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# Collaborative Manufacturing Systems

## I Collaborative Manufacturing Management

### Collaborative Manufacturing Management Model

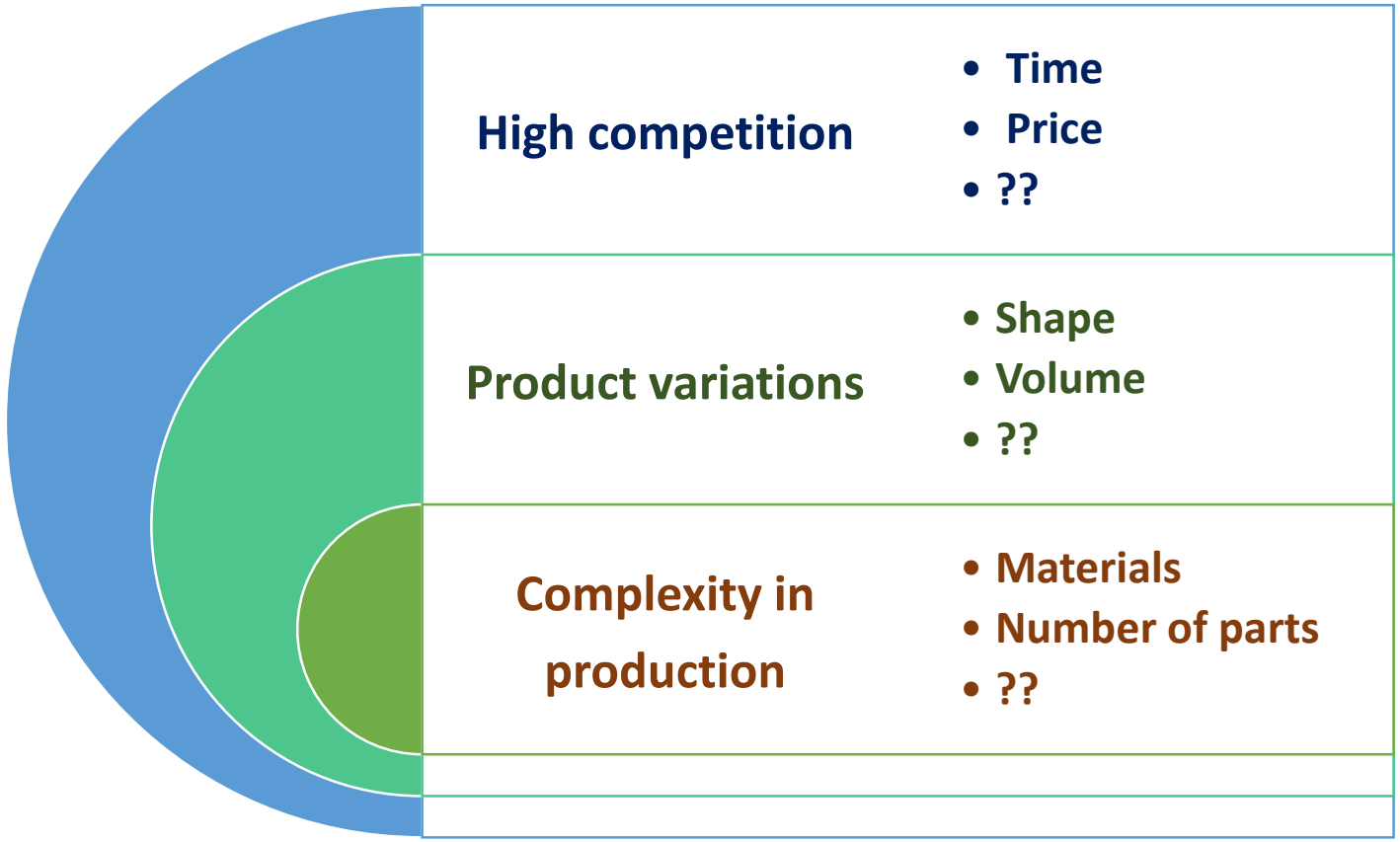
Curriculum Development
of Master's Degree Program in
Industrial Engineering for Thailand Sustainable Smart Industry

# Competing through manufacturing

Solutions for improve manufacturing efficiency

- ✓ Reduce waste material
- ✓ Conduct preventive maintenance
- ✓ Standardize work
- ✓ Quantify everything
- ✓ Apply new technologies
- ✓ Strengthen supply chain management

**Key is Collaborative manufacturing**

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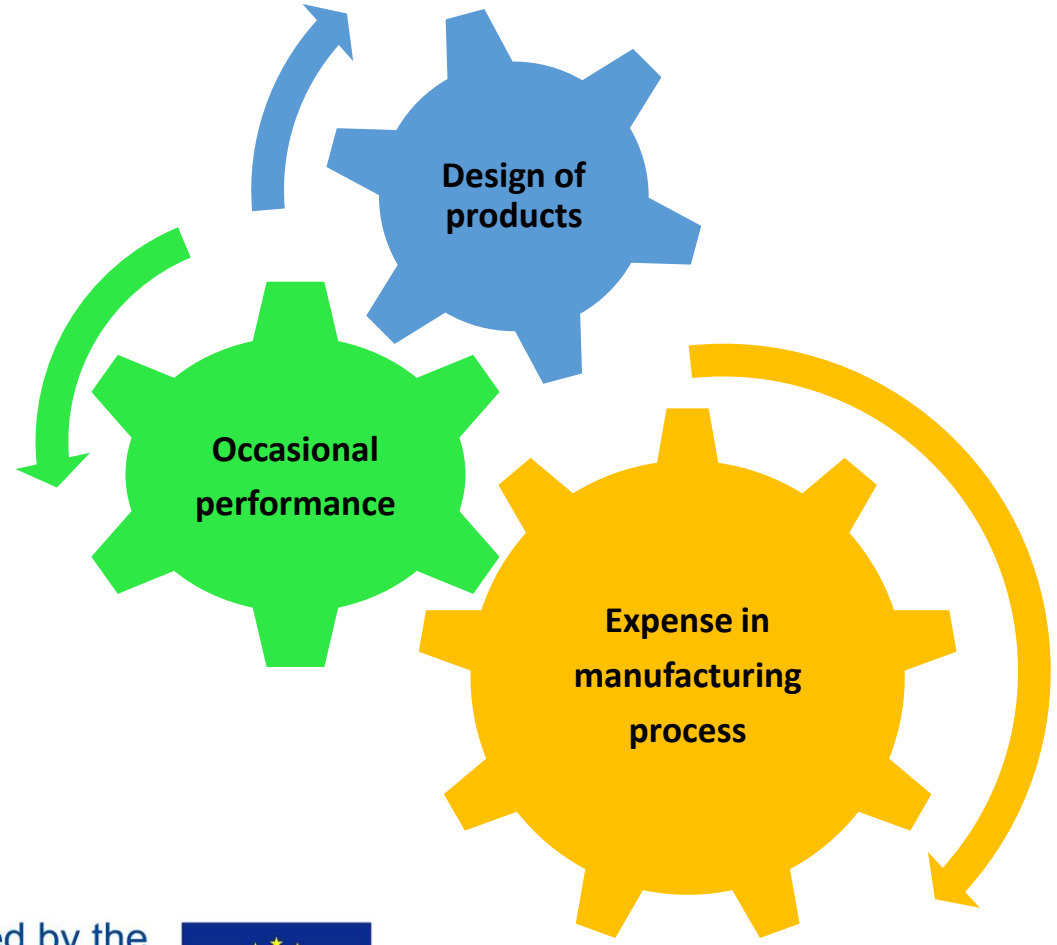
# Collaborative Manufacturing Systems

Sharing information between business processes across internal or external partners in the value chain network

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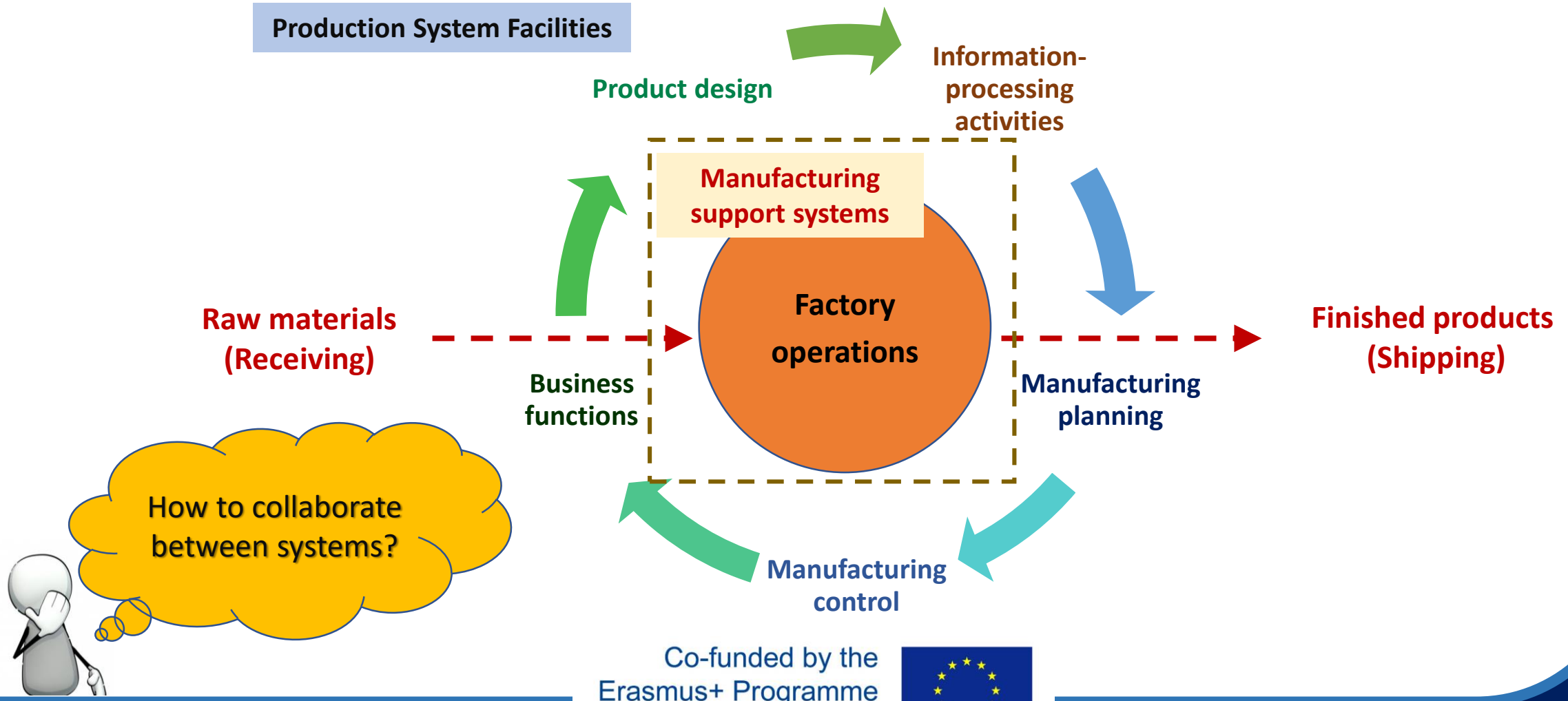
# Collaboration of Production System

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# Internal collaboration: Factory operations

## Factory operations

- Processing
- Assembling
- Material handling
- Inspecting and Testing

In a factory level, a variety of operations e.g. processing and assembling are conducted all together.

