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On the Lifecycle Management of Standards

Nils Johansson

Machine Design • Department of Design Sciences

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2011

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Dedicated to Ancestors, Inger, Anders, Peter and all other Helpers

of this developmental process.

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Lund, June 2011

Nils Johansson

Abstract

Standards are used everywhere in the modern world and are a fundamental part of a functioning society. But the creation and maintenance of international standards is not an easy task. In addition to the technical prerequisites that must exist to create a standard, there are also political, economic and cultural aspects that must be considered.

The present thesis does not interpret all these aspects in the creation and maintenance of international standards. The goal of the thesis is to assist the technical specialist who will participate in the process of creating a new global standard, with a map that describes the various steps involved in a standards life cycle, but also the interaction of the development team.

A composite model was created based on the work described in (Söderström, 2004) supplemented with the D-S-N process described in (Fomin, 2003). The composite model was then further developed into a modelling process using Six-Sigma methodology (Brassard, 2002), with requirements for input and output conditions for each process step.

To standardize the development process model each process step was complemented with suggested methods for the completion of each process step.

The developed process model, *LMS-Lifecycle Management of Standards*, can be applied for the development of global EDI standards in the automotive industry. The model can also be generalized to describe the standardization process where the development of software is included.

The author has been active in international standardisation groups as representative of the Swedish car industry for nine years. The elaborated model for a standardization lifecycle has been verified using the SASIG and Odette Sweden protocols from 2000-2007 and by the author's own experiences during standardization work on the global EDI standards ENGDAT V3, OFTP2 and PDQ V2.

Keywords: EDI, SASIG, ODETTE, Standard, ENGDAT, OFTP, PDQ, PDM, eXchange and Management of Technical Data, LMS

Populärvetenskaplig Sammanfattning

Globala internationella standards har stort inflyttande i var nutida teknikorienterade värld. Exemplen är många: vi kan importera och exportera produkter och tjänster i de flesta andra länder, vi kan kommunicera med andra personer var de än befinner sig, vi kan även resa snabbt och effektivt.

Men skapande och underhåll av internationella standarder är ingen enkel process. Förutom de tekniska förutsättningar som måste finnas för att skapa en standard finns även politiska, ekonomiska och kulturella aspekter som måste beaktas.

Föreliggande avhandling gör inget anspråk för att tolka alla dessa aspekter i skapande och underhåll av internationella standarder. Målet med avhandlingen är att bistå teknikern som kommer att delta i processen för att skapa en ny global standard, med en karta som beskriver de olika steg som ingår i en standards livscykel, men även samspelet i utvecklingsgruppen.

I avhandlingen används en modell, utvecklad i (Söderström, 2004). Modellen kompletteras med D-S-N processen som beskrivs i (Fomin, 2003). Den sammansatta modellen har sedan utvecklats till en modellprocess genom införande av krav på ingångs- och utgångsvillkor av respektive processteg i modellen med hjälp av Six-Sigma metoden (Brassard, 2002). För att standardisera även detta processarbete har respektive processteg kompletterats med förslag på metoder att använda för fullgörande av de olika processtegen. Denna processmodell har fått namnet *LMS - Lifecycle Management of Standards* och ska kunna appliceras för global utveckling avseende EDI standardisering inom bilindustrin. Modellen kan vidare generaliseras för standardiseringsarbete där utveckling av programvara ingår som ett verktyg för standarden.

Författaren har varit aktiv i internationella standardiseringsgrupper som representant för svensk bilindustrin under nio år. Den framtagna modellen för en standardiseringslivscykel har verifierats dels genom att studera protokoll från SASIG och Odette Sweden åren 2000-2007 dels genom författarens egna erfarenheter från global standardisering avseende ENGDAT V3, OFTP2 och PDQ V2.

Appended Publications

This thesis includes the following appended publications:

Paper A
Anderson, H., Hultman, J., Johansson, N. (2007). Creating a Business Case for Product Data Management Technology: a transaction cost approach *Paper presented at the 14th international Product Development Management Conference, June 10-12, 2007, Porto, Portugal:*.

Paper B
Giorgos Nikoleris and Nils Johansson, "Managing the exchange of data in the extended enterprise", In *Proceedings of the 10th ISPE International Conference on Concurrent Engineering: Research Applications*, Madeira Island, Portugal, 26 - 30 July, 2003

Paper C
Johansson, Nils, A Global Standard for eXchange and Management of Technical Data (XMTD), Swedish Production Symposium 2007

Also published by the author but not included in this thesis

Results from the following research papers have not been included in this work.

Johansson, 1998, “Fördjupat och Förnyat Ledarskap – Kommunikationens 13 nivåer – Från ego till samhörighet, (<http://www.daxwin.se/fuppsats.PDF>, 2010-12-29)

Johansson, 2001, “JOHANSSON COMMUNICATION TOOLS A Set of Seven Management Strategic Growth in the Communication of Technical Information”, Division of Robotics, Department of Mechanical Engineering Lund University, (<http://www.mkon.lth.se/fileadmin/maskinkonstruktion/robotteknik/arkiv/2001/Allt_JCT_2001August21.pdf>, 2011-01-10)

SASIG 2003. ENGDAT Version 3. Issue 01/2003, (Nils Johansson was the Odette Sweden representative and Co-chair in the SASIG XMTD WG for the creation of the ENGDAT Version 3 Standard)

Johansson, 2004, “Business Case for XMTD at Volvo Car Corporation”, 2004, SASIG XMTD WG, Gothenburg.(<http://www.powershow.com/view/ce658-MzU4M/SASIG_XMTD_WG_Gothenburg_May_2004>, 2010-12-21>)

Johansson & Lindblad, 2005, “ENGDAT Version 3 - Odette Sweden Common ENGDAT V3”, 2005-10-13, Odette Sweden & Fordons Komponent Gruppen, Gothenburg <http://www.odette.se/BinaryLoader.axd?OwnerID=740d612b-0c30-4126-b9f4-457b42e60b80&OwnerType=0&PropertyName=File1&FileName=johansson-lindblad-web.pdf&Attachment=True> Retrieved 2010-12-20

Johansson, 2009, “The Promise of Good and Global eXchange and Management of Technical Data”, 2010, Odette Sweden.

<http://www.odette.se/BinaryLoader.axd?OwnerID=4253ac46-6eff-42cb-b872-fbc0f86de68f&OwnerType=0&PropertyName=Files&FileName=GoodGlobalXMTD20081230+m+app.pdf&Attachment=True> Retrieved 2010-12-20

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1 Introduction

Standards may be overlooked by most people but are used everywhere in the modern world and are a fundamental part of a functioning society. Conformity in the use of symbols, measures, currency or the calendar are early examples of standards (Egyedi, 1996). Although mostly seen as a technical artefact, standards are used in a wide range of applications. In the broadest sense they make up one cornerstone of objectivity, since without a common reference frame no global knowledge would exist (Feng, 2003). An early example of standardization is the stone shown in figure 1.1.

Figure 1.1 The Salamis Metrological Relief (365 B.C.) (Dekoulakou-Sideris 1990)

Found on the island of Salamis, it is assumed to have provided standard lengths for the different measuring systems that existed in Ancient Greece; making it possible for workers from different places to calibrate their tools and measuring references.

