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STEP: Productivity For Industry

Abstract:

This document describes how to achieve industrial benefits from the STEP standardisation process.

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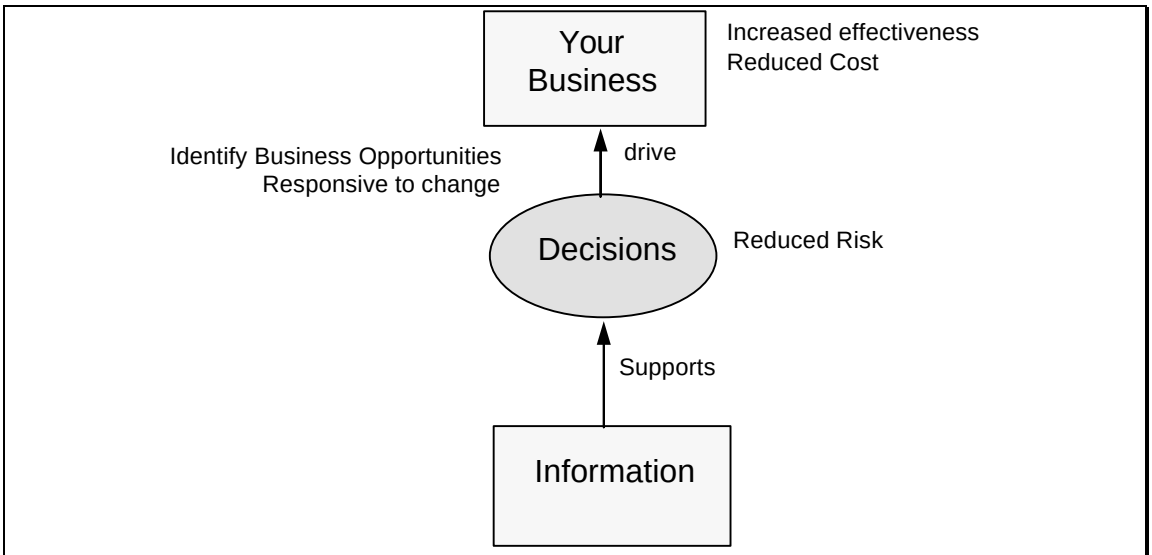
1. Introduction

To perform well, you need the resources to do the job. These resources include people, money, materials ... and information.



How information adds value to business

Information is involved in every business activity. Indeed, information is sometimes the only or main output of an activity. For instance, product design is conducted solely to create the information to be able to manufacture a product. The value of information comes from its use in contributing to sound decisions. If you can't rely on your information then the result can be missed opportunities, or higher costs.

	Image	Symbolic	Syntactic	Semantic
Meaning	In the Content →			In the Structure
Example	Bit Map Ink on Paper	Characters Vector Graphics	Hypertext Linked Files	"Intelligent" CAD
Computer Support	Touch Up	Spell Check Scale Drawing	Human Navigable Links	Computer Navigable Links
Standards	FAX TIFF	ASCII CGM DXF	OLE CDA SGML	STEP POSC