Today's manufacturer needs to operate on information in real time, as such they need to think through all the collaboration providing the value network

**How to communicate between operations for internal collaboration?**

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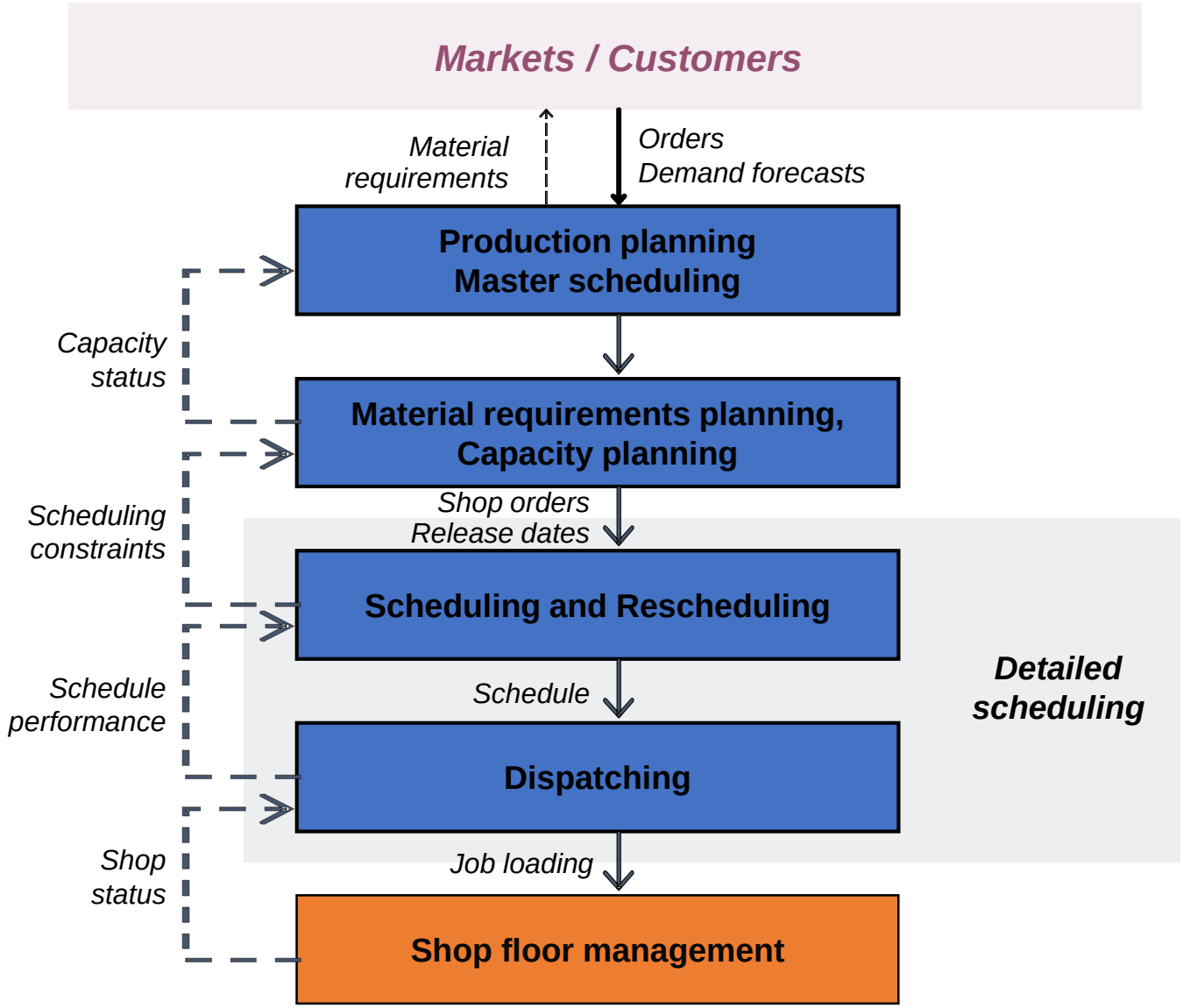
# Information Flows in Manufacturing

The *successful high-performance* manufacturing heavily depends on *proper organizational communication* and *information management*.

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# Discussion and Presentation

## Why the Management of Collaborative Manufacturing is required?

https://padlet.com/

padlet

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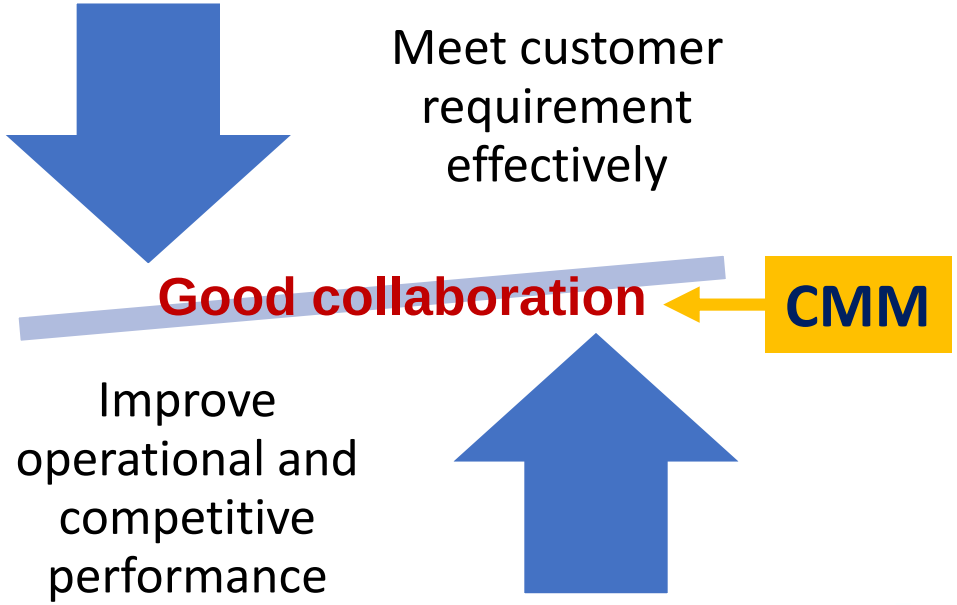
# Collaborative Manufacturing Management: CMM

Manufacturers must continue to improve their ***performance*** in order to survive as customers demand better product quality with tighter delivery requirement, and global competition is increasing.




**CMM** is the practice of managing for best performance by controlling key boundary-spanning business and manufacturing processes of a manufacturing enterprise.

**CMM** leverages new technologies to build robust relationships with trading partners. → Emphasize on Business Process Management (BPM)

(ARC, advisory group, 2001)

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# Role of Manufacturing Management


**Principle of CMM**:

- Focus on Business
- Leverage Existing Investment
- Bridge Traditional Boundaries
- Move to Adaptive Real-time Collaboration

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# Collaborative Manufacturing Management: CMM

**CMM** builds upon a collaborative infrastructure, business process system service and real-time strategic business management tools.

**CMM** connects critical applications, production systems and enterprise information to maximise the responsiveness, flexibility and profitability of the manufacturing enterprise in conjunction its value network partners.

The sharing information flowing from end to end of the value chain has changed from taking weeks or month to days, even hours with the internet technology.

**CMM** can improve response to changing market conditions, streamline product introductions, improve asset utilization, increase or maintain market share, reduce inventory and reduce cycle times.

↓

**Contribute profitability, Competitive advantage and Shareholder value**

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# Collaborative Manufacturing Management: CMM

CMM Model

- Functional View
- Process View
- Application view

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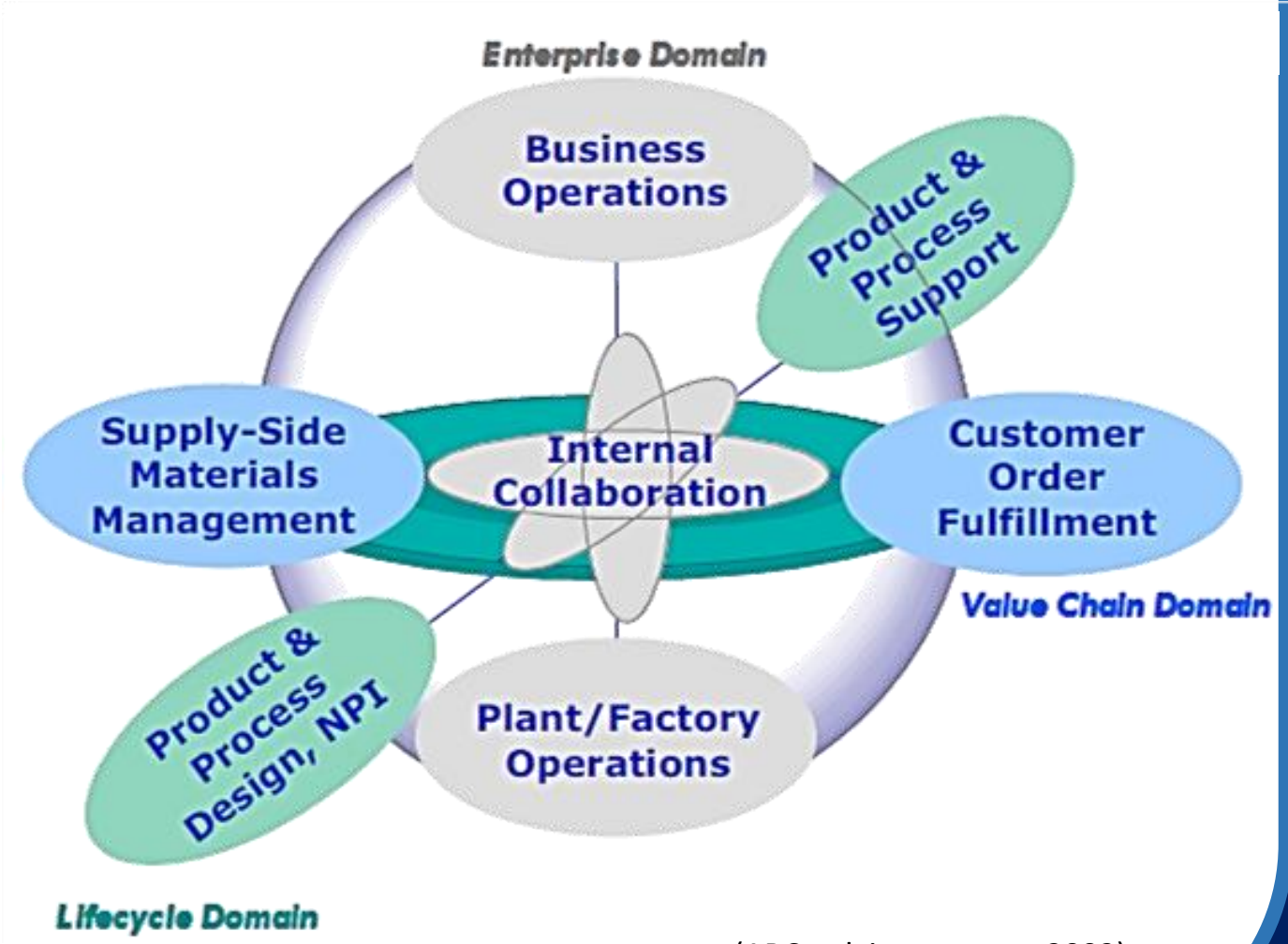
# Collaborative Manufacturing Management: CMM

## CMM Model

CMM model includes 3 intersecting domains: Enterprise, Value chain and Lifecycle.

CMM model has proven to be useful for both suppliers and manufacturers to recognise the need to support internal and out-source execution of all enterprise activities.

The collaborative value networks requires that manufacturers visualize the relationship among plant and enterprise applications, markets, value chains and manufacturing nodes in order to understand the context for planning and implementing collaborative manufacturing system.




(ARC, advisory group, 2002)

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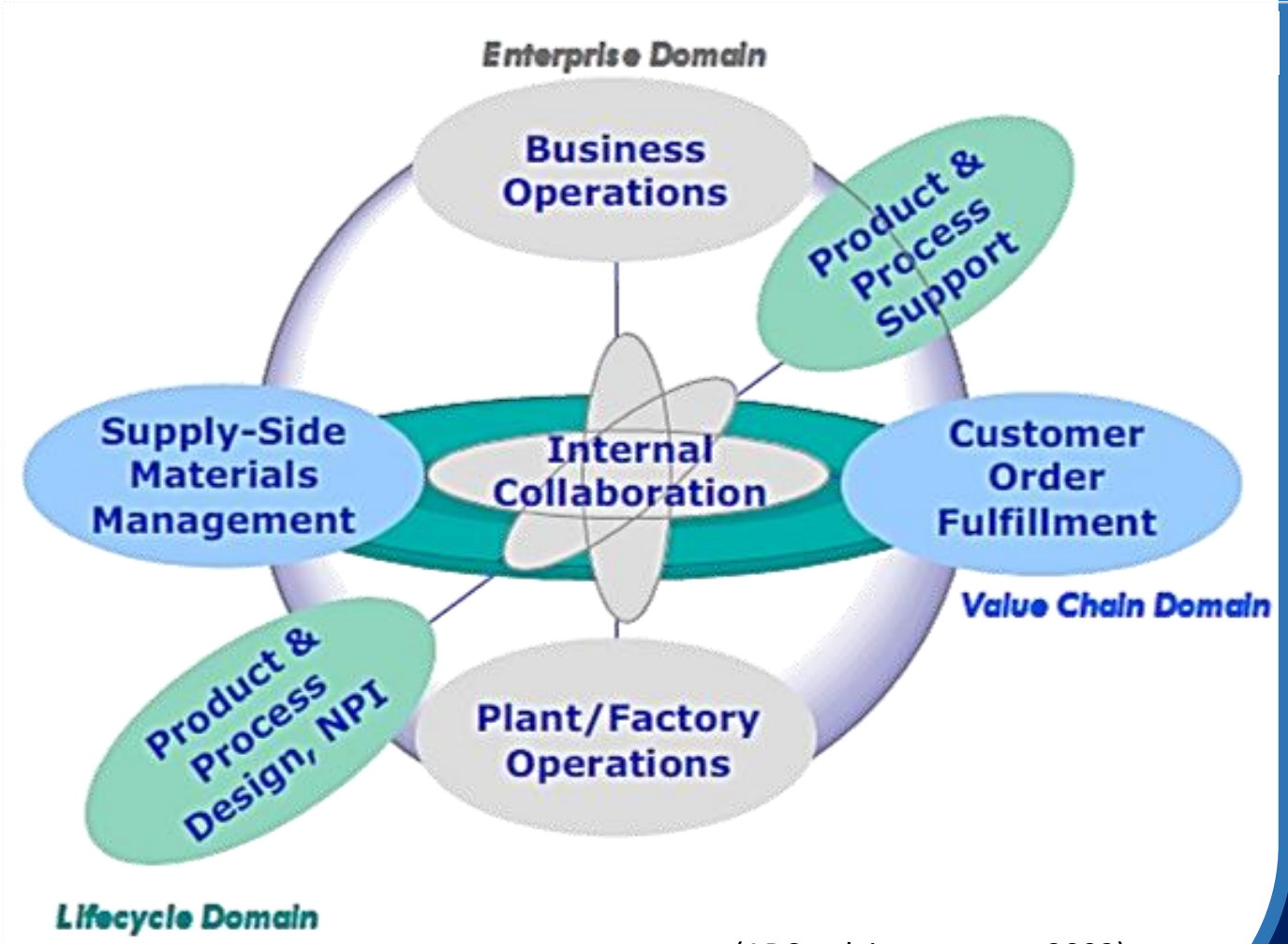
# Collaborative Manufacturing Management: CMM

## CMM Model

A collaborative value network consists of manufacturing nodes connected by material, information and process flow.