The origin and creation of standards differ. Since the middle of the 20th century global standardization organisations, such as ISO, have been active, with a formal process of standardization. Formal or semi-formal processes also occur within industry consortia that can be open or closed (Weiss et al., 1992). Standards can also emerge as a product of users' choices, a kind of "natural selection" or as a by-product of monopoly in a market. These kinds of standards are called de facto standards (Björk et al., 2010). The outcome of the different processes may differ, but there are some consistent similarities; whatever the standard concerns, it is always the product of social negotiations and compromises.

Standardization and standards have a variable and shifting meaning (Feng, 2003) and as such it is hard to know when the process of standardization emerged in history. Standardization as a way of creating uniformity in production can be dated back to the eighteenth century (Feng, 2003) with the dawn of the modern enterprise that operated in many places, handling more than one form of activity.

The word standard can be broadly defined, as "a document that provides guidelines or characteristics for activities or their results" (Söderström, 2004) or "... a set of technical specifications adhered to by a set of producers, either tacitly or as a result of a formal agreement" (Fomin, 2003).

1.1 Background and Motivation

Aspects of globalization and communication (an increased need to share product data)

Few companies today own their whole chain of production. From idea to end product, close co-operation between partners is therefore crucial and good communication is a necessary means to produce high-quality goods. Supply chain efficiency is based on effective communication. Today, many people at different levels in a company realize the importance of communication effectiveness. However, many people may not realize how much money, time and human resources can be saved by considering communication effectiveness at the very start of negotiations in a new project and by evaluating and following up communication effectiveness in all business operations. Senior management and communication managers must establish a joint forum for discussing communication effectiveness, analysing communication needs, determining communication strategies, and allocating monetary and human resources to the communication process, to ensure supply chain efficiency. Implementing the communication tools can lead to substantial returns, both tangible and intangible, generating corporate competitive power and improving the potential for corporate survival. (Johansson 2001)

In the automotive industry where a typical CAD-model of a vehicle contains 15.000-20.000 separate files (Johansson et al. 2007) there is a massive flow of technical data between suppliers and customers, which increasingly depends on sophisticated communication networks. Focusing on the operations at Volvo Cars Olofström, we further

note that the company operates both as a supplier to, and a customer of, other companies in the automotive sector. Such dual-oriented operations require highly effective external communication in order to function properly (Volvo Cars Body Components, 2001).

The manufacturing industry is increasingly dependent on digital tools, such as computer-aided design, CAD, computer-aided engineering, CAE, computer-aided manufacturing, CAM, and product data management, PDM, to design and manufacture products. Collaborative e-engineering requires different digital tools in different phases of the product development process. An interoperability error makes product model data unusable when applying digital tools. If an interoperability error arises in collaborative engineering applications, tracking the error back to its source is expensive, if not impossible, and requires a significant amount of time (Johansson et al. 2008). New models and types generate a substantial share of automotive turnover with new features in a complex automotive network. At the same time, development and manufacturing cycles have to break time-saving records from year to year. Standardization in the communication process would therefore be an effective means to accomplish better communication at a lower cost.

Driven by industry, standardization for programming languages and data exchange was already a fact in the 1960s (Burrows, 1999). Today there are such a huge number of different applications and standards for data transfer that the costs of data transfer increase as the number of parties involved in the network grows. Except for cost associated with every application, such as maintenance, specific equipment and storage of data, there are also difficulties for the users who must learn how to manage an increasing number of systems (BSharah, 2003).

1.2 Related work

The predominate research on standardization concentrates on the development of a standard, leaving out how the standard was used, how it evolved and why it was terminated. The model used and refined in this thesis is mainly the model presented by (Söderström, 2004). She investigates seven existing models, and identifies their similarities and differences to combine them into one general model consisting of seven steps in the lifecycle of a standard. It is stressed that important factors include stakeholders, feedback from users, human relations management and distribution of the standard. The model is then expanded to involve the phases of testing, education maintenance and termination (Söderström, 2004), trying to reach beyond the development process of standards. Although Söderström calls for "further research /../ into how standards are used in practice, and not just how they ought to be used in theory", the work is exclusively theoretical including the expansion.

Two groups of standards research can be identified: the study of the development of standards and the study of standards' effects on social relations (Feng, 2003). The study of the development of standards should, however, be expanded to include the

phases after implementation and use, to get a comprehensive picture of standards and their whole lifecycle (Söderström, 2004).

Söderström's model is used in a qualitative study performed by Björk and Laakso within the construction industry. They point out that the lifecycle model of Söderström must be modified; when a standard is released it must be able to remain stable for a long period (Björk et al., 2010) so as to be compatible with technology. Björk and Laakso use empirical material from interviews with domain experts together with the Söderström model to develop a process model of why and how a standard emerges within the construction industry. Their model consists of three parts: technological innovation, deployment, and development of a standard (Björk et al., 2010), where the last part can happen before or after any of the other two. The model is then used to investigate and compare four selected standards, finding that key issues for a standard to become successful are timing of defining the standard, the amount of resources put into the standard development, management of the standardization, and the number of industries joining and promoting (Björk et al., 2010). This is applicable whether a de facto standard, an industrial consortia standardization or a formal standard.

According to Feng, the study of "how standards achieve globality" is one of the most recurrent themes in the study of standardization (Feng, 2003). The question asked within the standards lifecycle context should be "how do new standards arise?" (Feng, 2003), complemented with the questions "how do they persist?" and "how are they improved?"

Feng introduced the two concepts of functionalist view and constructivist view within the development group (Feng, 2003). The functionalist view considers the development of standards as an outcome of and reaction to the needs of users, a mere technical solution to a technical problem. The why's and how's are explained in terms of the economic and technical benefits that the standard brings. Social factors that may in practice change or influence the standard process are seen as external and as irrelevant to the standard in itself (Feng, 2003). In a constructivist view, these factors are included and the standardization is seen as a complex process of negotiations between different parties involved. The model developed in this thesis will take a stance in between the two views, realising that both views are necessary to fully understand the development of a standard.

The development and use of an international standard is not only a complex technical process; the political, social, cultural and economic aspects of this process have to be considered. To use the language of (Fomin, 2003), the main factors describing each step in the development process are the design process (technical aspects), sense-making (largely economic aspects) and negotiation (psychological aspects)(Fomin, 2003). The second dimension of the model used in this thesis deals with these three different aspects in each process step that must be taken into consideration to fully understand standardization. The concepts are taken from (Fomin, 2003) who used three streams of research to make a more comprehensive understanding of the stand-

ardization process. The three streams indicated are that standardization is either viewed in terms of "design tasks, social sense-making challenges or negotiation problems" (Fomin, 2003). It is argued that these activities depend upon each other and they cannot be organised in any specific order or put into a hierarchical system.

1.3 Objectives

The emergence of a new standard has been studied in a large number of academic texts, (Feng, 2003) but so far no single model has been developed that explains the process of developing a successful standard (Fomin, 2003).

This thesis aims to:

> *describe the process of developing and maintaining an international standard, and point out lessons to be learned from this process to favour future work and deepen the understanding of the lifecycle of standards*.

A lot is written about the process of standardization, but not many empirically investigated cases can be found. By integrating two existing models, a tool to analyse and identify the phases of a standards lifecycle was created and used to evaluate three standards within the automotive industry. Hopefully this contribution will be an important brick in building understanding and improvement of the international standardization processes.

1.4 Scope and Delimitations

Standardization has an increasing importance in modern society and has therefore been studied in many different disciplines. In this study standardization is studied in a narrow sense. The process of creating a new standard is studied as a linear process, as defined by Söderström (2004), refined by multiple loops based only on *technical* prerequisites. In this work the model proposed by Söderström is enhanced by the D-S-N model proposed by Fomin (2003) with the scope to:

> *provide a guideline for individuals with technical background that participate in the creation of new international standards*.

