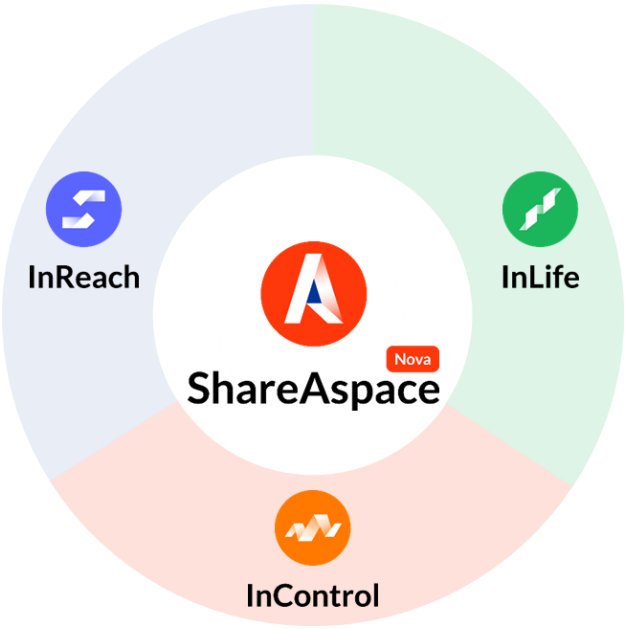
*Eurostep Group...for secure, through-life, product-centric collaboration*




# Enabling effective collaborative working for agile business

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| **Author** | **Rob Bodington** |
| **ID/Version:** | ESASSET-653379345-2 |

**Eurostep Group**
Email: info@eurostep.com
URL: www.eurostep.com

## Summary

The design and introduction to market of a complex product typically involves collaboration and the consequent sharing of engineering information across an extended enterprise involving a multitude of engineering disciplines and organizations throughout the product's life.

This collaboration and sharing includes information such as product requirements, CAD, bill of materials, manufacturing instructions for collaborative product design, information for the outsourcing of the design and build, information for manufacturing and information about equipment and standard parts suppliers.

The timely and accurate sharing of this information is critical to the rapid delivery of a high quality product to market. However, achieving effective data sharing is challenging. The necessary data is managed by a variety of systems across the extended enterprise. The data is often replicated and sometimes contradictory. Security, protection of Intellectual Property and export controls are paramount.

To overcome the challenges, organizations have applied a set of common tools, CAD, PDM, ERP etc. to the enterprise. Enforcing this requires tight coupling of the enterprise's processes and infrastructure with obvious cost implications for the enterprise and efficiency considerations for partners in the enterprise who will be working in other enterprises. Consequently, organizations often use basic file exchanges to share data, often using data exchange standards such as ISO STEP / Product Life Cycle Support (PLCS). However, file exchange also requires rigorous processes to ensure data integrity and quality are preserved as the data is propagated and replicated throughout the enterprise and the supply chain.

This whitepaper discusses the challenges in sharing data and the different business relationships in which information is to be shared. The paper outlines a data sharing approach based on a standards (PLCS) based collaboration hub, the ShareAspace suite of products, that overcome a number of the issues associated with file exchange. The ShareAspace products include InReach that focuses on supporting the sharing of the product data in the design and manufacturing stages of the life cycle across the extended enterprise, InLife that focuses on the in service phase of the product's life-cycle and InControl that focuses on system to system integration sharing of data across the product life cycle, across systems and beyond a single enterprise.

This paper focuses on the InReach product - an end user application for managing engineering collaboration and data sharing. It is designed to be flexible and to support the variety of different collaboration patterns used by organizations. Hence the product provides a set of configurable templates that encode best practice for managing engineering collaboration. This includes templates that define:

- Default types of organization, user roles, and permissions;
- Product data types e.g. Parts + properties, assemblies, documents + properties;
- Structures for managing and coordinating the collaborations.

The InReach product enables organizations to rapidly share data in a managed and controlled way.

## Contents

## The business need

The design and manufacturing of a product involves collaboration and information sharing both externally across an extended enterprise, with suppliers, partners, manufacturers, customers and internally across different departments and disciplines. The information to be shared includes documents, commercial data such as contracts, orders as well as product data such as product requirements, bill of materials, part information, CAD files, analysis results and so on.