Internet-based collaboration provides more automated ways to connect with suppliers and customers along the value chain.

Product lifecycle tools are emerging for collaborative product design and post sale product support via the Web.




(ARC, advisory group, 2002)

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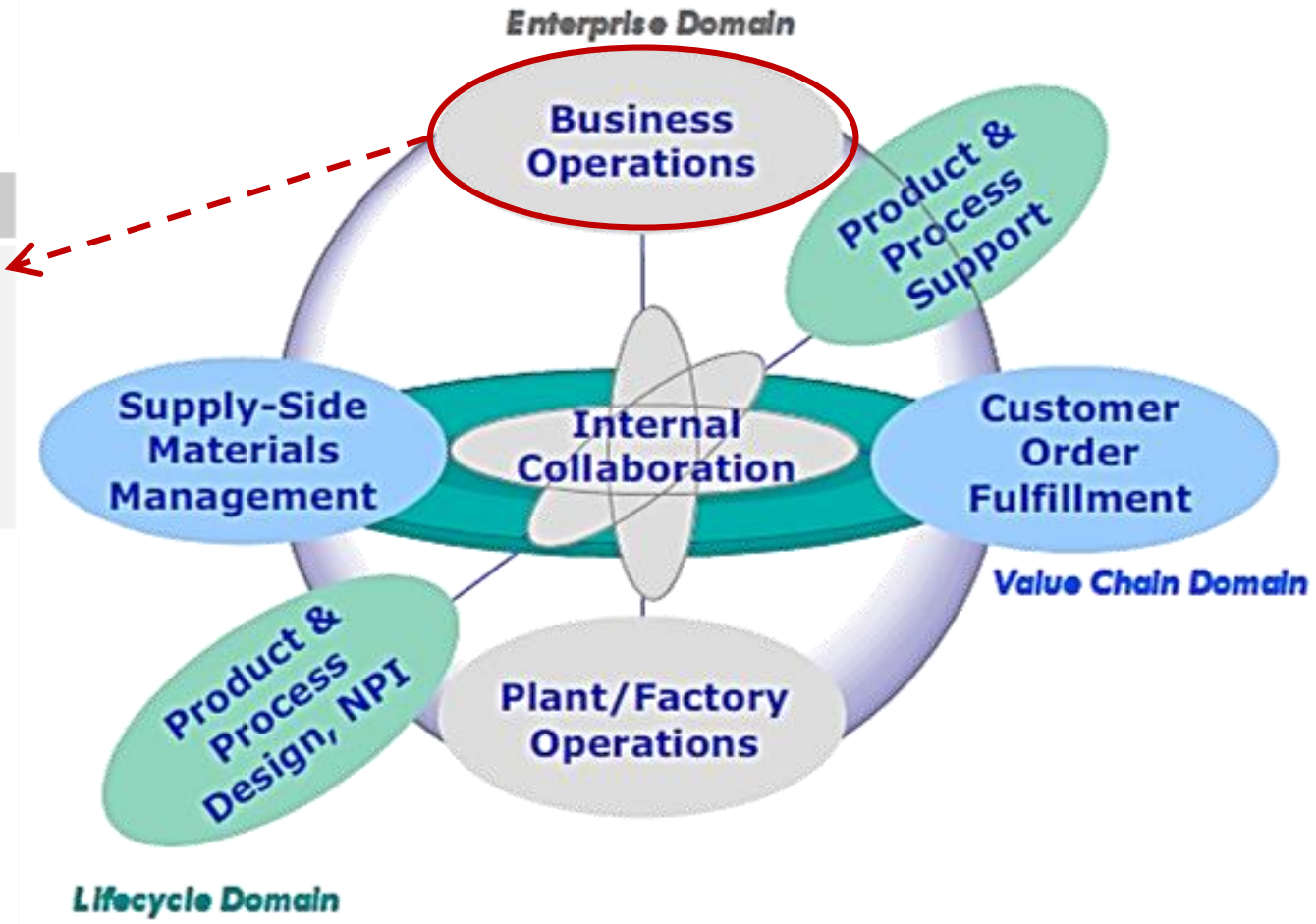
# 1. CMM Model: Functional View

Functional CMM Model highlights the relationships among the main functions in which all manufactures engage.

## 1.1 Business operation

| Function | Typical Applications |
|---|---|
| Business Operations | ERP, MRP, Financials, Cost Accounting, HR, Strategic Enterprise Management (SEM), Business Intelligence, Analytics, Decision Support, Capacity/Resource Planning, Value Network Design |

Manufactures need to provide executive management with tools to set targets, measure performance and formulate strategic in the context of " value network", where intimate partners cooperate to pursue specific business opportunities.




(ARC, advisory group, 2002)

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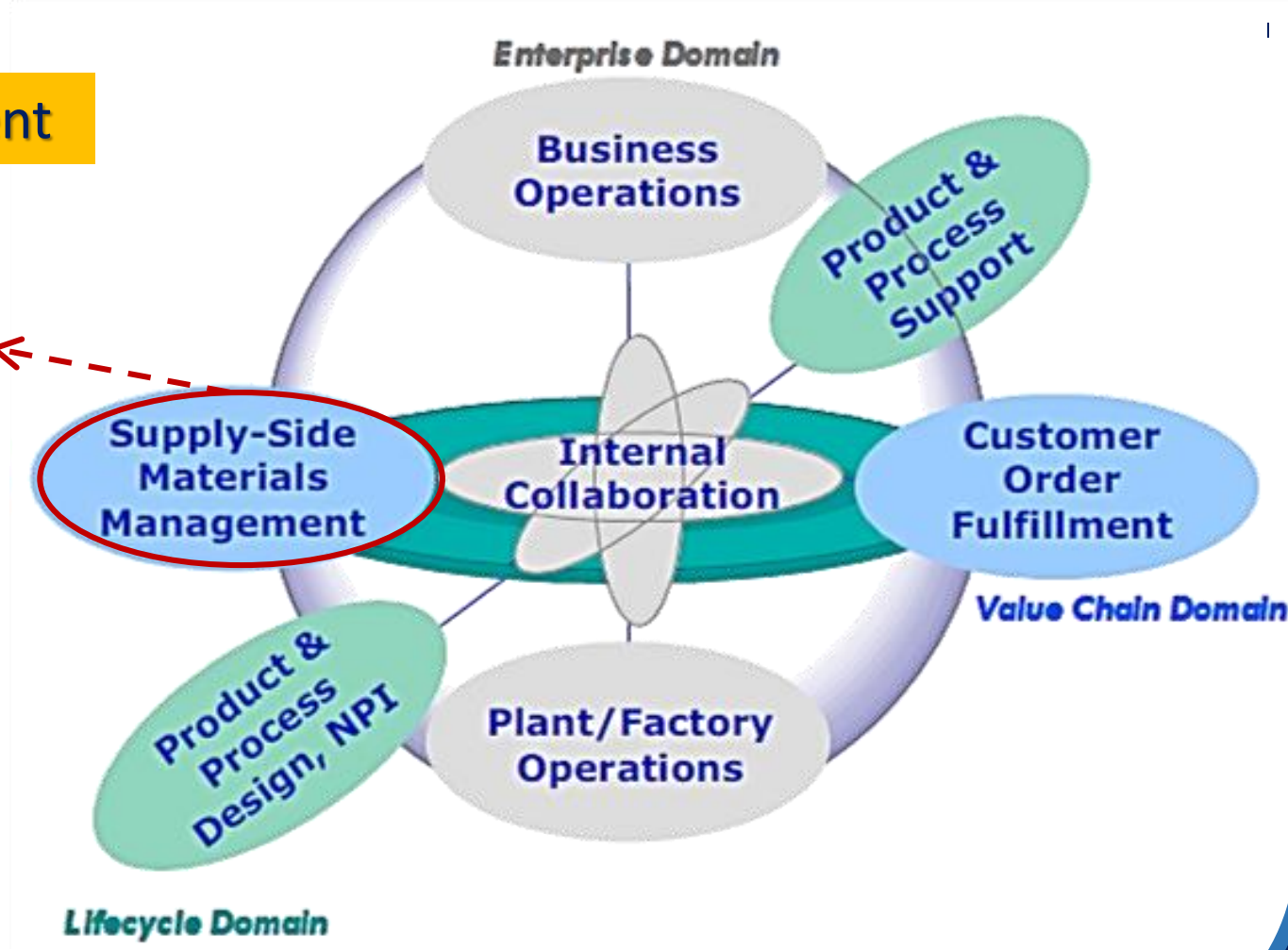
# 1. CMM Model: Functional View

## 1.2 Supply-Side Materials Management

| Function | Typical Applications |
|---|---|
| Supply-Side Materials Management | SCM, SCP, SRM, BPM/SCPM, Purchasing, supplier scorecarding, supplier performance monitoring, sourcing analytics |

A critical function for any manufacturer is ensuring that raw materials, parts, components and/or subassemblies are sourced, delivered and moved to manufacturing in a cost effective and timely way.




(ARC, advisory group, 2001)

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# 1. CMM Model: Functional View

## Supply-Side Materials Management

With CMM;

- ***Manufacturers*** benefit by having a high performance supply network and from being able to more easily offer different levels of support to different classes of suppliers.

- ***Suppliers*** benefits from immediate access to such information as demand forecasts or payments that they can use to reduce cost, improve performance accuracy and do more business.

**Example of implementing CMM Model**


- Sun gets Solectron deliveries within 4 hours of placing an order.
- Solectron gives customers like Sun role-based access to info.
- Real-time status, quality, cycle time, ECOs, etc.
- Factory floor information is available to global development and product teams using Solectron's portal and Teradyne CPM software.
- Result: Nimble, high confidence, outsourced manufacturing.

(ARC, advisory group, 2002)

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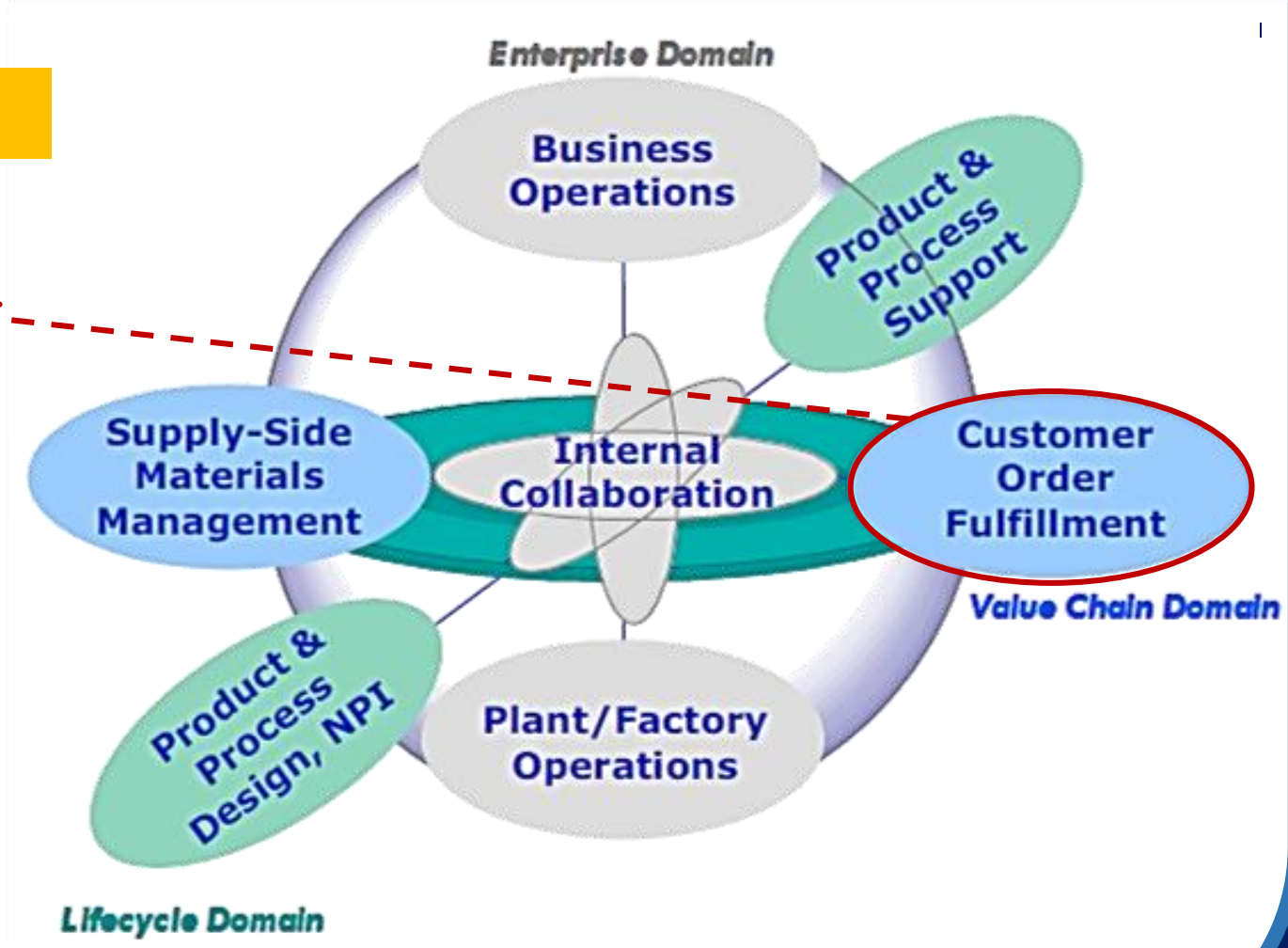
# 1. CMM Model: Functional View

## 1.3 Customers and Order Fulfillment

| Function | Typical Applications |
|---|---|
| Customers & Order Fulfillment | CRM, SFA, Demand Forecasting, APS, TPS/TMS, BPM, Distribution Planning, WMS |

This functional area addresses the need to serve the customer, where the managing customer interaction is the key.