There is no ambition in this thesis to cover all the perspectives of the standardization work, as important as they may be. The political, social, and economic aspects of standardization are not included in the presented model, even if they are mentioned in this thesis.

The study of standardization work is limited to standards created to promote business-to-business communications that are normally performed by software developed using the specification of the created standard.

1.5 Research Methodology

This is a qualitative study of three standards within the SASIG organisation formed as participatory case studies (Creswell, 2003). Its aim is to produce answers to the questions of how and why a standard is produced and maintained. By describing the process in depth, some generality will be lost, but putting it in the context of earlier models on the subject a greater understanding can be reached. The activities of the author as described in section 1.7, Contributions of the Author, are the main source of data collection, hence the choice of the *participatory* case study method. The author has been an active member of the committees that have developed the standards studied. Specifically, the empirical material was collected through the active participation of the author as an Odette Sweden and Volvo Cars representative within the studied technology standards development and management groups globally and nationally during nine years 2001-2009. The author attended the SASIG XMTD WG (Work Group) and the plenary meetings 2001-2005. He participated in the Odette Sweden OFTP2 WG 2004-2009 and the Odette Sweden PDQ WG 2006-2009.

The qualitative approach has been chosen due to lack of earlier empirical studies (Creswell, 2003, p.30). The subject of study is not easily described in quantitative measures either, which makes the qualitative approach still more suitable.

The following standard development cases are to be studied: ENGDAT V3, OFTP2 and PDQ V2. The ENGDAT V3 standard is the standardization of an EDI message that will serve as a file describing a package of files to be sent. The description is to be done in a syntax and payload that make the information possible to read by the receiving Computer Operating System, making it possible to forward the package of files to the receiver (which can be a person or a computer system). The OFTP2 is a file transfer methodology that makes it possible to send data securely via the Internet using up to date encryption technology. The PDQ V2 is a methodology that enables the purchasing party to prescribe in a standardised way the Product Data Quality of CAD-models desired and to use standard products that can automatically check the Product Data Quality of received CAD-models or assure that the supplier has already done the appropriate checking.

1.6 Outline of the thesis

In *Chapter 2* the model is explained and developed and put in a historical context of the standardization process.

This model is tested in *Chapter 3* on the following three standards:

- SASIG ENGDAT V3 – meta data for exchange and management of technical data,
- ODETTE OFTP2 – secure transfer mechanism via public Internet and

- SASIG PDQ V2 – product data quality guidelines for the global automotive industry.

In *Chapter 4* the updated model is transformed into a developmental process with gates and descriptions of methodologies to be used in each process step named LMS – Lifecycle Management of Standards.

Chapter 5 presents the conclusions.

1.7 Industrial Contributions of the Author

The author has been an active developing member of the following standardization groups:

1. Odette Sweden Engineering Functional Committee representing Volvo Cars Corporation.
2. SASIG XMTD WG and Plenary representing Odette Sweden.
3. Odette Sweden OFTP2 WG representing Volvo Cars Corporation.
4. Odette Sweden PDQ WG representing Volvo Cars Corporation.
5. Volvo Cars Corporation Six Sigma WG about the objective "Increased Quality for Archieved Product Data of Equipment in Production"

In the SASIG XMTD WG the main contributions for the Odette Sweden Stakeholders were:

1. The creation of ENGDAT V3 Subset that contains all items agreed on in the Odette Sweden common ENGDAT V2 and getting acceptance for use of this subset by the SASIG XMTD WG.
2. The creation of the SASIG XMTD WG liaison ODETTE INTERNATIONAL OFTP WG with the objective to create a secure File Transfer Process via Internet. The resulting standard is named OFTP2.

In the Volvo Cars Corporation with objective "Increased Quality for Archived Product Data of Equipment in Production" the main contributions were:

1. Awareness of the difference in quality in Archived Product Data for products in production and the contracted Technical Specifications concerning historical Die Purchasing Projects.
2. The creation of a Business Case showing the potential savings by checking Product Data Quality of purchased Product Data before paying the supplier and Archiving.
3. The creation of a pilot Q-Checker PDQ check file for automatic checking of the purchased CAD-models for production equipment against the Project Technical Specifications in coming Automotive Projects.

2 The Development of a Global Communications Standard

The methods used for communicating information for global purchasing of manufacturing equipment have evolved from time-consuming physical deliveries to time-saving data transfer using Internet connections. Before EDI, wooden models were flown with the process engineers in the aeroplane cabin so that they would not be damaged by the low air pressure in the cargo area. This method was upgraded in the late 1980s to numerical VDAFS data with ½ inch "pizza tapes" as transfer media, which e.g. took one week to transport to Spain. (Johansson, 2001).

The next method used from 1995 was the Odette EDI standard ENGDAT/OFTP/ISDN with which 1 MB files were transferred in less than 3 hours (Volvo Cars Body Components, 2001). Today's CATIA V5 files, of up to 1 GB, would take 50 hours to transfer with ISDN speed. Therefore different methodologies of transfer via SWA (ftp via SSL-security) and VAN-solution have been used for the latest car project. By using different non-integrated Exchange and Management of Technical Data systems, problems are created with control of what has been sent and received (Volvo Cars Body Components, 2004).

2.1 Why a global standard?

There are a huge number of different applications and standards for data transfer, and the costs of data transfer increase as the number of parties involved in the network grows. In addition to the costs associated with every application, such as maintenance, specific equipment and storage of data, there are also difficulties for the people who must learn how to manage an increasing number of systems (BSharah, 2003).

The choice of a global standard over a local standard can be justified by financial interest, as illustrated by Figure 3.1. A simple mathematical formula can be used to calculate the number, N_{local}, of possible interface connections between a number of parties, *n*, using local standards.

$$N_{local} = n(n-1) \tag{2-1}$$

A still simpler mathematical formula can be used to calculate the number, N_{global} of possible interface connections between a number of parties, n, using global standards.

$$N_{global} = n \tag{2-2}$$

This means that the savings, in number of different unique interface connections, is:

$$N_{local} - N_{global} = n(n-1) - n = n^2 - 2n \tag{2-3}$$

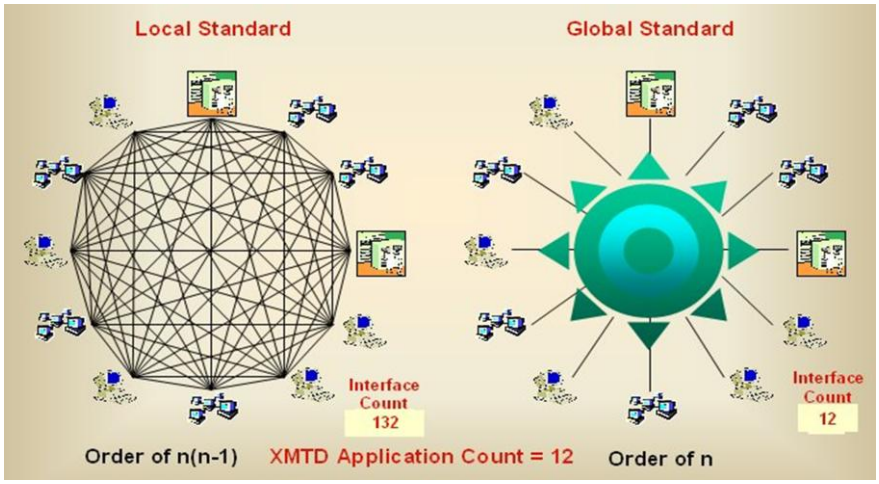

Figure 3.1 Calculation of interface-connections for local and global standards (BSharah, 2003).