Those involved need to act effectively, working together with access to a common, consistent and comprehensive information set that specifies and defines the new product, irrespective of organizational boundaries and their IT applications. Effective collaborative working includes the ability to set up fast whilst maintaining continued access to existing processes and tools and keeping control over the information made available to others.

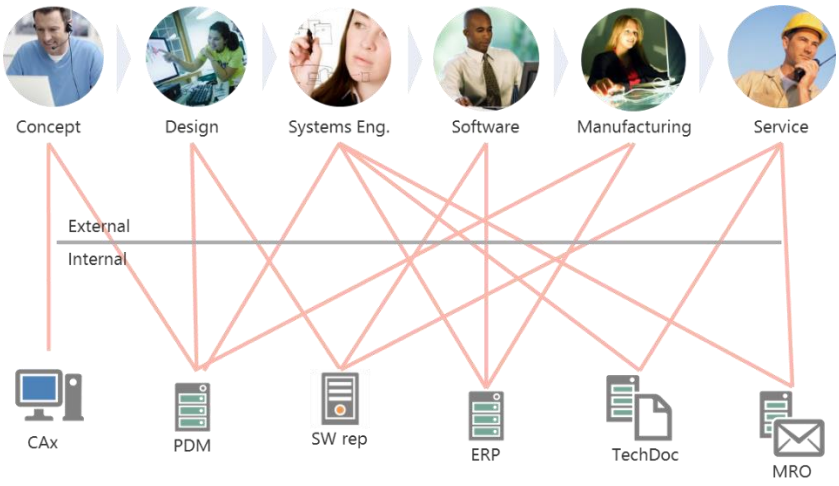



**Figure 1 Product sharing across the enterprise, across the life cycle**

The challenge is that the product information is typically distributed across the extended enterprise and is managed by a multitude of IT systems that are potentially owned and operated by different organizations and supporting different aspects of the product's lifecycle.

## Data sharing approaches

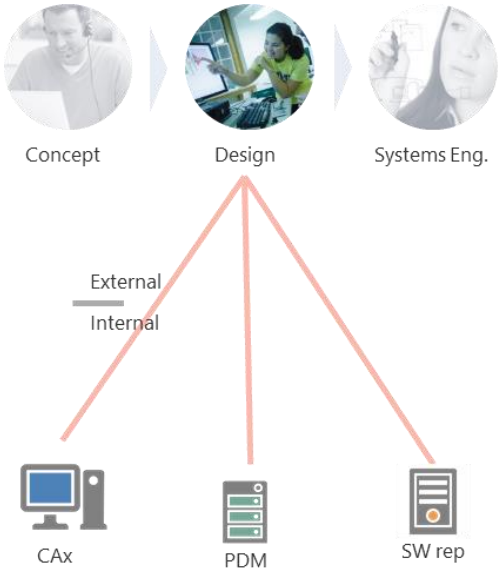
Organizations employ a variety of methods to share product data across an extended enterprise, from exchange of file based data packs, through to fully managed collaborative data sharing.

The different methods adopted are dependent on the maturity and nature of the business relationships and the maturity of the information management capabilities of the organizations, as well as the accepted practice within an industry.

### Common tools

At one level Original Equipment Manufacturers (OEM) may mandate that all suppliers work within the OEM's environment. For example, all suppliers have access to and use the OEM's PLM system and associated tools. At first glance this is the optimal approach. However, the OEM will have to ensure that adequate provisions are

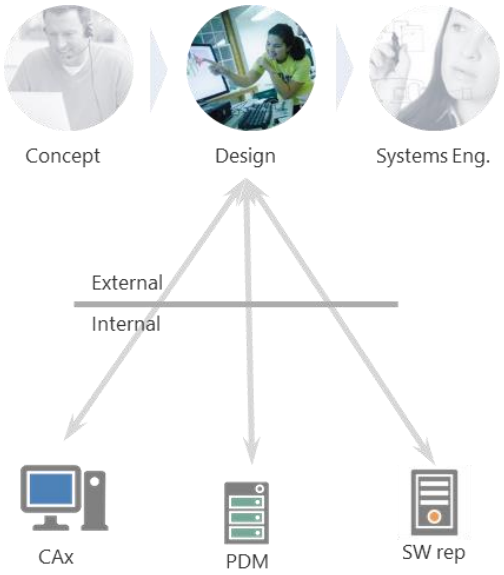
made to protect the Intellectual Property (IP) of all the enterprise. For example, it is inevitable that some suppliers will be competitors and hence would not want their IP shared with a competitor. Equally, the OEM may not wish the supplier to access all of the product design. In addition to the IP protection, there are often export control considerations. Some of the product data may be subject to ITAR and similar restrictions. Unless the OEM's PLM environment has been set up to meet these requirements at the outset, accommodating them may be challenging.