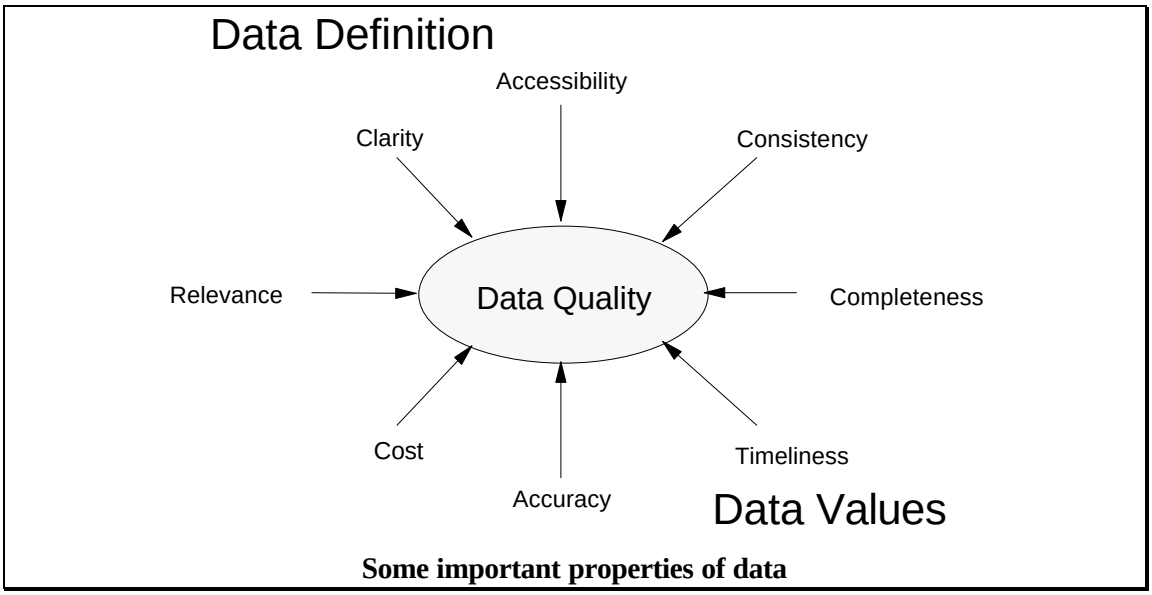
The changing shape of information

The way that we hold and manage information has been changing in recent years. Twenty years ago almost all our information was held on paper. Today most of it is held electronically either as electronic documents, or as data in databases. Even here the trend is to hold information as data because this enables increased computer support, for example "intelligent" P&ID packages. The intelligence comes because having information in a structured form means the computer can have knowledge of what the information is about, and can therefore act to support the user based on that knowledge.

"Quality is meeting agreed customer requirements"

Almost every business activity results in new data being created. The use of this data is not restricted to the activity that creates it; often it is used in other activities. The requirements for the quality of the data may be different for the activity creating the data, and for other activities that use

it. Therefore, the requirements for data need to be agreed between its suppliers and customers. The suppliers of the data are responsible for meeting the agreed requirements.



Some important properties of data

Some important properties of data for which requirements may need to be agreed are:

definition related properties

relevance: the usefulness of the data in the context of your business.

clarity: the availability of a clear and shared definition for the data.

consistency: the compatibility of the same type of data from different sources.

content related properties

completeness: how much of the required data is available.

timeliness: the availability of data at the time required and how up to date that data is.

accuracy: how close to the truth the data is.

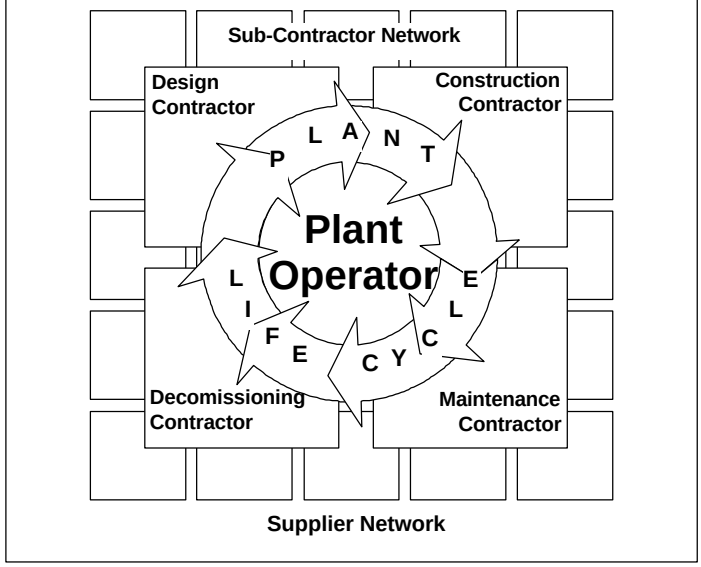
finally related to both are:

accessibility: where, how, and to whom the data is available or not available (e.g. security).

cost: the cost incurred in obtaining the data, and making it available for use.

The need to exchange information between organisations and to manage it for the life of a product, in our case with process plant perhaps for 30-40 years, means that we need standards so that data has the same meaning in different organisations and systems. This means addressing the properties related to the definition of data. STEP is a standard that aims to do this for engineering data.

2. The Current Situation In The Process Industries



Managing information throughout the life of a process plant

Today we manage engineering information using mixed technologies that are only integrated manually.

2.1. Design

There are many design and flow sheeting programs around. On the whole these are independent islands of automation with any data sharing between them being done manually, i.e. by re-keying information. Results are held in files and reports, rather than in databases.

It is only in the last fifteen or so years that CAD (Computer Aided Design) systems have been in existence, and only the last ten years that they have been widely used, so except for new sites, most of our P&IDs and data sheets are found and maintained on paper. Even where CAD systems have been used, the drawings and data sheets are not generally integrated (so called "intelligent" CAD).

Example: Breakdown of Design Time within a Contracting Firm

The design project time within a contracting firm can be split up as:

- Approximately a third is involved in management and overheads
- Approximately two thirds is involve in the design of the process.

Within the design process, approximately three quarters is doing 'value added' activities (i.e. doing the design process). The remaining quarter of this time is used in 'non-value added activities' (i.e. re-keying the data into computer format, forming the relationship, etc.)

3D plant layout drawings suffer in the same way as P&IDs, except that the advent of 3D CAD systems is more recent than P&ID CAD systems. Again, even where CAD systems are used there is generally no link to the equipment data sheets.

Maintaining the drawings has proven a problem as enhancements to plant take place. This generally results in creating a set of "as built" drawings of the part of the plant being modified as the first step in the design process because of the difficulty and expense of keeping plant drawings up to date. In the end this just adds to the drawing maintenance problem. This can easily lead to error.