This implies that the increase in savings is greater the more parties that are involved in the network. If it is assumed that each interface has an equal cost C and that the cost is spread equally to all communication parties, the cost per party using local standards is

$$\frac{C(n^2 - n)}{n} = C(n-1) \tag{2-4}$$

The corresponding cost per party for the global standard is $Cn/n = C$. This means that every company only needs to purchase one global standard communication interface. The saving per party in the communication network for using one global standard communication is:

$$\begin{aligned} &< Cost\ per\ party\ for\ local\ solutions > - \\ &< Cost\ per\ party\ for\ one\ global\ solution >= C(n-1) - C \end{aligned} \tag{2-5}$$

Presupposition: A global environment where the stakeholders are committed to use an open standard created as a consensus decision and the number of parties in the whole affected supplier net is *n*.

This presupposition and the formulas created above makes it possible to calculate the tipping point for a positive business case *TP* for creation of a global standard to replace the scenario of local standards to:

$$TP = C(n-2) - < the\ standard\ creation\ cost > \quad (2\text{-}6)$$

There is tension between local autonomy and global standards because local communities fear homogenisation (Feng, 2003). The formula above shows that the business case became more positive as more participants used the global open standard. This also means that companies outside of this cooperation creating their own VAN network reduce the effect of the open standard initiative. The customer in this case gets only one system for all suppliers thereby that this is prescribed in the customer Request For Quotation. This means that to get the order the supplier is forced to use the alternatives prescribed by the VAN supplier. The VAN supplier charges the customer supplier for using the VAN solution prescribed in the Request For Quotation. In this case the VAN supplier distributes IT cost from the customer to the suppliers. The transaction cost invisible hand then acts to increase the customer prices for the orders because the suppliers affected, in order to survive, have to return the costs caused by the customer in order to survive in the market.

Another illustration of the difference between local autonomy and global standards is the experience from the development of CAD-systems. Every CAD-system sought to create a system with new facilities so that their customers would not benefit from switching to another CAD-system. Open global standards were developed to prevent the Automotive Industry Suppliers from being forced to have one special CAD-system for each customer. There is still an on-going race. The positive side of the race is that the CAD-systems are constantly developing. The negative side is that the automotive supplier net needs to install more CAD-systems than if an open standard exchange of CAD-models existed with maintained quality. The ultimate solution for this was that an open standard existed for the entities in the CAD-systems database so exchange of CAD-models could be easily done between CAD-systems keeping the semantic meaning of the entities. The open standard for CAD-models should contain all basic geometry and other entities, and be required to be the core of each CAD-system. The CAD-system vendors could compete in the way the geometry base is used to create the CAD-model, but the geometry should be transferable with maintained quality between the CAD-systems using open standards.

2.1.1 Generating an expanded lifecycle model

To understand how a standard is generated and maintained, a good model is needed. Several models have been developed with different drawbacks and advantages. Most models have only considered the development process, not investigating further how the standards are implemented, used, improved and possibly terminated. Two models have been chosen to create a new tool for analysing standards, the general standards lifecycle (Söderström, 2004) and the D-S-N model (Fomin et al., 2003). The general

standards lifecycle is a good model to describe what is going on in the lifetime of a standard, but gives very little information on how to analyse how and why this is going on. The D-S-N model provides such a tool, and by applying it to each step in the general standards lifecycle a two-dimensional tool is created that makes it possible to thoroughly study standards.

The term lifecycle is used to emphasise that not only the development but also the whole process from "creation to termination" is taken into account.[1]

2.1.2 General Standards Lifecycle

Söderström proposes the general standards lifecycle as a result of studying seven existing lifecycle models for standards and standardization (Söderström, 2004). The models mainly describe the development of a standard (sometimes referred to as standardization) and Söderström argues that necessary parts such as use and feedback should be added; otherwise the models are unable to satisfactorily explain how and why the standard has become successful (Söderström, 2004).

The general standards lifecycle is a cyclic scheme of six phases for identifying the most important stages a standard passes during its lifetime. The six phases are:

1. Initiate
2. Develop standard
3. Develop product(s)
4. Implement
5. Use
6. Feedback (Improve)

Phase 4 can be seen as a parenthesis, since not all companies implement their standards when developing a software product (Söderström, 2004). The model presented later, however, will include this phase, and therefore it is considered a phase as important as the others.

The phases alone make up the backbone of the model, but in themselves describe little of what is actually happening. Söderström identifies a number of aspects that must be considered to successfully understand the lifecycle of a standard. The first one is to identify stakeholders (Söderström, 2004). This is important throughout the whole lifecycle. By identifying stakeholders, the decisions taken and the design of the standard can be explained. The actual use of standards has been neglected in earlier research, but is added in the general standards lifecycle, with the comment that older models, which did add the use phase, did not specify its contents. Nor is this done in

[1] Termination occurs when the Standard has been replaced with a new Standard and a decision of termination is done.

Söderström's model. However, how the standard is spread and how users are taught how to apply it is mentioned.

Equally important is to identify factors that may influence the standard's design, implementation and use, such as policies, funding, human relations management etc. Lastly the standard can be described as either anticipatory, participatory/enabling or responsive, meaning that it is created before, together with or after products or services are needed and created (Söderström, 2004).

Söderström suggests an expansion to her model including also the phases

- Conformity assessment
- Education
- Maintenance
- Termination

However, these phases cannot be sorted into the six-phase lifecycle described above. The expanded lifecycle model suggested below will instead add these activities as parts of existing phases. Conformity assessment should perhaps be added in implementation and use since it includes testing, inspection (quality check-up), certification and accreditation (Söderström, 2004).

Education can also be included in implementation. The knowledge of how to use standards and how they work has been identified as a problem (Söderström et al. 2003, mentioned in Söderström, 2004).

Maintenance can be included in the phase of use since it is necessary for this phase to function properly.

Termination is added as a seventh phase. It is an alternative to updating standards when they no longer measure up. In a way, it breaks the cycle but could be the start-up for a new standard. This phase should describe why the standard was seen as obsolete and how it affects the users.

2.1.3 The D-S-N model

The D-S-N model describes the process of developing a standard, and partly how to implement it, and was developed by studying existing models and collected data (Fomin et al., 2003). The model uses phases to describe the process that the standard goes through, but the main focus is on three activities that are intertwined during each phase. These activities are called design, sense-making and negotiation, and provide a way of analysing what happens during each phase of the development of the standard.

Focus on these three activities has been chosen because previous literature has been found to have different approaches to the study of standards. The authors argue that none of the approaches give a comprehensive picture of the emergence of a standard,

so all three must be applied (Fomin et al., 2003). In addition, their model suggests that during each phase all three activities — design, sense-making and negotiation — must have occurred for the phase to reach closure.

Fomin emphasises the fact that standards are not solely a technical creation but also a social one that is created through agreement between actors (Fomin et al., 2003). These social activities must be explored and analysed to fully understand the lifecycle of a standard.

The activities are not independent but strongly interact with each of the other two.

Design is needed to understand how technical specifications emerge. Stakeholders always evaluate and choose between different technical solutions and designs.