Apart from the obvious cost to the OEM of accommodating all their suppliers, and the time taken to establish secure external access to the systems, there is a cost to the supplier who is likely to supply multiple OEMs. The supplier will have to support multiple OEM environments and work within a process dictated by each OEM. Together this becomes sub optimal both in terms of costs and efficiency.

## Transactional File exchange

Consequently, a common method used to share product information is for organizations to use their own tool suites and export files from one system for loading into another at their partner. Using international data exchange standards, such as STEP and PLCS reduces the number of system translators required and improves the interoperability between systems.



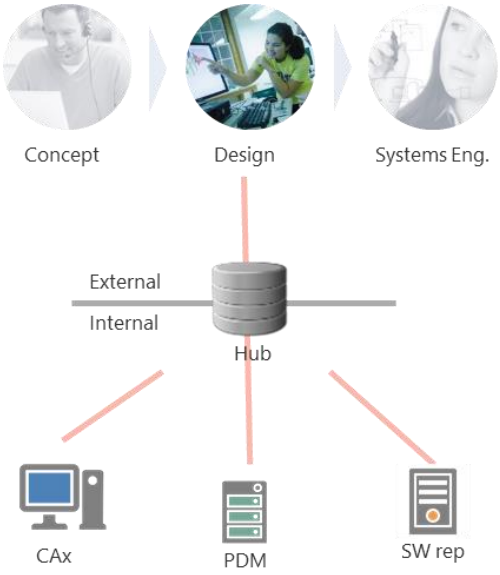

The benefit of the file exchange approach is that data ownership can be kept since all data is received and can be incorporated in to in-house systems without allowing external access to those systems.

There are however a number of challenges with this approach. The data to be shared is likely to reside in a variety of different systems, such as PLM systems, ERP systems, CAD tools, project planning tools. The data will need to be consolidated into a coherent set before being exported. This frequently reveals that data is duplicated in the source systems and in some cases is contradictory. A further challenge is placed on the system receiving the data which will need to consolidate the incoming data with their existing data. Consideration also needs to be given to the data's provenance and whether the receiving system is managing the master data record. In other words, when should imported data override existing data? It may also be that the receiving system covers a different information scope, hence not all data can be imported. The quality of the data being imported has to be considered. It is good practice, and in highly regulated industries such as Aerospace and Nuclear industries essential, that the exchange process is managed and accurate audit trails of data exchanges across enterprises are maintained. This needs to go beyond simply tracking the data files and their content and reflect the provenance of content. Where did the data come from, when was it changed? All of these challenges place

additional requirements on the sending and receiving systems, requirements that they may not have been designed to accommodate.

## Hub based data sharing platform

Given the challenges of file based exchanges, a better approach is to deploy a hub, or data sharing platform. This sets up a neutral product data hub between the various organizations within the extended enterprise.




This approach acknowledges the fact the data is going to be created and consumed in different systems, in different structures and through different processes which will not necessarily be harmonized with each other. So instead of trying to establish a common set of processes which would affect cost, time and probably quality, a neutral place is created where the different data structures and processes can interact, be shared and exchanged. The key to enabler for this is that the hub consolidates the product data from multiple sources into coherent data set rather than simply managing the exported files. For example, an OEM may export the upper level product structure and a design partner provide the detailed assembly. Consolidation in the hub will integrate the two structures into a coherent set as shown in Figure 2. Another example is where an ERP system exports asset information including serial number and part number, and the PDM system exports the design information about the part. Consolidation will reconcile on the part, meaning that design and asset information are integrated.