In this environment, the cost of finding or (re)acquiring the information needed has been shown to cost about 30% of professional engineers' time.

The cost of the handover of drawings at the end of a project is significant. Usually the drawings have to be converted to a "dumb" format like DXF, with the loss of the "intelligent" links to data sheets.

Example: Data Handover at the end of the Design Project

In the past, the systems used in a particular contracting firm were three 2D systems and one 3D system. 'In house' interfaces between the 2D and 3D systems were made. However, only 2D data was handed back to the client at the end of a project. DXF became the common de facto standard for 2D data at the handover.

Stand alone systems that use DXF cannot contain any intelligent information. To overcome this a DXF based system is used and home grown databases (SQL format), containing data (i.e. parts' information), interface into it. This allows information to be created in an 'intelligent' format.

At handover, work done by the contractor is converted into DXF for the client. The consequence of this is twofold:

1. Time and resources are committed to convert the information at handover. On one project they had one person employed full time during the conversion process, at a rate of 500 drawings per week.
2. The information that is converted does not contain all the relationships that were formed in the design stages (the relationships are stored on SQL and cannot be converted across due to the absence of a suitable data model). It is considered that 75% of the 'value' of the information is lost.

When we negotiate maintenance contracts we tend to forget about the information as "somebody else's problem". However, when the contract comes up for re-negotiation, the present holder has a significant advantage, because he has the engineering information in his format. He may not even be obliged to hand over the information except on paper. The result is that they have a structural cost advantage over their competitors, which enables them to put in a much higher bid than would otherwise be the case, and still win the contract.

2.2. Construction and Commissioning

Example 4: Commissioning for Brent Bravo Platform

The commissioning of the Brent Bravo Platform in the North Sea is currently underway. The budget for the commissioning of the Bravo, Charlie and Delta Platforms is US$ 60m, for the next three years. The breakdown of manpower for the checks on the platform is:

200,000 man-hours for construction checks

120,000 man-hours for commission checks

40,000 man-hours for dynamic checks.

An estimated 30-40% of the construction check man-hours could be saved if the checklist compilation could be automated. This equates to a saving of approximately 60,000-80,000 man-hours (translates to a saving of US$ 1.8-2.2m, or US$ 4.5-6m for the three platforms). This represents a 7.5%-10% saving across the commissioning budget for Bravo, Charlie and Delta.

Despite the designers' best efforts, there are inevitably changes to the design during construction. There are by now several sets of design documents in different hands, and keeping all these up to date in the middle of a shutdown is an impossible task, as a result confusion can arise and mistakes

can be made by implementing an out of date design. This can lead to errors and delay at a critical and expensive time.

Planning and control of activities for large projects is generally done using products like Artemis. However, these are not integrated with any of the other systems used such as design systems or maintenance systems.

2.3. Operations and Maintenance

Operations systems are now widespread for plant control and supervision, advanced control, scheduling, planning, and oil accounting. On the whole though, these systems are poorly integrated. Different coding systems for products can be found in each of these systems.

In addition there is no integration of these systems with design and maintenance systems. For example, you can't sit at the control panel looking at the trace for an instrument, and then call up the CAD drawing of that instrument (there may be a schematic as part of the control system, but it is an independent drawing from the design drawing). Similarly, you can't point to a pump in your control system, flag it as unserviceable, and generate a maintenance request.

The lack of integration in design and maintenance systems can mean that finding the information required about a piece of equipment that needs maintenance can take longer than it should, and that the information may not be reliable. Sometimes this leads to increased plant downtime.

Example 5: Consequences of the loss of Data Integrity

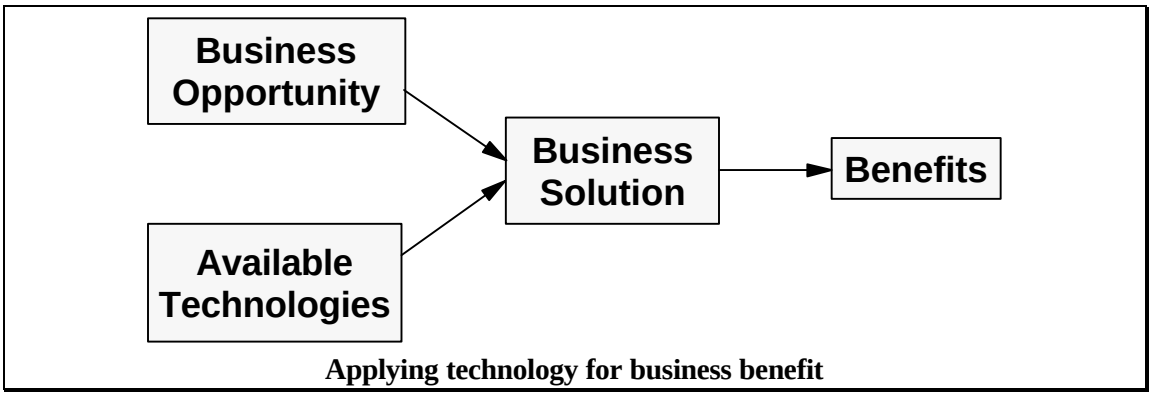
After a significant gas leak at a gas platform it was found that the drawings related to the incident did not reflect the physical position. An investigation found other areas of concern regarding current practice versus original design and operation. The result was a US$ 12+m exercise to confirm integrity and capital expenditure program to correct the difficulties found.