> *"Design anticipates that during negotiation each actor weights design alternatives against a set of criteria that may cover economic, political, social and technological criteria (Fomin et al., 2003)."*

Choosing between different designs links the model to negotiation.

Sense-making includes giving meaning to a prospective technology, or engaging the stakeholders about the importance of the standard. It yields new meanings that can be associated with existing technologies and put old technology in a new context. Sense-making also covers economic implications (especially in early phases).

Negotiation includes the relations between stakeholders and the networks they form by agreeing on who should do what.

2.1.4 An expanded lifecycle model

Söderström's lifecycle model gives a good picture of what is going on during the lifecycle of a standard but gives little information on how or why it is done. By applying the D-S-N model to the different stages of the general standards lifecycle, a two-dimensional model is able to explain what happens and how the standard emerges. Applying it to a case study, it should also be possible to answer the question why it happened. A schematic picture of the model is given in Figure 2. For each stage to be passed, the three activities design, sense-making and negotiation must have happened.

Table 2.1 The two-dimensional expanded lifecycle model

	Design Creating and choosing design alternatives	Sense-making Attaching meaning to design alternatives	Negotiation Agreeing between designs, fixing the actor network
Initiate			
Develop Standard			
Develop Products			
Implement			
Use			
Feedback			
Terminate			

Although the proposed model may explain the lifecycle of a standard, the framework in which the standard is developed must be identified to understand its emergence. Three main questions as suggested by Choi et al. should give a picture of the setting:

- Describe the standard (anticipatory, participatory/enabling and responsive)
- Identify stakeholders
- Who is in charge, is it a consortium? Is it open? Do the members have to pay a fee?

This model has been suggested since it suits well to explain standards within the frame of business consortia standardization processes. Standards developed by formal standardization organisations may differ, needing a different model to explain the development process.

3 Studies of ENGDAT, OFTP and PDQ

3.1 Methodology for transforming into 3-dimensional Lifecycle Management of Standards

”The used methodology for creation of the Common Denominators is a qualitative research that take place in the natural setting” writes Creswell (Creswell, 2003, page 181). The researcher participated as a standard developer within the standard organisations SASIG, ODETTE and Odette Sweden. These organisations create standards for the automotive industry in the area of Product Data Development throughout the PLM process.

Qualitative research is fundamentally interpretative. This has the semantic meaning that the researcher makes an interpretation of the data. It also has the semantic meaning that the researcher filters the data through a personal lens that is situated in a specific socio-political and historical moment. “One cannot escape the personal interpretation brought to qualitative data analysis”, writes Creswell. (Creswell, 2003, page 182). The personal lens used in this study is the two-dimensional expanded lifecycle model.

One Qualitative Data Collection Approach is to ”Have a participant keep a journal during the research study” writes Creswell (Creswell, 2003, page 189). In this study this was done by appointing people to keep notes during the meetings in the standard organisations.

Among eight primary strategies for Qualitative research pointed out by Creswell is: “Clarify the bias”(Creswell, 2003, page 198).

One bias for the researcher is during 2001 - 2009 belonging to a standardization organisation that has the mission to manifest the standard development process from initiation to termination.

A second bias for the researcher is from 2009 and onwards representing a company providing open standards for the automotive supplier network.

A third bias for the researcher is as a Volvo Cars Corporation Olofström employee during 2005 – 2006, participating in the Business Case to change the process of archiving CAD-models for production equipment.

The qualitative research ”also involves interpreting the data in light of personal lessons learned, comparing the findings with past literature and theory”, writes Creswell (Creswell, 2003, page 205).

This interpreting was done in three steps. First, all the protocols from SASIG during the period of 2000 – 2007 were studied.

Secondly, all parts of the notes that could be used as arguments for the common denominator of each matrix box of the expanded lifecycle model were sorted out.

Thirdly, the process of ”Intertwining quotations with (the author's) interpretations” (Creswell, 2003, page 197) was done inductively. The chosen parts of the notes where combined with the author global standard development experience and the outcome were common denominators to be filled in the two-dimensional expanded lifecycle model.

This process expanded the lens of the two-dimensional expanded lifecycle model used into a three-dimensional expanded lifecycle model where the common denominators created form the third axis.

3.2 Process step Initiate

Table 3.1 The Process Step Initiate

	Design Creating and choosing design alternatives	Sense-making Attaching meaning to design alternatives	Negotiation Agreeing between designs, fixing the actor network
Initiate	The ad hoc work group set up the initial technical specification and a project plan including necessary resource allocation for the standardization issue	The Board evaluated the ad hoc work group presentation including Business Case calculation	Activities to reach a common agreement to proactive commitment of using and marketing the presented standard. Agreement on funding of resources according to the organization law necessary to fulfil the standard development project up to status Use and Maintenance.

3.2.1 Column Design

The first example chosen for the matrix box Initiate/Design was that Mr Jens Kuebler writes in the minutes that the SASIG Plenary Detroit 2001 has made the decision to create a SASIG Ad Hoc Work Group to solve the issue of creation of a global mecha-

nism for EDI communications. The task for the Ad Hoc group is to study the benefits of the existing standard candidates ENGDAT and AP232 (Jens Kuebler, 2001, SASIG Plenary Protocol, Detroit).

A second example is the prelude of the creation of the standard that now goes by the name OFTP2. Mike Strub in the SASIG XMTD WG Workgroup Minutes, 2003, writes about the origin of OFTP2. It is documented that Mr. Nils Johansson, Odette Sweden presents where ENGDAT fits in the 7 layers of the OSI model. It was explained that a global standard of interoperability needs to be complemented with reference to the position in the OSI model and that" state of the art" technology is available to create a standardized solution for this by creating a secure transfer mechanism that uses the globally existing Internet (Mike Strub, 2003, SASIG XMTD WG Workgroup Minutes, 2003, Tokyo).

A third example is that the task to create what later on materialized as OFTP2 to the ODETTE OFTP Working Group that has created the OFTP Version 1 is written in the minutes by Mr Sten Lindgren in the SASIG Plenary Meeting minutes, 2004. In this case, the creation of an ODETTE Ad Hoc Work Group was given the task to solve the issue of fulfilling "a list of functional requirements on global ENGDAT V3 communications" including to create a transfer mechanism with existing standards and methodologies. The start is to study already existing technologies like RSA encryption, the Internet and experience from other existing transfer mechanisms like OFTP, AS2 and banking transactions (Sten Lindgren, 2004, SASIG Plenary Meeting, 2004, Göteborg).

"The used methodology for creation of the Common Denominators is qualitative research that takes place in the natural setting" (Creswell, 2003, page 181). The Common Denominator for this part is described with the following text: "The ad hoc work group set up the initial technical specification and a project plan including needed resource allocation for the standardization issue."

3.2.2 Column Sense-making

The first example chosen for the matrix box Initiate/Sense-making is that Mr Takamasa Tanaka in his minutes from SASIG Plenary year 2001 in Paris writes that the ENGDAT Ad Hoc group has now been transformed into XMTD WG (XMTD: eXchange and Management of Technical Data) with the mission to evaluate technical data exchange requirements against available standard approaches, and recommend solutions for the global automotive supply chain. (Takamasa Tanaka, 2001, SASIG Plenary Meeting, 2001, Paris.)

A second example is that Mr Jens Kuebler in his minutes writes that SASIG Plenary year 2001 in Detroit that a demonstration has been done by presenters from VDA showing how ENGDAT is working in Europe as an automatic EDI transfer mechanism for product data (Jens Kuebler, 2001, SASIG Plenary Protocol, Detroit).