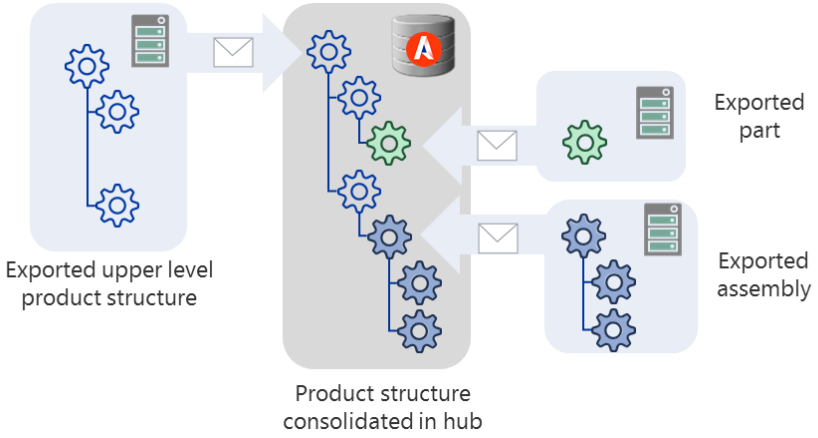



**Figure 2 Data consolidation**

Given that the product information needs to be shared throughout the product's life, from initial concept, through to design, manufacturing, operation and disposal, it essential for the hub to have a rich, flexible underlying data model that covers this scope. One model that meets this need is the Product Life Cycle Support (PLCS) ISO 10303-239 model.

One such product data hub is the ShareAspace suite of products (see Figure 3). These are based on PLCS and address data sharing across the life cycle of a product. The InReach product focuses on supporting the sharing of the product data in the design and manufacturing stages of the life cycle across the extended enterprise. The InLife product focuses on the in service phase of the product's life-cycle. The InControl product focuses on integrating and sharing data across the life cycle within an enterprise. This whitepaper focuses on the InReach product.

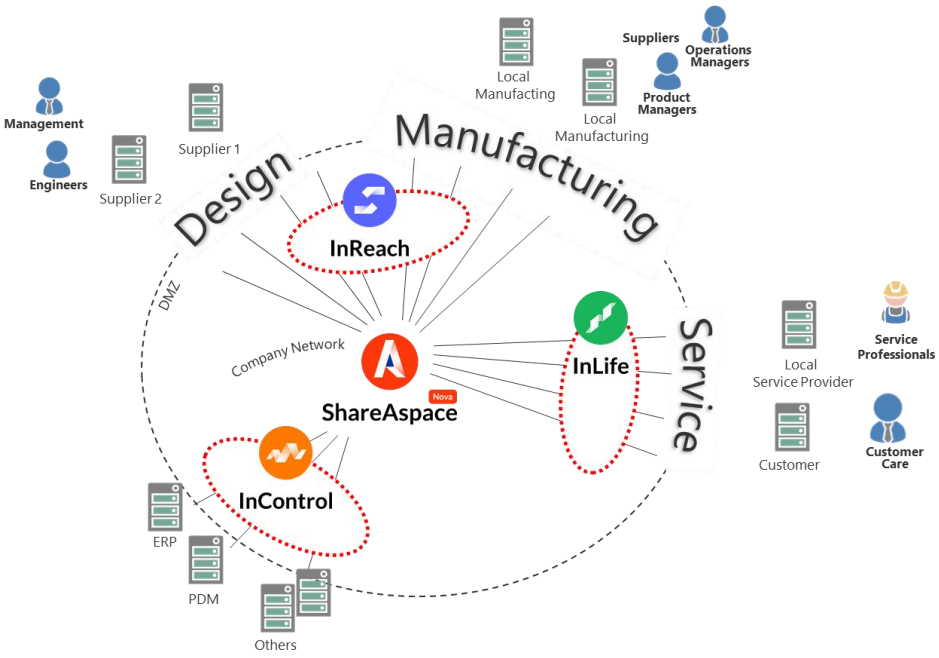



Figure 3 ShareAspace product suite

Using a PLCS based hub, such as ShareAspace, as the focal point of data sharing within an enterprise offers significant advantages.

**Information coherence**
The hub can integrate information from across the lifecycle of one or more products and manage relationships that are outside the scope of source systems, providing a coherent view of the product data.

**Single source of data**
The hub offers a common infrastructure to integrate the data regardless of its origin, making it useable in other processes. The hub provides the single point of access for the data to be shared.

**Enterprise wide Master Data Management**
The hub does not replace the systems authoring the data: the ERP, PDM, CAD systems, etc. Instead it explicitly manages the provenance of the data, i.e. where the data came from, and enforces data primacy. In other words, each element of product data can be "owned" by an authoring system and can only be changed if the data is changed in that system.

**Traceable / Auditable**
The management of product data primacy, the origin of the data, means that the hub provides an explicit audit trail of data sources from throughout the extended enterprises. This is critical in regulated environments.