***Production information*** on quality, material availability and production status must flow downstream to customers, while ***information on orders***, inventory levels, specifications and change orders flow upstream.




(ARC, advisory group, 2002)

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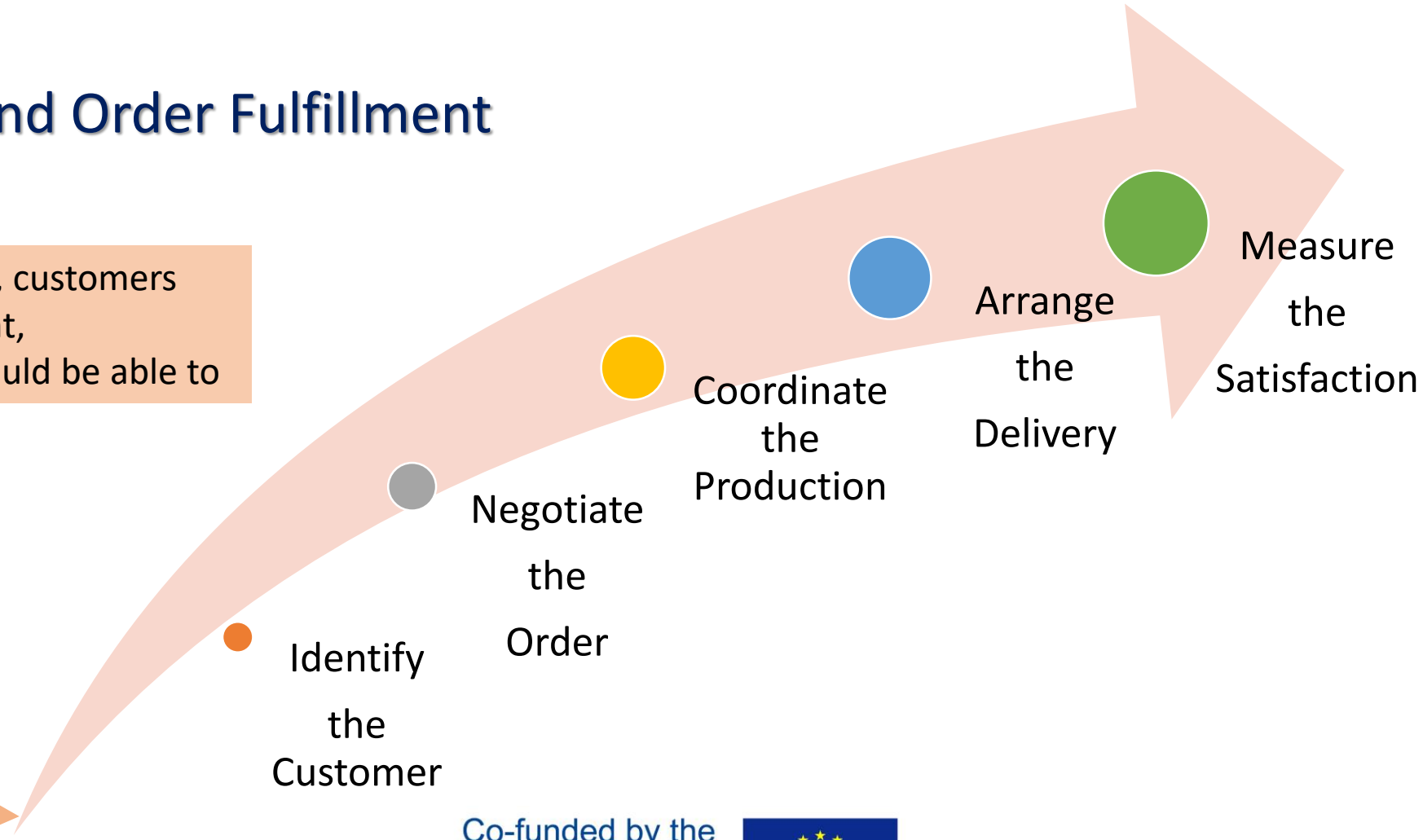
# 1. CMM Model: Functional View

## Customers and Order Fulfillment

In order to achieve, customers and order fulfilment, manufacturers should be able to

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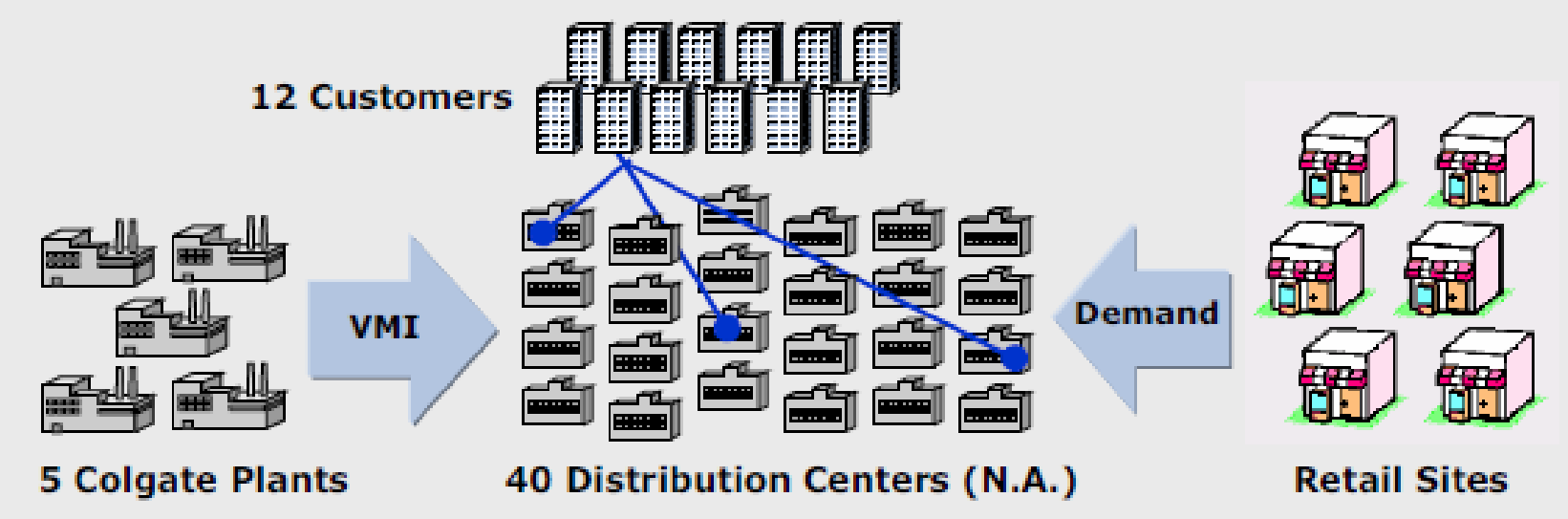
# 1. CMM Model: Functional View

## Implementation CMM for Customers and Order Fulfillment




With ***CMM***;

Brand managers armed with better information about production can begin their marketing campaigns ***before*** the inventory appears in the warehouse

- Colgate does VMI replenishment of DC's using SAP APO.
- Replenishment orders are calculated from daily inventory levels and demand from DCs.
- Production requirements are then driven back into plants.
- Results: 98% on-time, complete orders.

(ARC, advisory group, 2002)

Note
DC: Distribution center
SAP: Systems Applications and Products
VMI: Vendor Managed Inventory
APO: Advanced Planning and Optimization

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# 1. CMM Model: Functional View

## Customers and Order Fulfillment

### Modern eCommerce order fulfillment

- ***System Integration:*** your fulfillment provider seamlessly integrates into your shopping cart platform
- ***Freight Management:*** your fulfillment provider handles domestic and international inventory movements from your manufacturer to the fulfillment warehouse
- ***Inventory Management:*** your inventory levels are monitored and you are alerted when it's time to restock, through your order management portal
- ***Fulfillment Management:*** your provider receives your order through the system integration, then picks, packs, and ships order to your end customer
- ***Returns Management:*** your provider works with you to determine how returns are managed and handles return inventory and reshipping

**Key components of modern eCommerce fulfillment service**


https://www.rakutensl.com/post/customer-experience-and-modern-ecommerce-fulfillment-service

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# Adore Me Improves Shipping Times With Automated Order Fulfillment


https://www.youtube.com/watch?v=nSVJhXpkLM0&ab_channel=BastianSolutions

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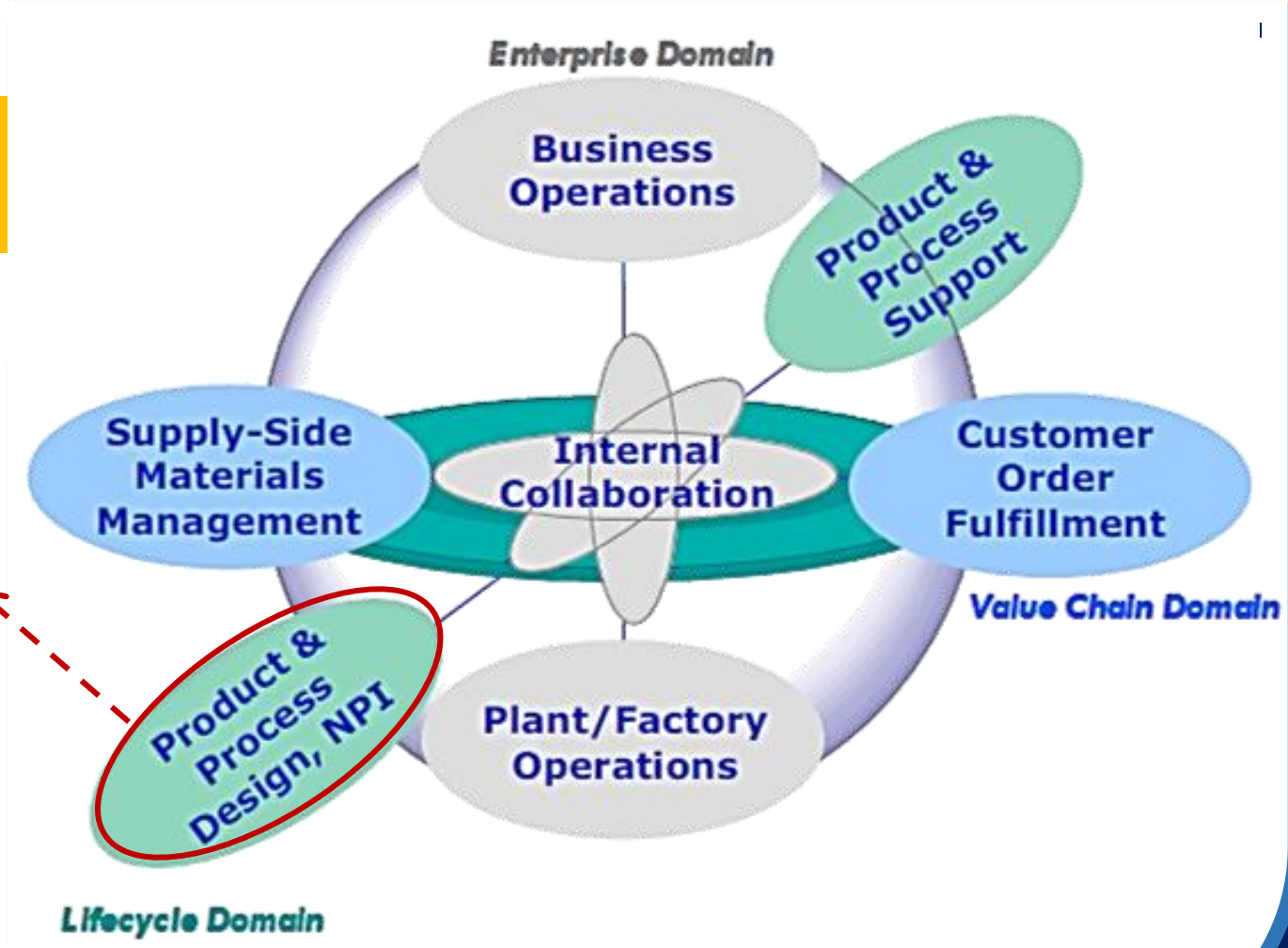
# 1. CMM Model: Functional View

## 1.4 Product and Process Design, New Product Introduction (NPI)

| Function | Typical Applications |
|---|---|
| Product & Process Design, New Product Introduction (NPI) | PLM/D, PDM, Formulation Management, Specification Management, CAD, Line Design & Simulation, Plant Design & Simulation |

***Designing new products*** and their manufacturing processes is collaborative in nature, and new digital/internet-based tools are emerging to support these activities quickly and effectively.