2.4. Decommissioning and Demolition

During the decommissioning process in particular, records need to be kept of waste produced. These may need to be kept for some considerable time, and so computer systems are often unsuitable because of their short life (relatively). As equipment is salvaged in the demolition process, so the equipment records need to be salvaged, so that the operating history is known when the equipment is reused. Finally, records about the ground status need to be kept - often for a very long time.

3. Productivity In Business

In this section I will outline some possible ways that STEP can help with the work that we do throughout the life of a plant, either to make it more efficient, or to enable new ways of working.



Applying technology for business benefit

First I would like to point out that a technology such as STEP does not produce benefits in isolation. If there is no business opportunity, there is no benefit. If there is a business opportunity, then there are usually a number of technologies that can be used to provide a business solution. The question is one of which technologies can give the benefits that are sought, and what are the relative costs of implementing that technology (do they justify the cost)?

As a result of this, it is not possible to talk about the benefits of STEP without talking about the impact it has on the way we do business and the costs of doing business.

A particular impact of STEP is that through standardisation of data it reduces the cost of managing engineering data dramatically, just as the Whitworth system of nut and bolt threads reduced the cost of making assemblies. This in turn changes the economics of a number of activities, making different ways of doing things worthwhile.

3.1. Design and Construction

The most important thing that STEP will do is reduce the cost of exchanging and managing engineering design data. It does this by providing a neutral definition and format for the exchange and sharing of drawings and associated technical data that means that organisations and systems can share and exchange data with minimum cost. The main result from this will be reduced time and cost in developing the project.

However, in addition it will take less effort to maintain up to date information about a plant, and most of the work to do so will be automated. One result from this is that if drawings and data sheets are kept up to date then when revamp projects come along it will no longer be necessary to develop a set of as-built drawings as the first step. This will save several weeks of elapsed time, and a considerable amount of money.

On completion of the design it will be possible to hand over the "intelligent" design information, together with the design history, to the plant operators and maintainers and to integrate the modifications with the existing information, so that a single up to date version of the plant information will exist.

It will be possible to include the provision from process licensors of standard designs for processes in a parameterised form for process simulation. This will mean that alternate processes can be compared and scaled in the process definition phase.

Finally, the standard will provide a basis for meeting contractual or legal requirements to hand over information about a plant.

3.2. Operation and Maintenance

STEP will facilitate the handover of project documentation to Operations and Maintenance, as a result project documentation would be integrated into the total plant documentation, rather than being an extension to it. Both Maintenance and Operations systems would be directly linked to the Drawings systems they share, ensuring both are using the same information, and that it is up to date. For Operations staff operating instructions for the plant are accessible from a plant drawing, as well as any special instructions related to the currently installed equipment.

For Maintenance staff, when Operations ask them to fix a particular facility, they will have immediate access to the piece of equipment currently installed, so that the equipment records and manufacturer's drawings can be made available. The isolation details for maintenance will be available, as well as the task and spares list required to do the job.

3.3. Demolition and Restoration

Even after a plant has been demolished it is increasingly important to keep records about it for regulatory reasons. We will have a standard way to archive information about where it was, about any soil contamination found, what the source of it was, and how this was dealt with.

3.4. The Information and Computing Potential

STEP will provide an infrastructure for data that will enable systems to exchange data, and eventually to share data concurrently. The result of this will be that the current crop of application packages that are monolithic in nature, but in reality do some things well, and others only indifferently, will be replaced by smaller applications that specialise in doing one thing well, and inter-operate with each other. In addition data repository systems will become available that hold your information and make it available to the applications. Together this will mean that your information is no longer locked in to a particular vendor's package, and you will be able to manage your engineering information independent of particular systems or hardware over the life of a plant.

As a result of the open data that STEP will enable, there will be freer competition amongst application vendors. This will lead both to reduced prices, and increased quality of software, as well as new software that will meet specialist needs which the larger market creates.

3.5. What Does It Take?

So what are the elements that are required to make STEP a reality and produce benefits for your business?