**Managed access**
Protection of Intellectual property is essential when using a hub to share data. Hence the hub ensures that only those who should be able to access the product data can do so.

**Timeliness**
Once data is loaded to the hub, it is immediately available to all with appropriate rights, potentially across the tiers in the extended enterprise.

**Synchronization**
The hub will synchronise with both people and systems in the extended enterprise. When data is loaded, users can be notified. It may also be the case that the data is destined for an authoring system and can be automatically forwarded for import.

**Security**
The hub approach decouples the in-house systems from the extended enterprise. The hub can be subject to different security regimes to the in-house systems. It can be hosted on a separate network for example. Furthermore, the hub acts as a staging post for data in the extended enterprise, enabling the data to be validated before importing into in house systems.

**Obsolescence management**
The provision of a hub means that the data sharing is in effect decoupled from the systems. The source systems can be replaced without affecting the sharing of data throughout the enterprise.

The Hub based approach, in combination with the transactional file approach, provides secure, auditable, timely data sharing across the extended enterprise.

## Business collaborations

Different organizations typically require different styles of product data collaboration throughout the life-cycle of a product. This is dependent on the nature of the relationship between the collaborating organizations and the life-cycle stage of the product around which the collaboration takes place.  Examples of typical business relationships that are supported by InReach's product data collaboration facilities are:

- Collaborative Design;
- Design and Build;
- Build to print / Manufacture to plan;
- Equipment supplier;
- Standard part supplier.

Each of these summarized in the following sections.

### Collaborative Design

The design of many aerospace and automotive products is typically no longer undertaken by a single design organization. Design partners are engaged to collaborate in the design of the product. Frequently, the partners are competitive organizations that are collaborating on the design project. In other cases, the design may be outsourced to a design house with the Intellectual Property (IP) and the legal and commercial responsibility for the design, the design authority, being retained by the OEM.

The partners collaborate on the design of a product, which is then manufactured, or in the case of a service, delivered.

Such business arrangements require the sharing of product requirements, specifications and designs, including CAD models, simulations and analysis results, as they develop. Business processes will be put in place to ensure approval of the evolving design by the design owner (design authority) and to provide an audit trail for product certification.

The product data collaboration platform needs to ensure that the Intellectual Property of the product data being shared is respected, as well as any applicable export controls that may be in place. Only those who should be able to access the product data can access the product data.

## Design and build

In some instances, a design partner is also responsible for the manufacture of the product that they are designing.

Such business arrangements require the sharing of product data between design and manufacturing, such as bill of materials, part lists, CAD models and manufacturing instructions.

Business processes will be necessary to manage the propagation of design changes through to manufacturing and to manage when each change is implemented in the production runs, i.e. manage consequent product effectivity. As well as managing the flow of information from design to manufacturing, the product data collaboration platform needs to manage the flow of information in the other direction, from manufacturing to design. Manufacturing should be able to provide input to the manufacturability of the design, the production plans, costs, etc. Processes and information flows are necessary for the manufacturing organizations to raise waivers and report defects back to the design authorities for proposed changes or for approval.

## Build to print / Manufacture to plan

Increasingly, manufacturing is being "outsourced" or "off shored". The organization responsible for the design contracts a manufacturing organization to manufacture the product according to the design owner's specification. The intellectual property, the design, remains the property of the design owner.

The information shared is similar to the design and build relationship. The critical difference is that the manufacturing organization is likely to be a separate organization to the design organization. Consequently, the information for manufacturing needs to be bounded as the manufacturing organization is unlikely to have free access to all the design information.

As with the design and build case, information coming back from manufacturing will need to be controlled in order to manage the flow of change, approval and waiver/defect information.

## Equipment supplier

In any complex product there are likely to be equipment or sub systems, such as an entertainment system or radar system, which is either bought off the shelf or procured according to a set of design requirements. The Intellectual Property, including the design of the equipment, is retained by the equipment supplier. In some cases, the system integrator rebrands the equipment and provides the aftermarket support for it.

The system integrator will need to provide requirements to the equipment supplier who in turn will need to provide sufficient information about the equipment to the system integrator so that it can be incorporated into the product's design, manufacture, and through life support.

### Standard part supplier

Design and manufacturing organizations typically maintain libraries of standard parts that are used in a variety of different end products. Examples are Bolts, fasteners, rivets, circuit board connectors. These are parts or materials that conform to an established industry design and production specification and may be supplied and manufactured by multiple organizations.