A third example is that Mr Sten Lindgren writes in the SOFEC meeting minutes 2001-02-21 that a global EDI message is insufficient. There is also need to investigate the issue of how the transfer of the files is going to be handled (Sten Lindgren, 2001, SOFEC protocol, 2001-02-21).

A fourth example is that Mr Mike Strub writes in the SASIG XMTD Work Group Minutes, 2003, Stuttgart that SASIG XMTD have an interest in transfer protocol FTP and OFTP because the consciousness reached the level that the global EDI message ENGDAT needs a transfer mechanism that can handle the transfer of product data within the requirement and within the required time. This is why it is recommended to study FTP and OFTP to find a solution of the issue (Mike Strub, SASIG XMTD Work Group Minutes, 2003, Stuttgart).

A fifth example is that Mr Mike Strub writes in the minutes of SASIG XMTD Work Group Meeting, 2005, Fukuoka that Mr Andreas Exner, VDA has been given the task to create" a white paper based on ODETTE research of new Internet communication protocol alternatives for ENGDAT" to be presented at the autumn XMTD meeting about recommended transfer mechanism for ENGDAT (Mike Strub, 2005, SASIG XMTD Work Group Meeting, 2005, Fukuoka).

A sixth example is that Mr Sten Lindgren in the minutes of SASIG Plenary Meeting, 2004, Gothenburg writes that the SASIG Plenary approved the Business Case presented by Mr Nils Johansson based on the Volvo Cars, transfer volumes and transfer mechanism for transfer of product data with description of cost savings in the transition to global ENGDAT communication via secure internet transfer mechanism to compel sponsors to make the necessary resourses available for development of methodology to realize the necessary standard development (Sten Lindgren, 2004, SASIG Plenary Meeting, 2004, Gothenburg).

A seventh example is that Mr Jens Kuebler writes in the SASIG Plenary minutes, 2001, Detroit that the work with PDQ V2.0 shall be started Q1/2002. The new standard development is started to create an extension of the PDQ standard. The reason for this is that NIST had published a Business Case that showed how much the automotive industry lost in costs concerning reworking due to poor CAD quality and contributes to publishing a methodology of how the automatic control of the CAD quality can be made by posting and publication of guidelines (Jens Kuebler, 2001, SASIG Plenary minutes, 2001, Detroit).

"The used methodology for creation of the Common Denominators is qualitative research that takes place in the natural setting" (Creswell, 2003, page 181). The Common Denominator for this part is described with the following text:"The Board evaluated the ad hoc work group presentation including Business Case calculation".

3.2.3 Column Negotiation

The first example chosen for the matrix box Initiate/Negotiation is that Mr Emery Szmrecsanyi presented on the SASIG Plenary, 2002, Detroit according to the minutes that "There is a tremendous amount of cost involved in these questions. Government funding is sought to support interoperability projects" (Emery Szmrecsanyi, 2002, SASIG Plenary, 2002, Detroit).

The second example is that Mr. Jens Kuebler writes in the minutes of the SASIG Plenary minutes, 2000, Detroit that at the previous workshops in Detroit SASIG an Ad Hoc Work Group started up with participants from AIAG, JAMA, GALIA and a chair from VDA to investigate the "benefits" of ENGDAT/AP232 and study how these standards can be harmonized (Jens Kuebler, 2000, SASIG Plenary minutes, 2000, Detroit).

A third example is that Mr. Sten Lindgren writes in the minutes of SOFEC meeting 2001-02-21 that Mr. Per-Olof Gustavsson, Volvo Truck mentioned that Odette International has made a comparison between ENGDAT/CONDRA. Because of this it was decided that Ms Birgitta Karlsson, Scania should be contacted to inform Odette Sweden of how to handle the issue (Sten Lindgren, 2001, SOFEC protocol, 2001, Sweden).

A fourth example is that Mr Mike Strub writes in the SASIG XMTD WG Workgroup Minutes, 2003, Tokyo that Mr. Nils Johansson, Odette Sweden presented where ENGDAT fits in the OSI model 7 layer structure. It was explained that a standardized transfer mechanism also needed to be added referring to the OSI model, and that there is available technology to create a standardized solution for this by creating a secure transfer methodology using the globally existing Internet (Mike Strub, 2003, SASIG XMTD WG Workgroup Minutes, 2003, Tokyo).

A fifth example is that Mr Takamasa Tanaka writes in the SASIG Plenary meeting minutes, 2005, Paris that XMTD presented the wish that AIAG and JAMA should be open for use of OFTP2 because it is a global solution that via a secure transfer mechanism via Internet provides a global transfer mechanism for the interoperability of product data (Takamasa Tanaka, 2005, SASIG Plenary meeting minutes, 2005, Paris).

A sixth example is that Mr Emery Szmrecsanyi reports on the SASIG Plenary, 2002, Detroit that "There is a tremendous amount of cost involved in these questions" because the cost to rework bad CAD quality and a solution to solve this issue has been investigated by Work Groups within AIAG. These have sent representative to the SASIG PDQ group to find methodologies for solving this issue in a global perspective (Emery Szmrecsanyi, 2002, SASIG Plenary, 2002, Detroit).

"The used methodology for creation of the Common Denominators is qualitative research that takes place in the natural setting" (Creswell, 2003, page 181). The Common Denominator for this part is described with the following text: "Activities to reach a common agreement to proactive commitment of using and marketing the pre-

sented standard. Agree on funding of resources according to the organization law necessary to fulfil the standard development project up to status Use and Maintenance. ”

3.3 Process step Develop Standard

Table 3.2 The Process Step Develop Standard

	Design Creating and choosing design alternatives	Sense-making Attaching meaning to design alternatives	Negotiation Agreeing between designs, fixing the actor network
Develop Standard	The work group investigates state of the art of closely related technical specifications. Based on the study and the standardization issue, the specification of the standard is done. The specification is documented in a publication as well as guidelines how to use the standard.	The Board evaluates the presented publication and guidelines.	Negotiation between the parties results in a common agreement of how to publish the document. The agreement that has to be legally signed includes rules of how to publish, copyright and distribution.

3.3.1 Column Design

The first example chosen for the matrix box Develop Standard/Design is that Mr Philippe du Revault in the minutes of the SASIG Plenary Meeting, 2001, Detroit writes that the SASIG XMTD WG is given the ”mission to evaluate technical data exchange requirements against available standard approaches and recommend solutions to the global automotive supply net”. The task is to be solved in harmony with the existing standard candidates in the field. Each representative for the different National Organisations, that is members of SASIG, presented their demands that have been consolidated in a list. This list contains the entities that the standard delegates have demanded to be within the new message for product data interoperability (Philippe du Revault, 2001, SASIG Plenary Meeting, 2001, Detroit).

The second example chosen is that Ms. Petra Ålund writes in the minutes of SASIG Plenary Meeting, 2002, Las Vegas that the SASIG XMTD WG presented that the total amount of desired entities for the new message for product data interoperability has been organised as a development issue of the ENGDAT message by specifying the entities in different CC: Conformance Classes where CC1 describes ordering of a file; CC2. corresponds to ENGDAT V2, CC3 integrates the entities in ENGDAT V2 and

some of the entities from the list of entities for product data interoperability created on the SASIG XMTD WG, 2001, Detroit as an extension of the process to send files from sender to receiver; CC4 describes the entities for the abstract message when the receiver sends confirmation that the files are received OK. CC5 is the sum of all conformance classes CC1, CC2, CC3 CC4. This solution of splitting the total issue into different Conformance Classes means for Europe that they can continue to use ENGDAT V3 with entities on the same level as ENGDAT Version 2. The ENGDAT V3 has become a mechanism for product data communication to be used within global trading (Petra Ålund, 2002, SASIG Plenary Meeting, 2002, Las Vegas).