Awareness

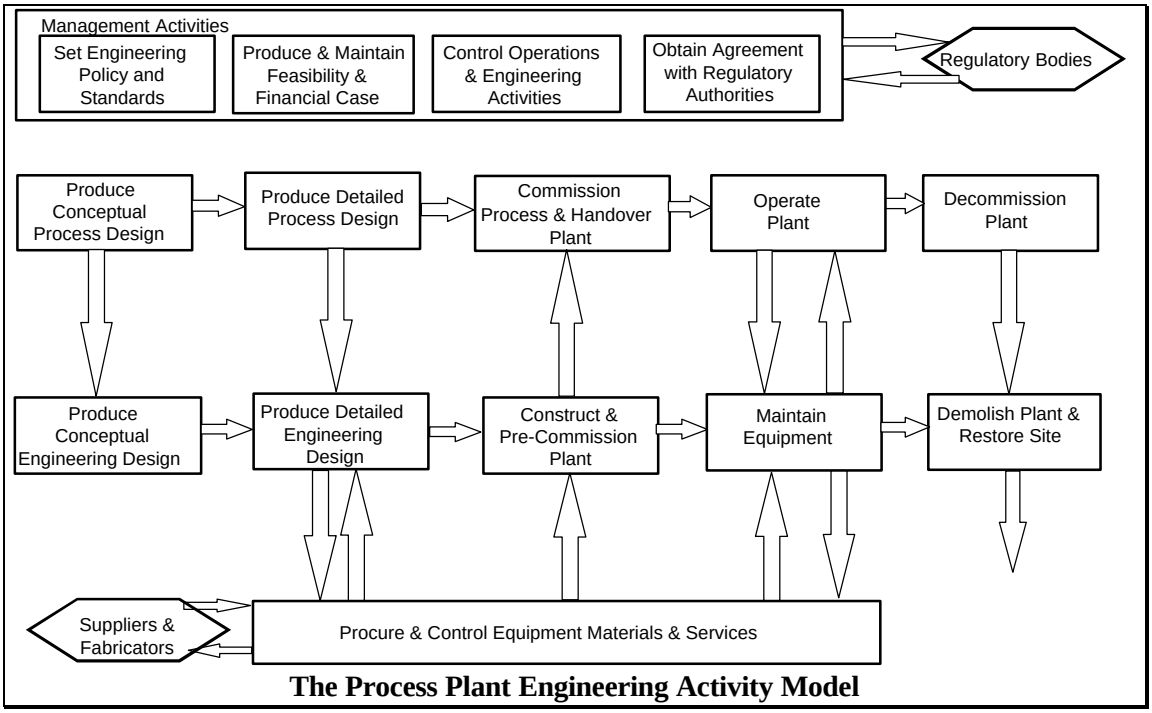
Your industry needs to be aware of the potential benefits that working together more closely and efficiently can bring through the efficient and effective sharing and exchange of information, both within companies and between companies. The gap between present reality and what is realistically possible needs to be understood, and as a result a sense of dissatisfaction with the current situation needs to be aroused.

This bit is surprisingly difficult, because we have to sit back and look at what we do and see it in a different way. However, it is cheap.

Identify Your Requirements and Priorities

Where does it hurt?

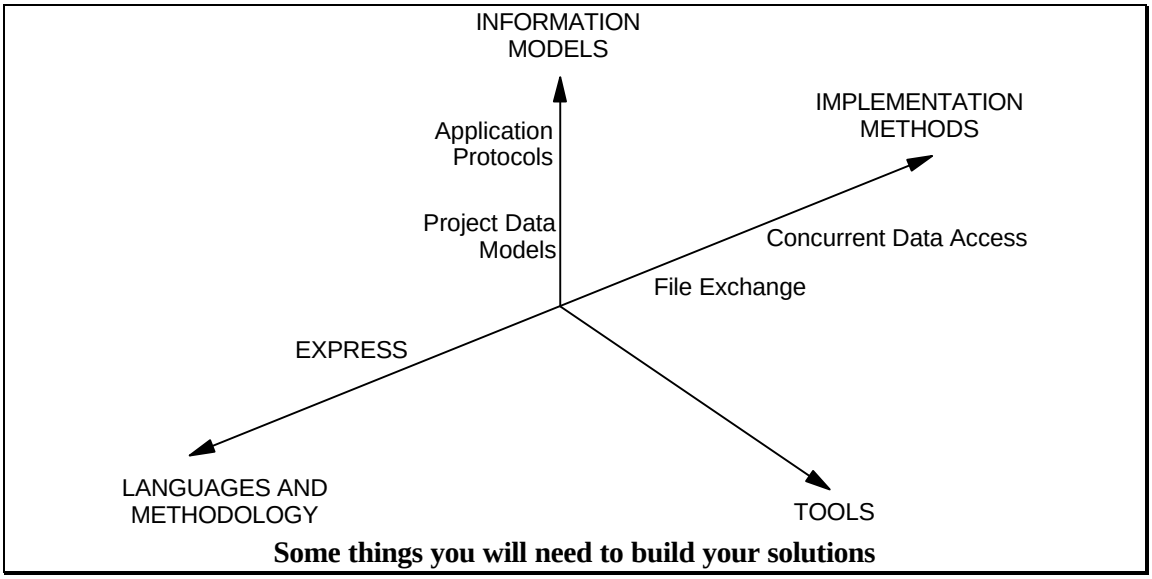
- Translating data is expensive. In Shell, Upstream and Downstream companies have reported that interfaces account for 25-70% of the total cost of recent system development projects.
- The need to translate data means that users of different systems can often only share data sequentially, and not concurrently. This can extend the time required for critical business processes.
- There is a slower response to the need for change in systems. Interfaces cost time as well as money.
- Quality suffers. Interfacing is inefficient and invites errors in the data, which may lead to inferior business decisions.
- Staff time is wasted trying to locate and reconcile data.