(ARC, advisory group, 2001)

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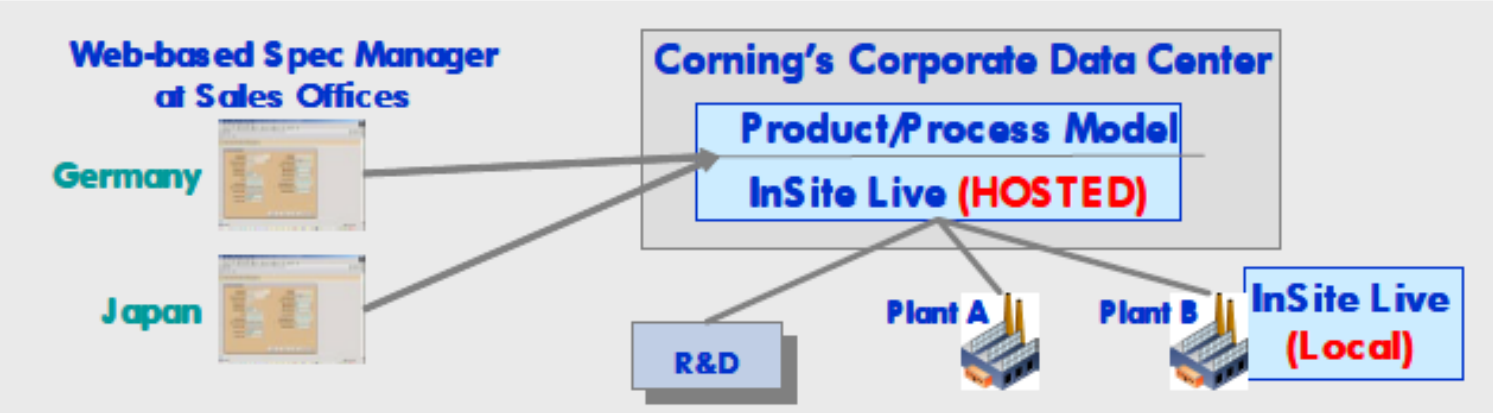
# 1. CMM Model: Functional View

The ***management and collaboration*** of specification and product development information must be conducted.

***Collaborative systems*** must support a number of processes, including assembly sequence planning, constrain-based design, distributed process planning and layout.

## Implementation CMM for Product and Process Design




- Corning manages Specifications and the Product/Process Model centrally using Camstar's Virtual Factory Suite.
- Product Specs captured and maintained centrally with controlled release to local sites.
- Product/Process Model developed in R&D phase with knowledge of individual plant peculiarities and constraints.
- Same Product/Process Model is used for R&D, small lot testing, and volume production.

(ARC, advisory group, 2002)

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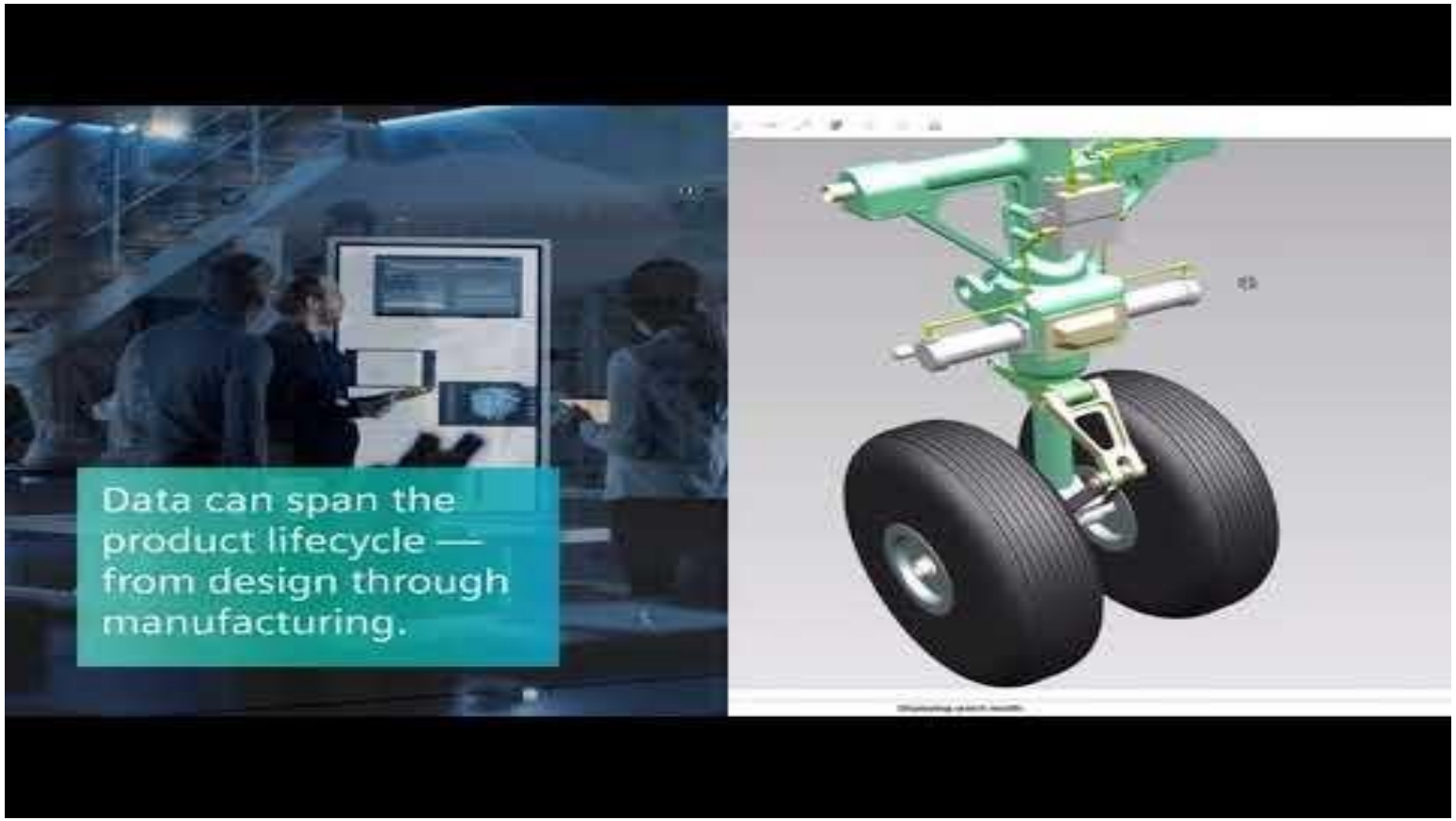
# Collaborative Product Design:

## Collaborative Design and Management with NX




https://www.youtube.com/watch?v=TblDbvaUV2A&ab_channel=SiemensSoftware

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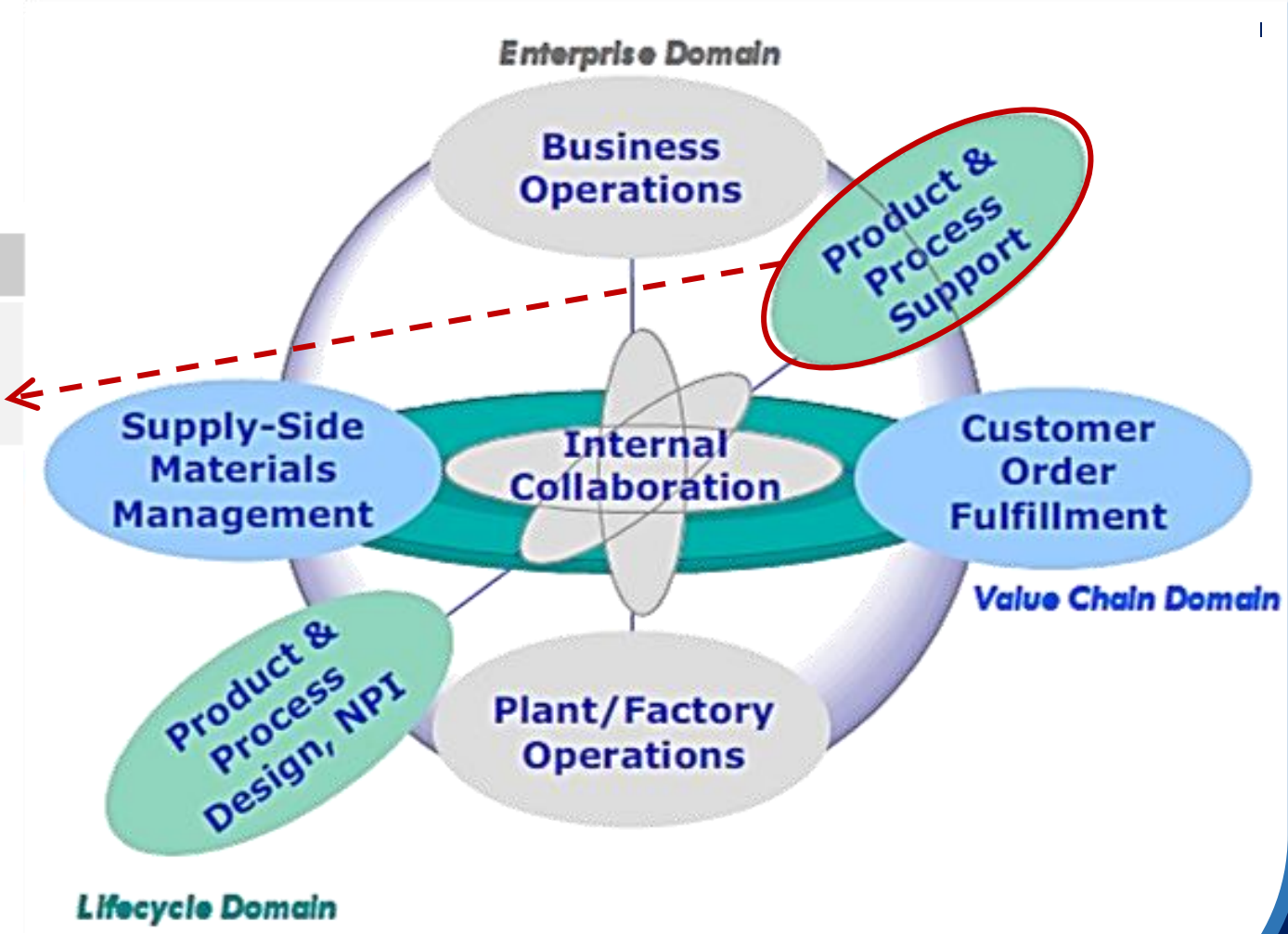
# 1. CMM Model: Functional View

## 1.5 Product & Process Support

| Function | Typical Applications |
|---|---|
| Product & Process Support | PLM/S, EAM, MRO, CRM/Help Desk, PAM, PSM |

Manufacturers compete by making production and delivery commitments to their collaborating network partners and customers.

***Collaboration of plant equipment suppliers*** may offer remote monitoring and maintenance of plant equipment via digital system and internet.




(ARC, advisory group, 2002)

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# 1. CMM Model: Functional View

## Mitsubishi Electric: Connect Everything - The "e-Factory" Concept


https://www.youtube.com/watch?v=z73gybomR-Q&ab_channel=MitsubishiElectricAutomation%2CInc.