A third example is that Mr. Mike Strub writes in the minutes from SASIG XMTD Work Group Meeting, 2005, Fukuoka 2005 that the SASIG XMTD WG meeting decided that ENGDAT V3, in order to keep to the project plan, shall have a XML syntax. The XML syntax was already created. This decision was approved by the SASIG Plenary. The freezing of the ENGDAT V3 standard is a condition for the delivery of the standard to the Software Suppliers and Standard Publishing editors to be done (Mike Strub, 2005, SASIG XMTD Work Group Meeting, 2005, Fukuoka).

A fourth example is that Mr. Kazuharu Taga, JAMA according to the minutes at SASIG Plenary Paris 2003 presents that ”Version 2.0 expected to be approved by the end of January 2004” so the standard publication shall be sent to the software vendors instructing them how to create check programs for PDQ V2.0 (Kazuharu Taga, 2003, SASIG Plenary, 2003, Paris).

A fifth example is that Mr. Sten Lindgren writes in the minutes of the SASIG Plenary Meeting Göteborg 2004 that Mr. Lutz Voelkerath, VDA presented that ”The PDQ V2.0 documentation was officially released” and Mr Akram Yunas, AIAG declared that the process to ”Proceed with the publishing of PDQ Guidelines V2.0” is OK. This has the semantic meaning that the standard and the guidelines are at that moment published according to PDQ V2.0 so that “software vendors” can start the task of how PDQ V2.0 shall be realised in the tool for checking Product Data Quality (Sten Lindgren, 2004, SASIG Plenary Meeting, 2004, Gothenburg).

A sixth example is that Ms. Petra Ålund in the minutes of SASIG Plenary Meeting Las Vegas 2002 writes that Mr Pierre Germain-Lacour, GALIA, presents that for SASIG PDQ the following is planned. “In V2 new domains will be added; CAE meshes, manufacturing data, the quality stamp and some more” to also check these aspects and create tools for how to handle this with an automatic process. The protocol also recalls the following: “Don’t forget that the guideline also is a good tool for the SW vendors!” (Petra Ålund, 2002, SASIG Plenary Meeting, 2002, Las Vegas.)

A seventh example is that Mr Mike Strub writes in the SASIG Plenary minutes Stockholm 2002 that PDQ WG announce from their first meeting of the new PDQ-version that “Document structure will be kept” and “New contents” are “Non-geometric criteria, Meshing, Manufacturing, Quality Stamp”, so also these factors shall be checked

and given prerequisites of how to be checked with automatic check programs (Mike Strub, 2002, SASIG Plenary minutes, 2002, Stockholm).

”The methodology used for creation of the Common Denominators is qualitative research that takes place in the natural setting” (Creswell, 2003, page 181). The Common Denominator for this part is described with the following text: ”The work group investigates state of the art of closely related technical specifications. Based on the study and the standardization issue, the specification of the standard is done. The specification is documented in a publication as well as guidelines how to use the standard.”

3.3.2 Column Sense-making

The first example chosen for the matrix box Develop Standard/Sense-making is that Mr. Philippe du Revault writes in SASIG Plenary minutes Detroit 2001 that “XMTD WG informed that a common scenario and a first draft of data requirements has been developed during the workshop and those results have now to be validated by each national organization for the next XMTD meeting by arranging national XMTD WG activities” (Philippe du Revault, 2001, SASIG Plenary minutes, 2001, Detroit).

The second example is that Mr. Mike Strub describes in the SASIG XMTD WG meeting minutes Sindelfingen 2005 that the following was presented on the SASIG XMTD WG: ”ENX, ANX, JNX have no global common standard – ”GNX” – and won’t in the near future. OFTP should be promoted as an international standard, because it combines security with the ability to re-start or continue sending of data after communications links have been interrupted. It is being improved to include encryption, files over 10GB, and longer virtual file names. It will hopefully become capable of secure, robust, accurate Internet exchanges.” through development in an OFTP WG. (Mike Strub, 2005, SASIG XMTD WG meeting minutes, 2005, Sindelfingen.)

The third example is that Mr. Mike Strub describes in the SASIG Plenary Minutes Tokyo 2003 that the report from the PDQ WG by Mr Hidetaka Motooka presented that AIAG and GALIA “expressed great concern that publication must occur by end of year” to enable starting with the next step, that is to develop products for how the checks are to be performed.

The Common Denominator for this part is described with the following text: “The Board evaluate the presented publication and guidelines.”

3.3.3 Column Negotiation

The first example chosen for the matrix box Develop Standard/Negotiating is that Mr. Mike Strub describes in the SASIG Plenary Minutes Stuttgart 2003 that the Plenary stressed the importance of keeping the project plan for XMTD WG. The issue was about funding of a consultant. AIAG and JAMA demanded that the project plan was held as the consultant fees were not budgeted, This was a matter for negotiation to

solve for the SASIG organisation (Mike Strub, 2003, SASIG Plenary Minutes, 2003, Stuttgart).

The second example is that Mr. Mike Strub describes in the SASIG XMTD WG Meeting minutes Fukuoka 2005 that XMTD WG wishes to present ENGDAT V3 only with XML-syntax and support the utilisation of JADM in ENGDAT V4 in order to "support vendors and editors" who are translating the standard publication into their native language, which can only be done with a "finalized" standard (Mike Strub, 2005, SASIG XMTD WG Meeting minutes, 2005, Fukuoka).

The third example is that Mr. Mike Strub describes in SASIG XMTD WG meeting minutes Fukuoka 2005 that XMTD WG postpone the issue and asks how JAMA is able to implement ENGDAT without virtual filename because there has been no success in finding out how the issue is to be resolved (Mike Strub, 2005, SASIG XMTD WG meeting minutes, 2005, Fukuoka).

The fourth example is that Ms. Petra Ålund describes in the Plenary Meeting Las Vegas 2002 that Mr. Akram Yunas has given the following decision:"Each organization must send a formal email to Akram that states that we all agree upon the MoU, just to have it formally approved that nothing has been altered" to insure the legal binding between the parties and thus make clear what are the cooperative rules and what happens if you violate them (Petra Ålund, 2002, Plenary Meeting, 2002, Las Vegas).

The fifth example is that Ms. Petra Ålund describes in the Plenary Meeting Las Vegas 2002 that Mr. Pierre Germain-Lacour, GALIA presented that the PDQ WG have added requirements about the website in the private area and some directory to share the intercommunicating PDQ WG work between the SASIG PDQ WG meetings to handle how to solve the task of publishing the standard PDQ V2.0 (Petra Ålund, 2002, Plenary Meeting, 2002, Las Vegas).

The sixth example is that Ms. Petra Ålund describes in the Plenary Meeting Las Vegas 2002 that the Plenary discussed how to share costs for e.g. copying of the document. This discussion resulted in the following: "Each organisation has to decide how to handle the documents themselves. Please note that if anybody translates it must state that the original is in English and handled by SASIG." For a semantic debate about the meaning it is always to be considered that the English issue is the source for how the semantic interpretation is to be done (Petra Ålund, 2002, Plenary Meeting, 2002, Las Vegas).