The Process Plant Engineering Activity Model

Creating an activity model showing the activities performed in your industry and the information required to support them, especially that which is shared or exchanged, will help you focus on what really matters.

Evaluate What Is Already Available



Some things you will need to build your solutions

You should not assume that everything you need is there and all you have to do is pick it up and use it. Life is rarely that simple. Be hard headed and check it out so that you know what is available before you either duplicate the work of others, or fix budgets before you know what you will really have to do.

Develop the Standards with Others

Data Models

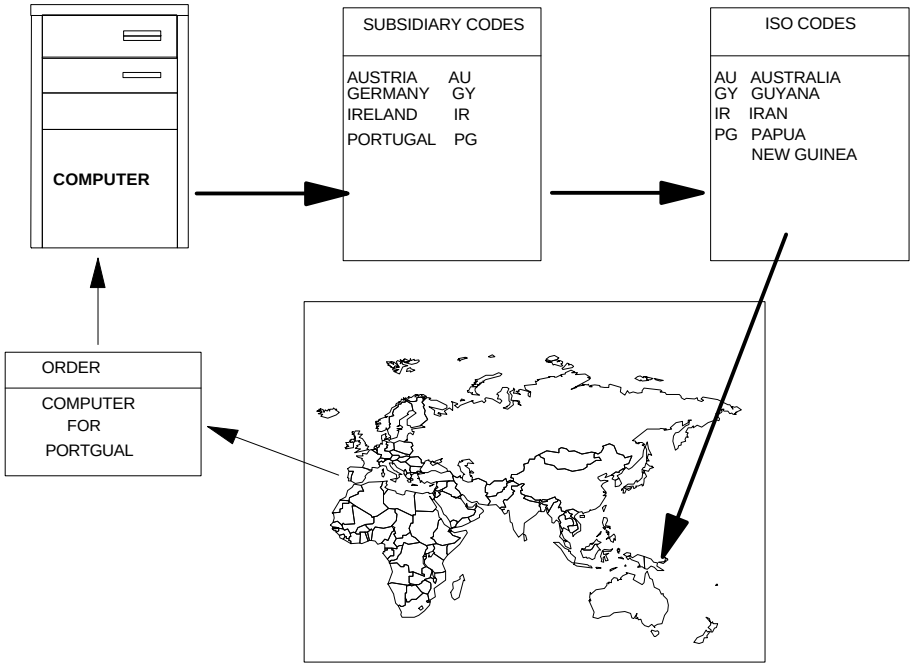
The physical means to communicate is not sufficient in order to share data. For example you can make a phone call from London to someone in Beijing. However, there is not much point if the person at the other end only speaks Mandarin and you only speak English. You need a common language to communicate. Equally one computer system can only share data with another system if they share a common language. A data model is where this "language" is defined.

Thus the first key element of the STEP standard is the data models that define the structure and meaning of the data we need to share and exchange.

Standard Data

Commonly used data (currency codes, units of measure, classification schemes) needs to be identified and standardised, so that data means the same thing when it arrives as when it left.

Example: Consequences of failing to use standard data



A computer company received an order for a computer to be delivered to Portugal. The order used the local country code for Portugal which was "PG". The head office processed the order and asked for the computer to be sent to country "PG". However, in Head Office they used ISO country codes, and the country with code "PG" was Papua New Guinea. The computer was sent to Papua New Guinea ...

Implementation Methods

A data model does not share data for you, so ways of implementing interfaces and data stores are necessary to provide the technology layer to support the data models.

Conformance Test Suites

"To err is Human" - unfortunately, so you need to be able to be sure that an implementation does conform to the standard so that it will work with other implementations. This is the role of Conformance Test Suites that exercise an implementation to make sure it does what it is supposed to.

Standards Development Methods

The deliverables above themselves need to be supported by methods to ensure their effective, consistent, and efficient development.

The costs of standards development are relatively low (from the perspective of the organisations involved). The key is developing them with others, which both shares the costs, and widens the circle of acceptance.

Implementation

Of course a standard does not deliver any benefits on its own. It just sits there. You have to USE it to get benefits.