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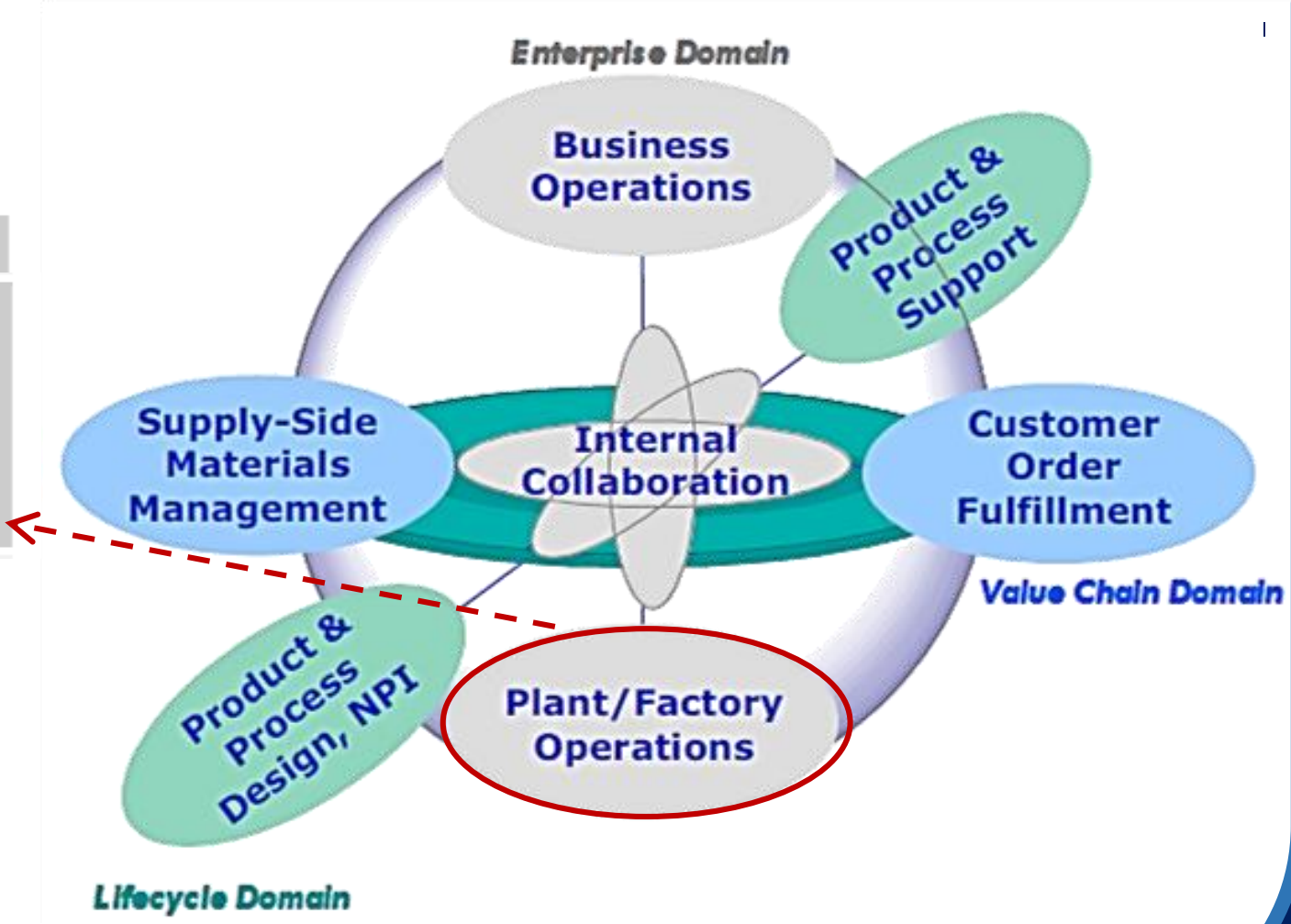
# 1. CMM Model: Functional View

## 1.6 Plant/Factory Operations

| Function | Typical Applications |
|---|---|
| Plant/Factory Operations | Production Management, CPM, LIMS, Plant Services Connector, CPAS, CDAS, APC, PAM, AMHS, Production Planning & Scheduling, Tool Management, Batch, Energy Management, Waste Management |




The two collaboration imperatives for the plant floor: *surface more information for sharing* with other audiences and *make production* systems more responsive and flexible.

(ARC, advisory group, 2002)

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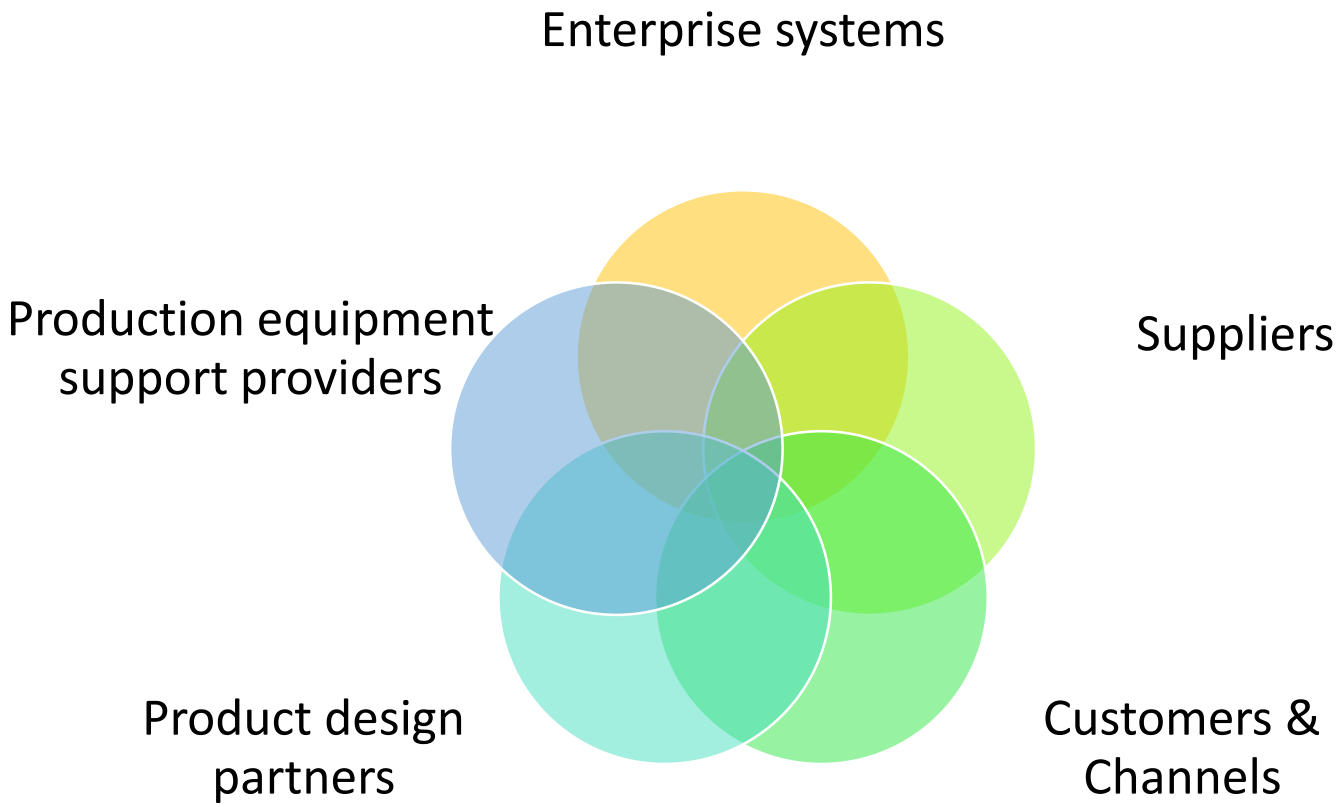
# 1. CMM Model: Functional View

## 1.6 Plant/Factory Operations

***Collaboration*** must be embraced on the plant floor in 5 key dimensions:

*Over time*, manufacturing systems will be able to participate in environment where they operate collabollatively with markets




(ARC, advisory group, 2002)

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# 1. CMM Model: Functional View

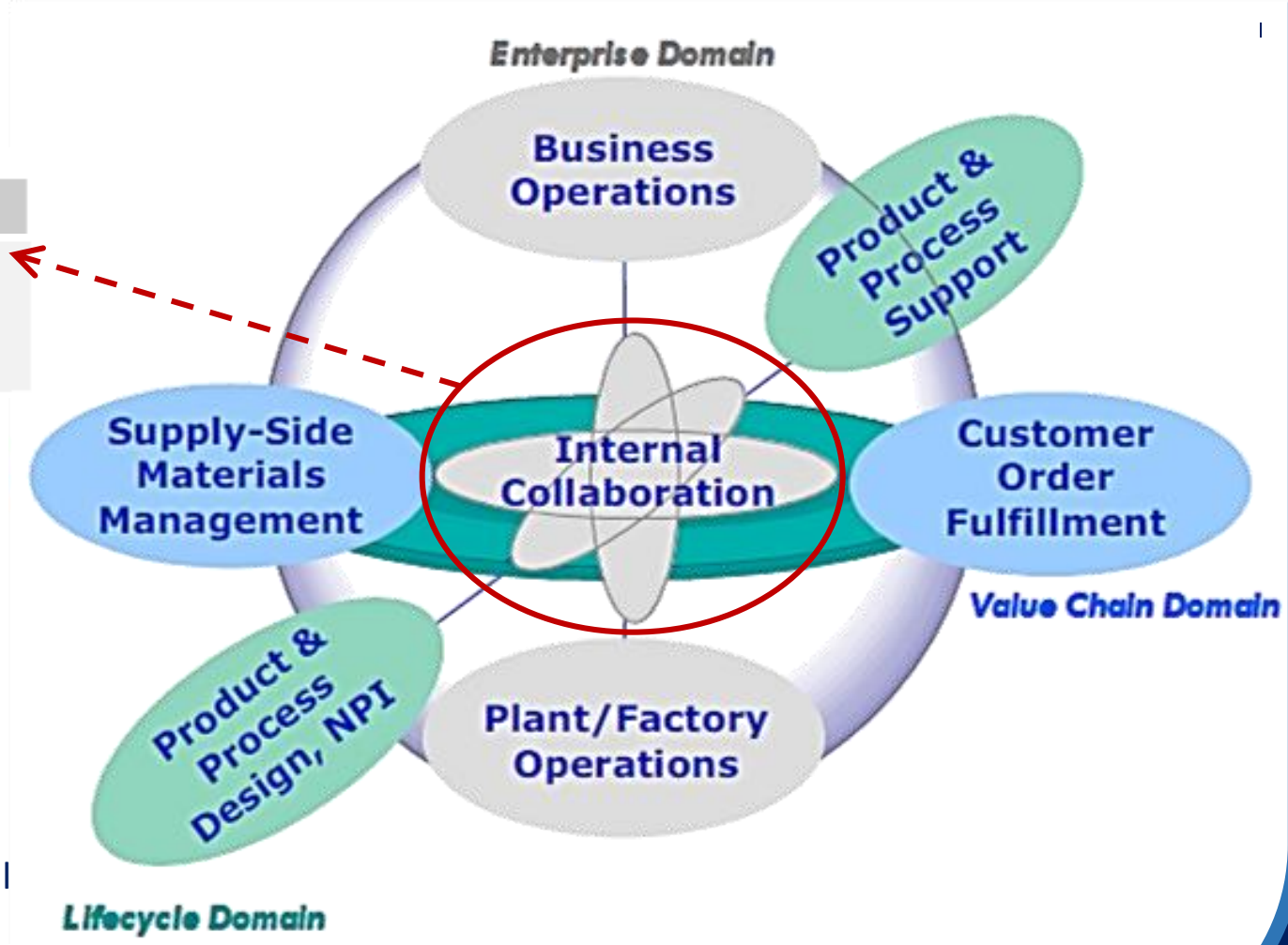
## 1.7 Internal collaboration

| Function | Typical Applications |
|---|---|
| Internal Collaboration | BPM, Enterprise Integration, Plant Data Services, Change Management, Document Management |

For internal collaboration, manufacturers should explicitly consider the interrelationships among each of the main functional areas.

Many approaches can systemizing internal collaboration requirements:

- ***Collect*** all the data in a single database
- ***Model the problem*** as an integration problem, and to then to identify, connect, move and transform all of the data as required
- ***Identify*** the business processes involved




(ARC, advisory group, 2002)

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# 1. CMM Model: Functional View

*Internal collaboration*


Collaborative manufacturing management based on functional view, ***control*** is a critical component of an effective collaborative manufacturing infrastructure.

Making the ***right information*** available, along with the appropriate management tools, throughout all levels of the organization, customers and suppliers, is also the key of effective collaboration.