Typically, the Intellectual Property and design authority is owned by the provider of the part. The part is then bought in and used.

Hence the product data collaboration platform needs to allow standard part suppliers to provide catalogues of standard parts or details of individual standard parts that are then made available to the design and manufacture of assembled products.

## Collaboration management patterns

Regardless of the sharing approach adopted, the collaboration process needs to be managed and controlled. There are a number of different patterns or styles for achieving this, again dependent on the maturity and nature of both the business relationships and the information management capabilities of the organizations.

Consequently, InReach can be configured to cater for a wide range of collaboration patterns:

- Technical Data Pack collaboration;
- Assembly or Part based collaboration;
- Project based collaboration;
- Product structure based collaboration;
- Change based collaboration;
- Configuration change based collaboration.
- Enterprise collaboration coordination

These are detailed in the following sections.

People are central to any collaboration. They need access to the right product data which is achieved by using the collaboration patterns described. This access needs to be timely, so stakeholders need to be notified of any changes to the data so that they are using the latest data. This may be done formally through a change process, or by an informal collaboration process, by automated notifications of changes or a mixture of all approaches. Collaboration also involves discussion, hence there needs to a forum for the discussions and the ability to reference to the product data that is being discussed.

### Technical Data Pack collaboration

A typical data sharing pattern frequently used is for an organization to package up data, such as documents, CAD files, assembly structures, and parts lists into a single package, often referred to as a Technical Data Pack, that is then provided to another organization.

A Technical Data Pack can be assembled by the sending organization, and loaded into InReach for download by the recipient. This will require the sending organization to consolidate all the data required from multiple systems. A better approach is to load all the individual files into InReach where the different product data within the files, e.g. Bill Of Material, assembly structures, can be consolidated, then use InReach to select the content of the Technical Data Pack. This way InReach manages an explicit audit trail of the data sent and, importantly, the source of the data.

The use of Technical Data Pack can be combined with the other approaches to managing the collaboration process detailed below.

## Assembly or Part based collaboration

Assembly or Part based collaboration is the most basic form of collaboration in which two or more organizations collaborate around the design and manufacture of a part. Hence the collaboration is managed around the assembly or part. For example, an OEM identifies a Part that is to be designed and outsources the design to a supplier. The OEM grants access rights to the supplier who then details the design of the part or assembly.

The focus is on the part data and the coordination of changes is managed in an ad-hoc manner with relevant parties being automatically notified of changes. Any formal configuration change management processes are managed externally to the InReach collaboration platform.

## Project based collaboration

Project based collaboration treats the collaboration as a project and it is managed accordingly. A project is divided into work packages that are allocated to collaboration partners. The work packages reference the product data and associated documentation that is necessary to undertake the work.

The collaboration is coordinated via the managed work packages.

## Product structure based collaboration

Product structure based collaboration focuses the collaboration around an end product. Hence collaboration is managed through a project and an end product with the end product being decomposed into a product breakdown structure. The decomposition is according to the business rules of the OEM or "owner" of the end product. Examples of breakdowns used are decomposition of the product according to systems or decomposition into functional areas. Elements within the breakdown are then identified as collaboration points and have associated work packages that are allocated internally or to suppliers.

## Change based collaboration

Change based collaboration uses change management processes to manage the collaboration. Hence collaboration is coordinated via Change Cases, Change Proposals and Change Orders.

## Configuration change based collaboration

Configuration change based collaboration extends the product structure based collaboration by introducing configuration change management into the collaboration. As with the product structure based approach,

collaboration is managed through a project and an end product with the end product being decomposed into a product breakdown structure. The decomposition is according to the business rules of the OEM or "owner" of the end product.

Elements in the breakdown are then identified as Configuration Items. These are points in the product structure where the development of the design or the interaction with manufacturing is explicitly managed, effectivity controlled and subjected to change orders.

## Conclusion

There are many ways to collaborate. The InReach product is an end user application for product data collaboration. It is designed to be flexible and to support the variety of different collaboration patterns used by organizations. Hence the product provides a set of configurable templates that set up the collaboration space. The templates define:

- Default types of organization, user roles, and permissions;
- Product data types e.g. Parts + properties, assemblies, documents + properties;
- Structures for managing and coordinating the collaborations.

The product encodes best practice for managing engineering collaboration.

For more information see: http://www.eurostep.com/products.