Demonstrators

Demonstrators have two purposes:

1. To check that the standard you have developed (or some aspect of it) really works. The results usually provide very useful feedback into the standards development process.
2. To gain experience of the issues and problems to be overcome for software product development.

Note: you should not attempt or expect to use demonstrators for industrial purposes.

Developing demonstrators is difficult but not hugely expensive. Expect time over runs because of unforeseen difficulties, especially from partners who are not used to working with others.

Software Products

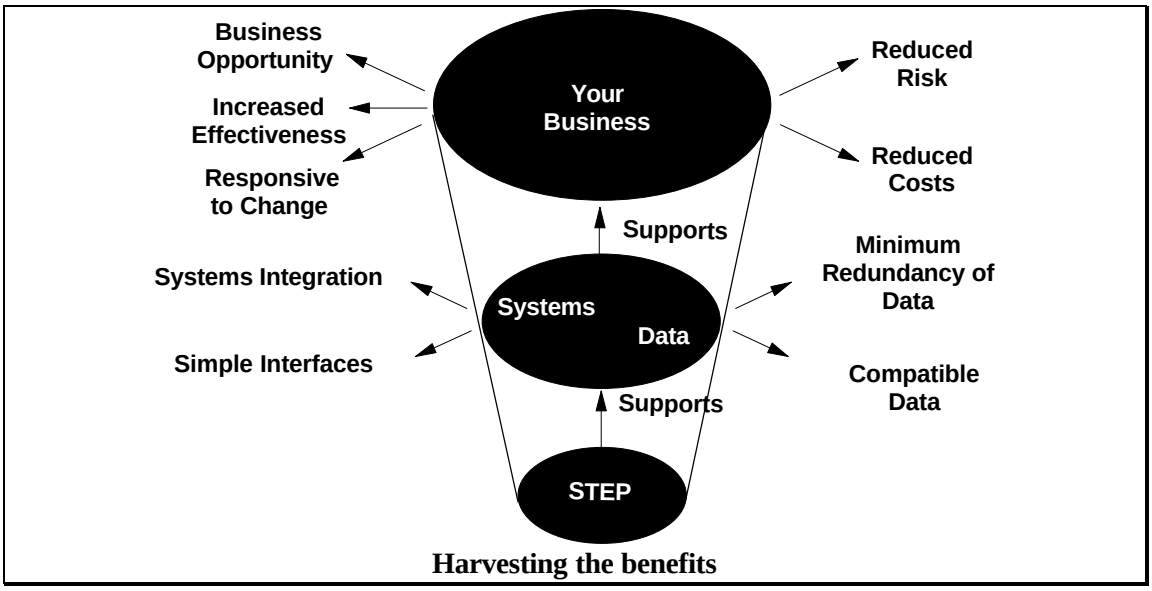
Before you can use something you have to make it. In this case that means developing industrial strength software products that implement the standard.

Software products are expensive, both to develop and support. Make sure it is done by a commercial organisation for whom developing and supporting software products is their livelihood.

Trial Implementations

You should not bet your company on a new piece of software. Test it on a real but not critical problem. Iron out the bugs, and get it moved to Version 3.

