge ERP Interface' window. It features a menu bar (File, View, Tools, Help) and an 'Operations Log' dropdown set to 'None'. The main content is divided into three sections:

- Connections:** A table listing five connections with columns for #, Description, Connection Type, Database Type, Enabled, and Connected.

#	Description	Connection Type	Database Type	Enabled	Connected
1	Global Edge Connection	Database	Infomix	Yes	Yes
2	Web Portal Connection	Database	SQL	Yes	No
3	Epicor Connection	XML	File	Yes	Yes
4	Generic ERP Connection	XML	File	Yes	Yes
5	External Quoting Database	Database	SQL	Yes	No
- Timing:** A table showing transfer schedules with columns for Name, Maps, Events, Occurrences, Last Occurrence, and Status.

Name	Maps	Events	Occurrences	Last Occurrence	Status
Real-Time Transfers	2	1	2	4/27/2021 10:32:38 AM	Active
Setup Transfers	3	1	0	1/1/0001 12:00:00 AM	Active
Once Daily	0	1	0	1/1/0001 12:00:00 AM	Active
- Maps:** A table listing data maps with columns for Maps, Source, Last Transfer, and Transfers.

Maps	Source	Last Transfer	Transfers
Epicor ERP Download	Epicor Connection	9/14/2020 12:00:00 ...	0
Epicor ERP Upload	Epicor Connection	9/14/2020 12:00:00 ...	0
Epicor Hot Order Download	Epicor Connection	9/14/2020 12:00:00 ...	0
Generic ERP Download	Generic ERP Connection	4/27/2021 10:32:38 ...	2
Generic ERP Upload	Generic ERP Connection	4/27/2021 10:32:38 ...	2

At the bottom, there is an 'Operation:' field showing 'Column Translation loading Complete' and a 'Run Source' button. The status bar indicates 'Logged in as: 'Idc' since: Tuesday, April 27, 2021 10:32:25' and 'Database: globoledge'.

The various defined data connections can include scheduled transfers of data, real-time data transfers and event driven data transfers. Transfers can be done through direct ODBC data connections and using file transfers to existing import and export functions with formats including CSV, XML, and HTML. This also includes the ability to place data files where needed in specific locations on the network that can be retrieved and imported however your IT department deems necessary according to their preferences and control.



5) Incorporating Automated Workflows

Once the data infrastructure has been established with the previous steps, the next step is to establish automated workflows for labor intensive tasks. These workflow tasks can include the following:

- ⊕ **Automated Quoting / Product Configuration**
- ⊕ **Automated Routing Generation**
- ⊕ **CAD Automation & Integration**
- ⊕ **Automated Shop Floor Integration**

Automated Quoting / Product Configuration

This potential automated workflow is designed to supplement and/or replace your existing quoting system. Many companies that quote simple-to-complex products have developed intricate quoting spreadsheets to generate sales quotes. These quoting spreadsheets typically contain significant tribal quoting knowledge that is not easily duplicated into a new quoting system. In cases like this, quoting spreadsheets can be integrated with the Engineering & Manufacturing Data Warehouse, which allows you to utilize existing quoting logic and integrate it with the enterprise. LDC has developed configuration technology that automatically generates routings and cost rollups that can be applied to the existing quoting process to help ensure accurate and timely sales quotes.

Automated Routing Generation

Automated Routing Generation is a powerful automated workflow that automatically generates optimal routings based on CAD part and matching machine tool parameters. This capability can also help automate the scheduling process because it provides complete information on every operation including which machines can run the operation and how long it will take to complete. This routing information can be directly incorporated into an automated job build process.



CAD Automation & Integration

Another potential automated workflow that can be introduced to the preparation of engineering information for the shop floor are automated tasks such as the following:

- **Automated CAD Part Batch Unfolding**
- **Automated CAD Part Resizing to Match Available Tooling**
- **Manufacturability Testing**

These automated workflows can save your company significant time and money by automating the preparation of engineering information for the shop floor. This includes the automatic unfolding of large batches of sheet metal CAD models and the automatic generation of DXF flat files. Also included is the automatic adjustment of sheet metal bend radius to match your shop floor tooling.

Automated Shop Floor Integration

Additional workflow automation that can be achieved includes the automated generation of shop floor scheduling and production information. This includes the automated integration of daily order information from ERP automatically merged with engineering generated information that includes laser nestings, bend programs and other CAM programs needed to streamline and automate the scheduling / production process.



6) Shop Floor Data Collection

The next incremental step to achieve an integrated factory environment is the effective and automated return of production information back to the rest of the enterprise including ERP. Data connection capabilities provided by the Engineering & Manufacturing Data Warehouse includes the following:

- ⊕ Integration with Machine Tool Control Software
- ⊕ Direct Connection to PLCs (Programmable Logic Controllers)
- ⊕ Integration with IoT (Internet of Things) Enabled Shop Floor Equipment
- ⊕ Workstation Data Collection / Bar Code

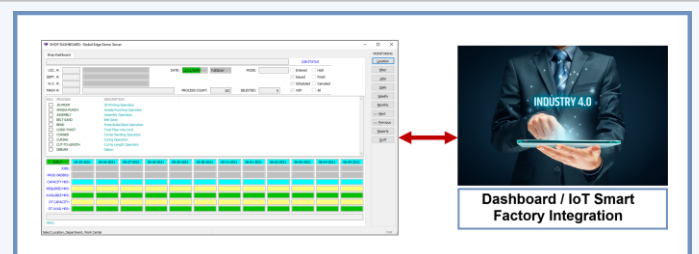


This process can also benefit from building jobs to include complete routing information which facilitates the ability to record production data at some or all the manufacturing levels if it makes sense to go to that detail. The level of this detail is best determined with the Strategic Automation Planning process on how far to take things.

7) Production Dashboard

With all the previous components in place, the overall system facilitates the information required for a real-time production dashboard. The production dashboard can include the following information:

- ⊕ Available Capacities (By Date, Machine, Work Cell)
- ⊕ Real-Time Material Usage
- ⊕ Real-Time WIP Transactions
- ⊕ Percent of Job Complete
- ⊕ Jobs Behind Schedule
- ⊕ Daily Production Completed / Value
- ⊕ Daily Product Shipments
- ⊕ Real-Time Raw Material / WIP Inventory
- ⊕ Real-Time Finished Goods Inventory



An effective production dashboard is made possible by capturing and consolidating the right information throughout the engineering and manufacturing enterprise. The Engineering & Manufacturing Data Warehouse not only centralizes information, but melds information such as job orders with optimal routings to help provide a real-time snapshot of your manufacturing operations.



Summary

The whole philosophy behind the Integrated Factory is to take things in smart, incremental, and practical steps. For some manufacturers and product lines, a high level of detail or integration may not be required. For other companies and product lines, greater detail may offer tremendous cost savings and workflow improvements. And as step-by-step improvements are achieved, our illustration not only shows what is possible, but illustrates what has been achieved following this methodology.

Logic Design Corporation (LDC) has a 30-year history of helping small, medium, and large-scale manufacturing operations achieve an integrated factory environment and Industry 4.0 and saving them thousands of engineering hours each year. LDC offers an initial free of charge Engineering and Manufacturing Workflow Assessment and consultation to determine how and where we can potentially help improve your quoting, engineering, and manufacturing workflow process.

Your Simplified & Practical Path to Industry 4.0 ...



Global Edge® Integrated Manufacturing



Industry 4.0 Consulting



Programming & Integration

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