**These reinforce, enhance and optimize business processes**

https://www.exoplatform.com/blog/2017/02/23/4-ways-to-improve-internal-communications-with-digital-collaboration/

(ARC, advisory group, 2002)

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# 2. CMM Model: Process view

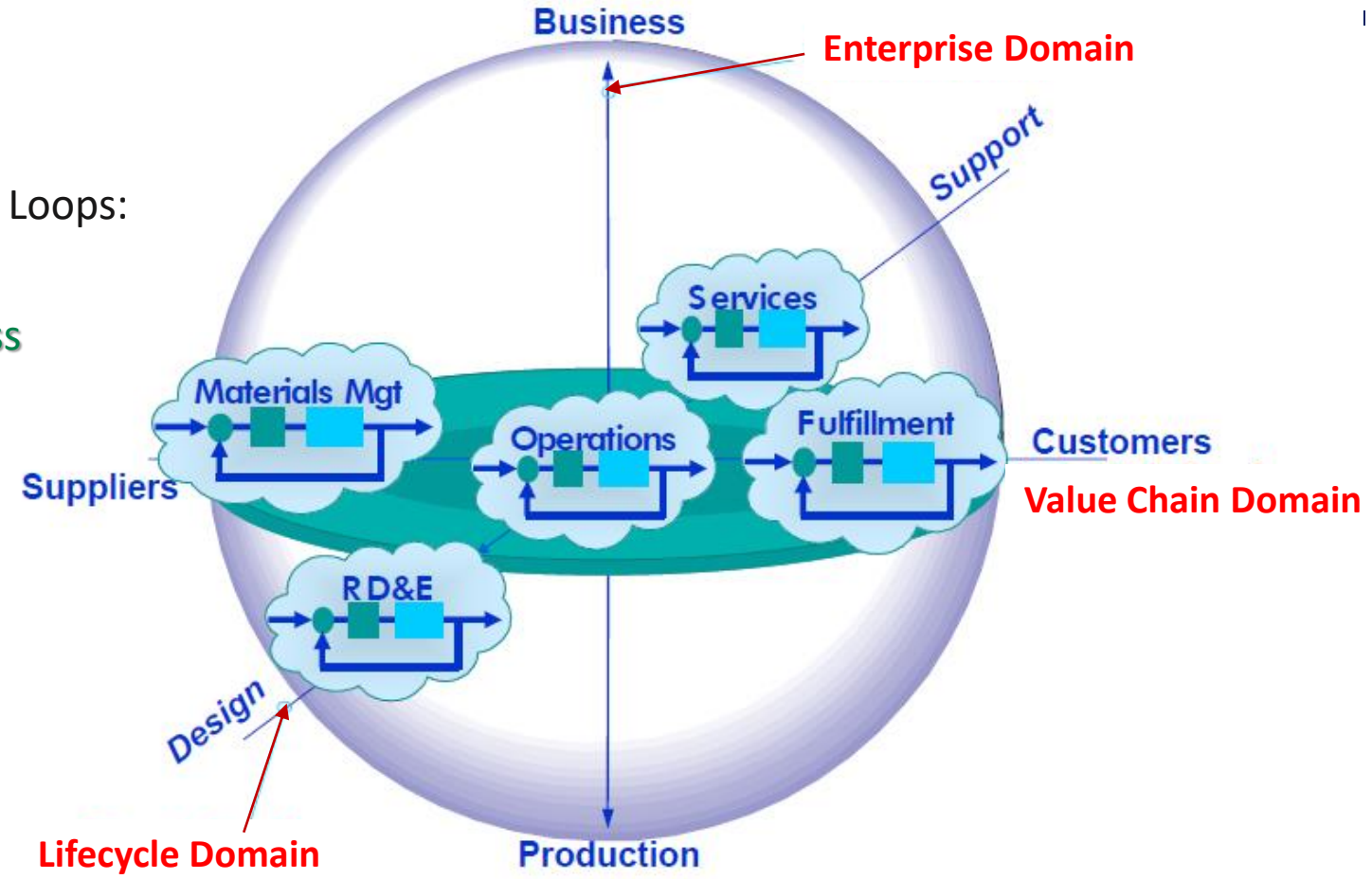
For any manufacture,

4 fundamental collaborative Business Process Loops:

- Customer, Order/Fullfillment Process
- Supply-side Materials Management Process
- Product/Process Design, NPI process
- Product/Process Support Process

must be Synchronize with Manufacturing and Business Operations

The ***infrastructure*** for CMM must support connectivity within the enterprise and among various sites, departments and locations




(ARC, advisory group, 2002)

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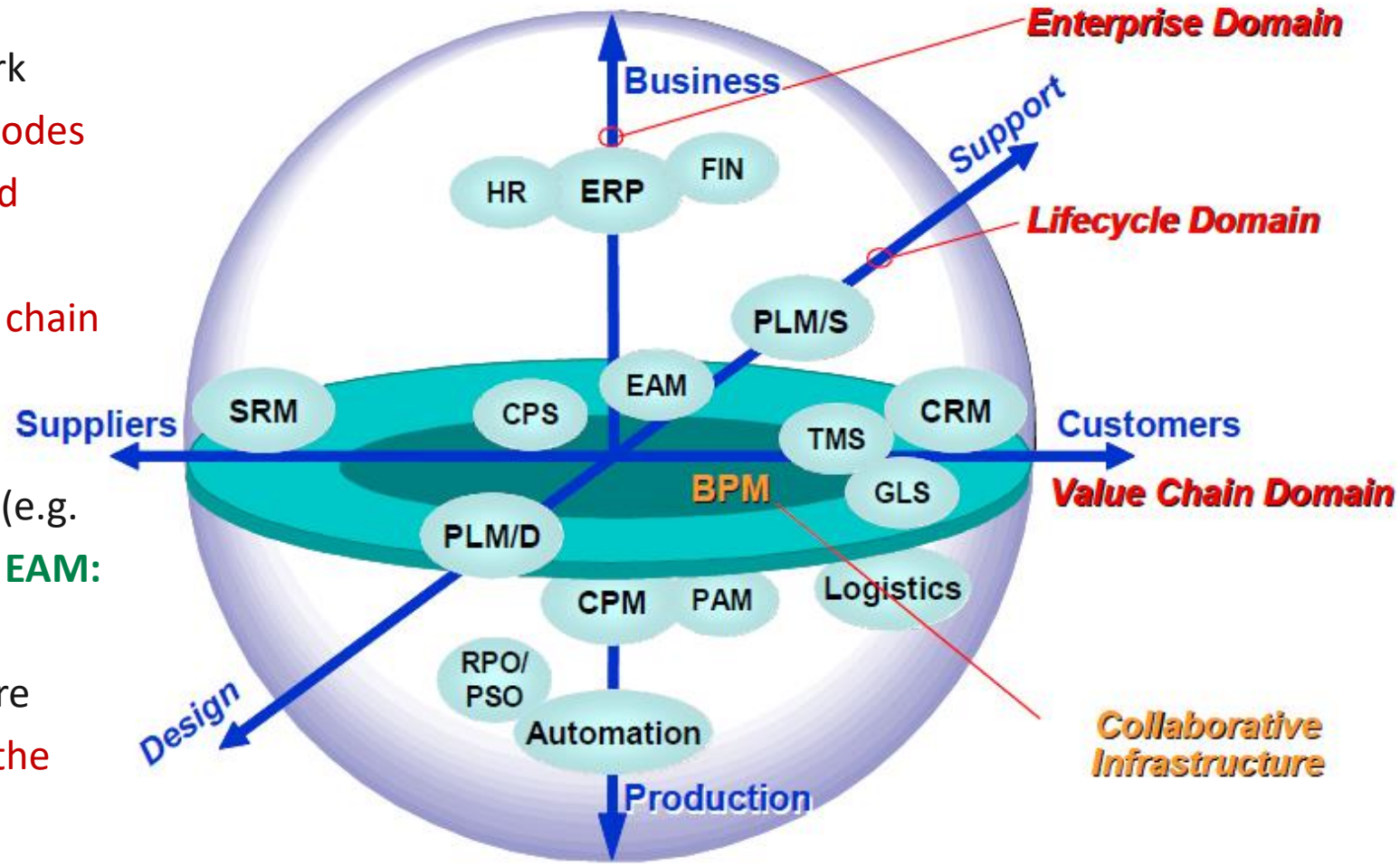
# 3. CMM model: Application view

***A collaborative manufacturing*** network consists of spheres or manufacturing nodes connected by material, information and process flows. The nodal sphere encompasses 3 axes: Enterprise, Value chain and Life cycle.

In the sphere, standalone applications (e.g. **CPM:** collaborative Production Mgmt., **EAM:** Enterprise Asset Mgmt. and **CPS:** collaborative Planning & Scheduling) are selected by manufacturers to support the system




(ARC, advisory group, 2002)

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# Collaborative Manufacturing Management: CMM

**CMM Architecture**

- Business Process
- Service-Based Architecture
- Network and Systems Infrastructure

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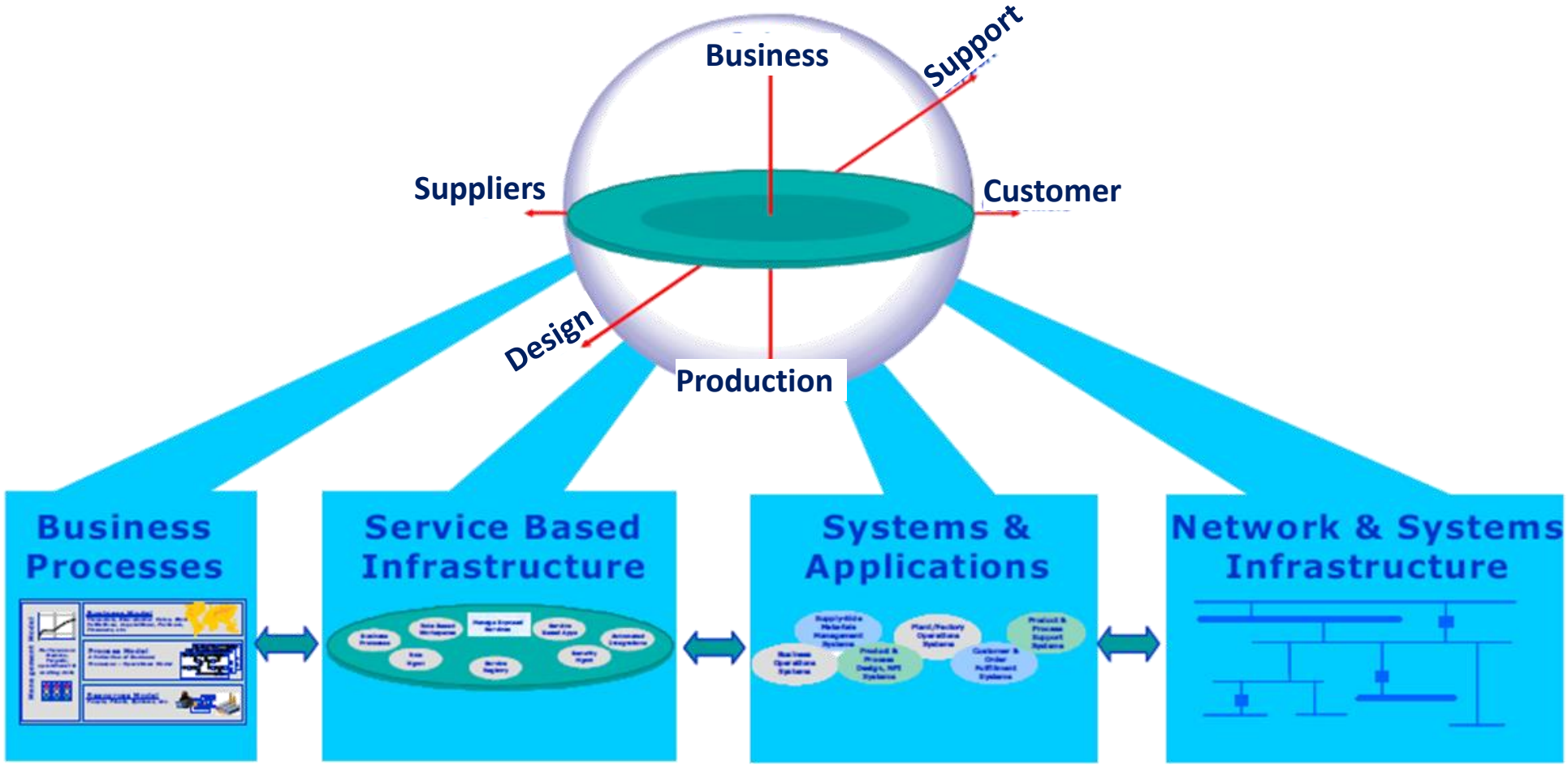
# CMM Architecture




(ARC, advisory group, 2002)

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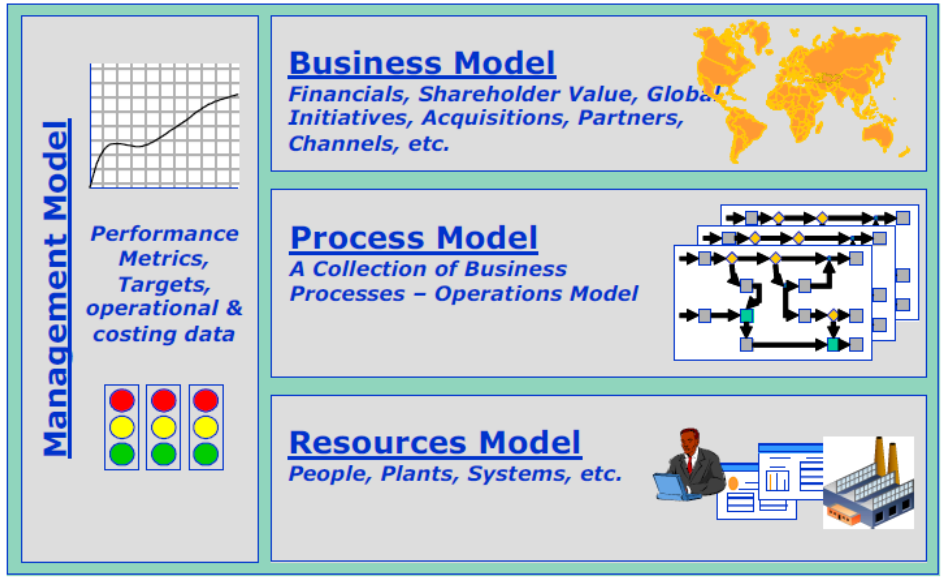
# CMM Architecture

## 1. Business process

- ***Business process*** depicts the *interplay of people*, processes, *systems*, organizations, *locations* and *business goals*.
- The business needs *drive and determine* the *software* and *infrastructure requirements*.




**Relationship of Management Business Process and Resources models**

- ***Business model*** *addresses* the core values, strategies and relationship of the enterprise.
- ***Process model*** *encourages* a fresh look at business processes and operations.
- ***Resources model*** *addresses* all of the resources which need to be place to operate effectively, supporting the process requirements.
- ***Management model*** *represents* control, performance metrics and leveraging of operating data to ensure optimal performance.