Harvest the Benefits

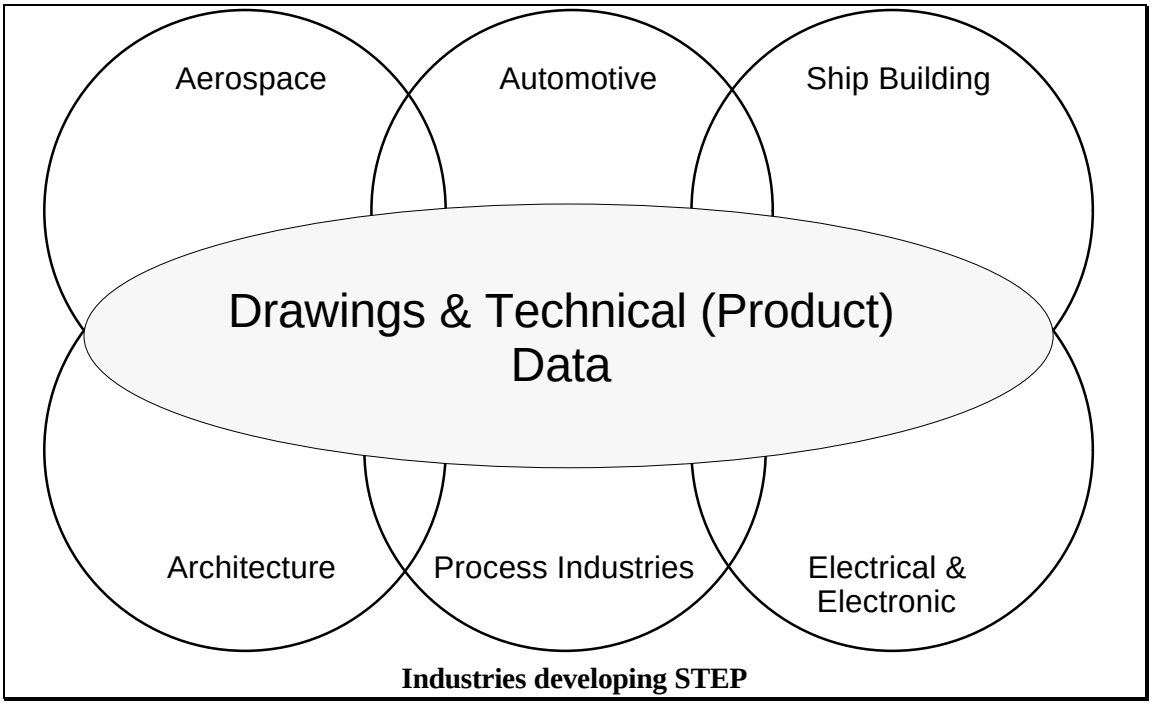


Harvesting the benefits

So far you have probably only paid money out. Now you need to get it back. It is never enough just to install systems that are STEP compliant. This may save some costs just by being more efficient (for Shell I estimate these benefits at US$ 15m/year world-wide) but the real benefits come from taking advantage of the potential to do business more effectively (for Shell I estimate these benefits at US$ 150m+/year world-wide). This does not happen without working out where you want to be, and how you want to do business. You have to do this for yourself; then put the plan into action.

4. Productivity In Standards Development

4.1. Build on the work of others



Industries developing STEP

STEP has been going now for 10 years. This means there is a significant body of experience you can draw on in your own industry, or in a related industry. This can give you a significant leg up as we have found in the Process Industries over the last few years.

4.2. Work with others

It can appear unnatural to work with competitors as well as business partners to develop standards. But in the end it just makes sense. The more organisations involved in developing and using standards the lower the costs (to you) and the greater the benefits.

4.3. The Role of Government

Governments who are concerned with the competitiveness of their economy in world markets will be interested in ensuring that STEP takes root in their country. However, STEP does need planting, and watering if it is to grow and bear fruit.

Competitors do not naturally come together. Most companies are not aware of the threat to their competitiveness in the world economy that is represented by other economies adopting STEP. They tend only to see what their local competitors are doing. A sense of urgency needs to be instilled.

Developing and implementing standards can take time, and initially at least seems improbable. Companies need encouragement, try some money. Most governments active in STEP have stimulated industry initiatives, and funded them in the initial stages by up to 50%. This seems to be enough to overcome industry's natural shyness. Fifty percent of what though? The good news is not a lot. European experience seems to be that a project for an industry might have a budget of US$ 0.5-1m per annum over say four years. A project might involve between 10-20 partners from the industry in question. After this period you can hope to have made STEP unstoppable in that industry, though not to have it in place yet.

In addition to industry initiatives, you need a national STEP centre. STEP is complicated, and needs a lot of getting into. You need to develop experts who can show people the way, and ensure co-operation and cross fertilisation across industries. Again, this does not have to be expensive, probably a team of five people will be enough. You can plan to move progressively to having it self funding in five years as you move towards implementation of STEP when the benefits are short term and industry can see clearly what is at stake.

4.4. The Role of Industry

The first thing industry needs to provide is a vision of where it is going, and to communicate that effectively both to itself, and to software vendors. After that it needs to plan to bring that about, and commit the resources to the task. Particular resources are required, some of which at least are scarce.

Domain Expertise

In the end STEP supports the work of your technical experts. They then need to be the people who ensure that any standard meets your technical requirements.

IT expertise (especially Data Modelling)

The heart of STEP is the data models that define the basis for sharing information. However, developing data models is not easy. In general if you give three groups of people the same requirement to produce a data model for, you can expect three different "answers" and you will be lucky if any of them meets your real requirements (including those you assumed they understood implicitly). I know, I spend a good deal of my time trying to bring together different modelling efforts.

Finally, as an industry you need to work together with software vendors to make sure they know what you are expecting of them. It might surprise you to learn that most software vendors would be only to happy to develop products to meet the requirements of your industry, if only you would tell them what they are as an industry!

5. A Recipe For Success

To sum up, here are some things you should do.

For Industry

1. Build awareness of STEP and recognition of its importance to your company.
2. Identify your requirements for sharing and exchanging data both internally and externally and prioritise those requirements. Plan now how you will exploit STEP.
3. Understand what is already available and work with others to develop the parts of STEP that are missing for your industry.
4. Develop demonstrators of the standards you develop, followed by industrial strength products based on what you have learnt.
5. Make sure you harvest the benefits of STEP. This does not happen by itself. It takes planning and commitment.

For Government

1. Initiate consortia in your key industries. Make sure they know what is at stake, and that they have your support.
2. Set up a STEP centre as a resource to these consortia.