(ARC, advisory group, 2002)

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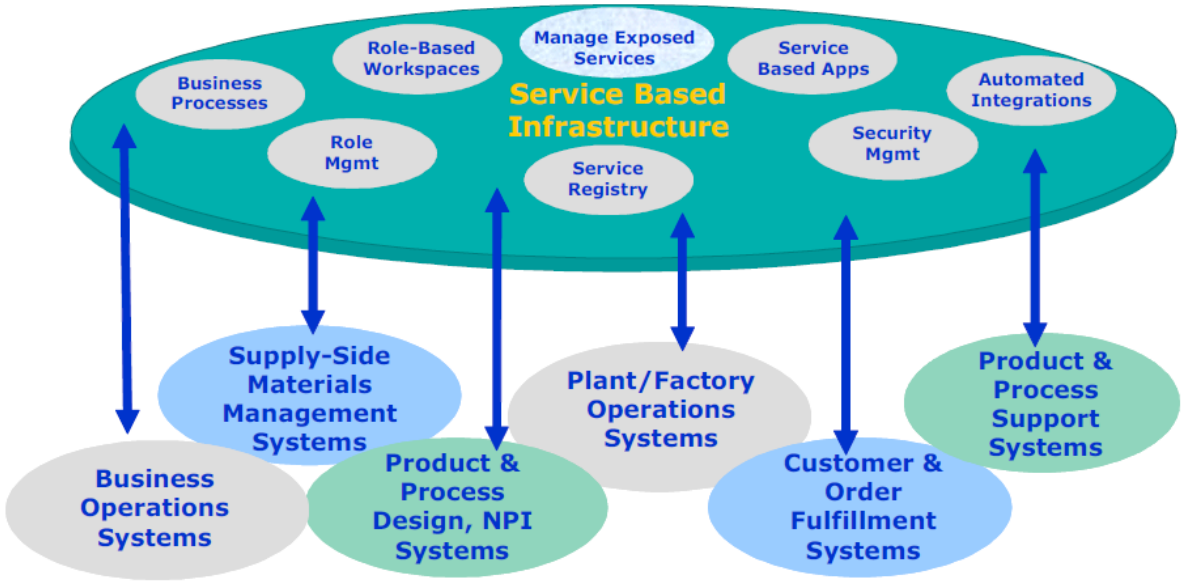
# CMM Architecture

## 2. Service-Based Infrastructure

- ***Service-Based Architectures*** are the norm of manufacturing and are at the heart of CMM
- ***Service-Based Infrastructure*** corresponds to the collaborative infrastructure.
- ***Service-Based Infrastructure*** provide 7 core functions to active service management;
  - Security management
  - Service registry
  - Role management
  - Role-Based workspaces
  - Service-based applications
  - Business process
  - Automated integration




(ARC, advisory group, 2002)

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# CMM Architecture

## 3. Systems and Applications

Currently, *systems and applications* are required to *connect to critical functionality* with existing application programming interfaces (APIs)

It is feasible to introduce business process management and service-based infrastructure and make improvement as needs and as opportunities arise.

(ARC, advisory group, 2002)

***Modern API*** has taken on some characteristics that make them extraordinarily valuable and useful:

- **Modern APIs** adhere to standards (typically HTTP and REST), that are *developer-friendly*, easily accessible and *understood broadly*
- **Modern APIs** are treated *more like products than code*. They are designed for consumption for *specific audiences* (e.g., mobile developers)
- **Modern APIs** have a much stronger discipline for security and governance, as well as monitored and managed for performance and scale.
- **Modern API** has its own *software development lifecycle (SDLC)* of designing, testing, building, managing, and versioning.

https://www.mulesoft.com/resources/api/what-is-an-api

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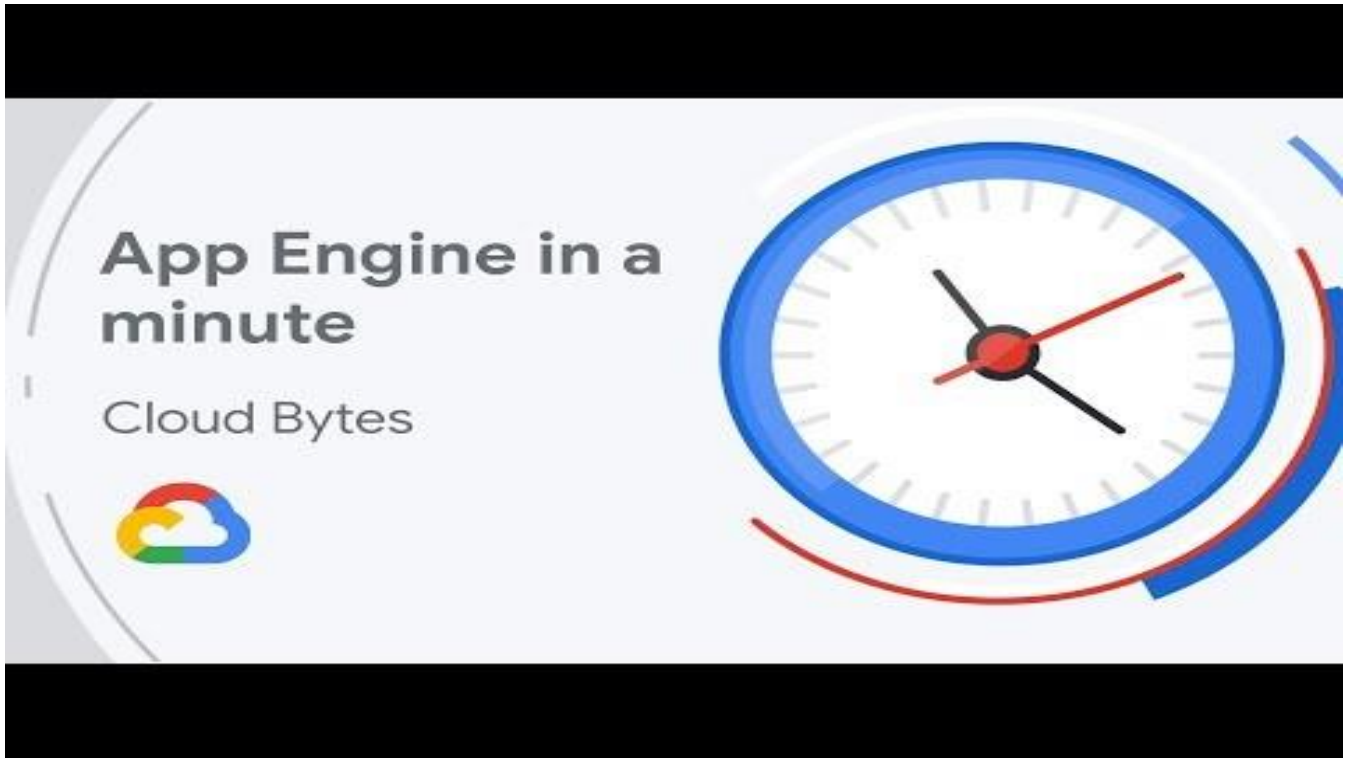
# App Engine:

**Build highly scalable applications on a fully managed serverless platform**




https://www.youtube.com/watch?v=Xuf3J6SKVV0&list=PLIivdWyY5sqIQ4_5PwyyXZVdsXr3wYhip&index=3&t=1s&ab_channel=GoogleCloudPlatform

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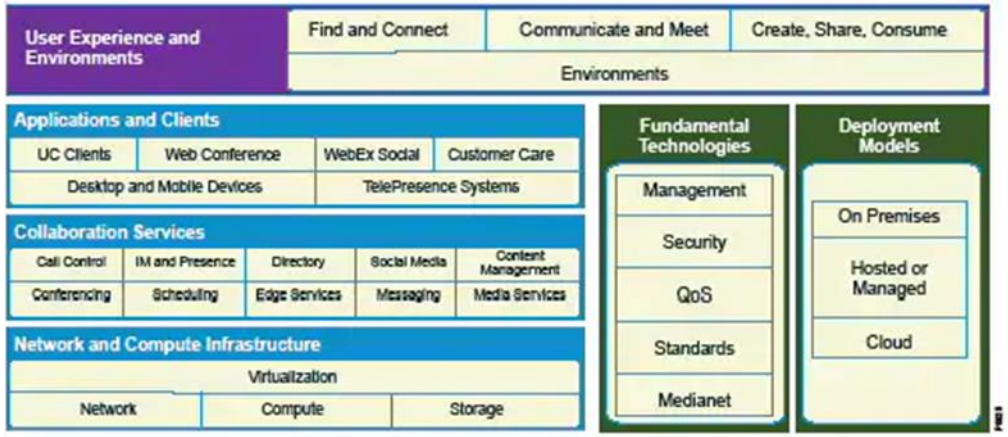
# CMM Architecture

## Cisco Collaboration Architecture




- ***Quality of Service (QoS)*** mechanisms available on Cisco switches and routers ensure that the voice, video, and data communications will be of the highest quality throughout the network.
- ***Cisco gateways*** provide a number of methods for connecting your enterprise's *internal network to an external wide area* network (WAN) as well as to the public switched telephone network (PSTN) and to legacy systems such as a PBX.

https://www.cisco.com/c/en/us/td/docs/voice_ip_comm/cucm/srnd/collab09/clb09/intro.html

## 4. Network and Systems Infrastructure

**Network and Systems Infrastructure** encompasses the *internet, enterprise and plant network,* communication infrastructure, computing platforms and plat equipment for deploying systems in support of the process model requirements.

These systems are *necessarily complex* and *need to be robust enough* to *support the increasing real-time nature* of business process throughout the ***extended enterprise.***

(ARC, advisory group, 2002)

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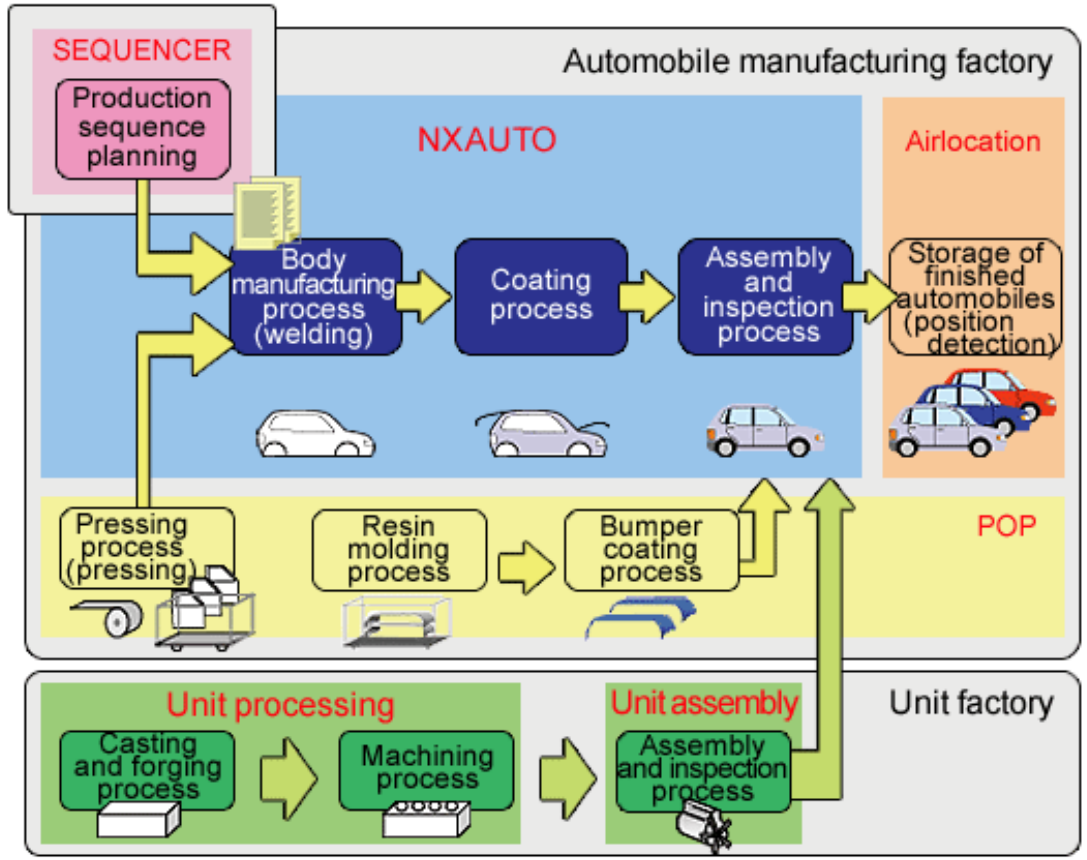
# Activity: CASE BASED LEARNING

For automobile manufacturing process as shown in figure, discuss

- *How to collaborate between manufacturing processes?*
- *Identify a value network for collaborative manufacturing*




Source: https://www.hitachi.com/businesses/infrastructure/product_site/car/index.html

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# Key references


- ARC Advisory group, 2001, Collaborative Manufacturing Management Strategies, ARCweb.com, pp.1-28
- ARC Advisory group, 2002, Collaborative Manufacturing Management Strategies, ARCweb.com, pp.1-28
- McClellan M., 2003. Collaborative manufacturing: A strategy built on trust and cooperation, ǁ Control Solution International, vol. 12, pp. 27-31


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