The seventh example is that Mr Mike Strub describes in the SASIG XMTD Minutes 2003 (The participation list indicates it is the SASIG Plenary Minutes) that Plenary discussed the question of Chinese membership in SASIG because Chinese delegates expressed interest in the PDQ at the ISO meeting. Several proposals for resolving the issue were discussed but no solution on how the issue would be dealt with emerged (Mike Strub, 2003, SASIG XMTD Minutes, 2003).

The Common Denominator for this part is described with the following text: ” Negotiation between the parties results in a common agreement on how to publish the document. The agreement that must be legally attested includes rules for how to handle publishing, copyright and distribution.“

3.4 Process step Develop Products

Table 3.3 The Process Step Develop Products

	Design Creating and choosing design alternatives	Sense-making Attaching meaning to design alternatives	Negotiation Agreeing between designs, fixing the actor network
Develop Products	The software provider's design department creates the necessary software to fulfil the requirements in the published standard documentation.	The Software Developing Companies' CEOs evaluate the Business Case of developing and selling of software for published standard documentation.	An interoperability testing of the different software providers is done, supervised by standard organisation. If the solution has the required negotiation skill to pass it will be certified by the standard organisation according to this standard

3.4.1 Column Design

The first example chosen for the matrix box Develop Products/Design is that Mr. Sten Lindgren describes in the SASIG Plenary Meeting minutes Gothenburg 2004 that Mr. Lutz Voelkerath, VDA made the announcement that ”The PDQ V2.0 documentation was officially released” and Akram Yunas, AIAG announced that ”Proceed with the publishing of PDQ Guidelines V2.0” is OK. Because of these announcements, the standards and guidelines are now published for PDQ V2.0 so that “software vendors” can start working on how PDQ V2.0 shall be used as input to create the tools in the checker products (Sten Lindgren, 2004, SASIG Plenary Meeting minutes, 2004, Göteborg).

The Common Denominator for this part is described with the following text: ” The software provider design department creates the necessary software to fulfill the requirements in the published standard documentation. “

3.4.2 Column Sense-making

The first example chosen for the matrix box Develop Products/Sense-making is that Mr. Mike Strub writes in the SASIG XMTD WG meeting minutes Sindelfingen 2005 among the issues in the “to be done” list are SASIG XMTD WG ”Provide letter to ENGDAT V3 implementers and vendors with whom you work, explaining the chang-

es made by agreement at Fukuoka meeting." This "to be done" issue was reported to have been DONE only in Germany. In Germany the implementers and vendors had received the information that the standard was finalized. This message meant that the next step is how to develop the standard software (Mike Strub, 2005, SASIG XMTD WG meeting minutes, 2005, Sindelfingen).

The second example is that Mr. Mike Strub writes in the SASIG XMTD WG meeting minutes Fukuoka 2005 that it was reported by AIAG that "Ford and DC are talking to Autoweb on the side, creating their own internal business case" to motivate the investment in economic figures in the Business Case format that economic decision makers require (Mike Strub, 2005, SASIG XMTD WG meeting, 2005, Fukuoka).

The third example is that Mr Mike Strub writes in the SASIG XMTD WG meeting minutes Sindelfingen 2005 that in Sindelfingen more than 12 "SOFTWARE VENDORS e.g. SSC (SWAN), ProSTEP (DXM), ProCaess (DDX), Atos Origin (EDI Manager), GEDAS (RVS Engdat), Hüngsberg (Daxware), Seeburger (Winelke), Strålfors (eCAD), Numlog (FT Master), ICD, Schnitt (EurexC), Datranet, etc. were presented to map what support the standard will get concerning available products that ares able to handle it." From the standard organisation the information is given to the automotive industries supplier net about which suppliers are supporting the standard in question, which for XMTD WG is ENGDAT (Mike Strub, 2005, SASIG XMTD WG meeting minutes, 2005, Sindelfingen).

The fourth example is that Mr Lutz Völkerath reports in the SASIG PDQ WG Plenary presentation Stockholm 2007 that "Armonicos concentrates on geometric quality checks; about 50% of violations in the test models found agreement: PDQ WG delivers more information, Armonicos will repeat the test a.s.a.p.; TRANSCAT, Q-Checker geometric + non-geometric checks 100% of violations in the test models found the test result acceptable and are going to be reformatted to be published via SASIG-PDQ homepage. Candidates having performed the conf. test may state: "Check tool <xy> has performed the SASIG PDQ Guideline V2.1 conformance test with Checktool Version <abc> in <Date>." Optional: "Please visit www.sasig.com or www.sasig-pdq.com for details and possible remarks or restrictions;4 additional candidates will be asked to perform the conf. test in fall 2007, test data, documentation and result templates have to be corrected/updated (minor changes)". Because of this information it was stated that the process of certification is on-going to make final adjustments of how the certifying process is to be done (Lutz Völkerath, 2007, SASIG PDQ WG Plenary presentation, 2007, Stockholm).

The Common Denominator for this part is described with the following text: " The Software Developing Companies' CEOs evaluate the Business Case of developing and selling of a software for published standard documentation."

3.4.3 Column Negotiation

The first example chosen for the matrix box Develop Products/Negotiating is that Mr. Mike Strub writes in SASIG XMTD WG Minutes Paris 2003 (The participation list indicates that this ought to be the SASIG Plenary Minutes). At SASIG Plenary (2003-10-23) in Paris, a discussion arises partly from the need of an additional Euro 15 000 for ”further consulting work in 2004 from SASIG” about how software developers ought to share some of the standard development costs because they are able to make money-selling software for the standard. It was also discussed that the members of SASIG sponsor the standard with member fees, and arrange a meeting of SASIG plenary to find the Business Case that motivates why a standard is to be chosen and developed as well as how the development is to be financed (Mike Strub, 2003, SASIG XMTD WG Minutes, 2003, Paris).

The second example is that at the SASIG PDQ WG meeting (2004-09-30) in Gothenburg was reported that the PDQ V2.0 was published in 2004 and reached the status of ISO PAS in 2005. The conclusion of this was that the PDQ WG keep their schedules and have found a working model for delivering promised PDQ versions according to project plan (Lutz Voelkerath, 2004, SASIG PDQ WG Meeting, 2004, Gothenburg.) The conclusion from the clues is drawn that Development PDQ V1.0 starts and ends 2001. PDQ V1.1 starts 2001 and ends 2003. PDQ V2.0 starts 2002 and ends 2004.

The Common Denominator for this part is described with the following text: ” An interoperability testing of the different software providers is done supervised by standard organization. If the solution has the required negotiation skill to pass it will be certified by the standard organization according to this standard.”

3.5 Process step Implement

Table 3.4 The Process Step Develop Implement

	Design Creating and choosing design alternatives	Sense-making Attaching meaning to design alternatives	Negotiation Agreeing between designs, fixing the actor network
Implement	The standard stakeholders and customers in the business area stipulate in the Technical Specification that is attached to there Request For Quotation that the standard is to be used as a delivery demand for the requested order. Marketing presentations are designed and marketed. Education material is designed and taught.	The Supplier CEO evaluate the Business Case of investing hardware, software as well as education of personnel to fulfil the customer standard obligations when creating the Quotation for the potential customer	The standard stakeholders and customers in the business area stipulate in the Technical Specification that is attached to there Request For Quotation that the standard is to be used as a delivery demand for the requested order.

3.5.1 Column Design

The first example chosen for the matrix box Implement/Design is that Mr. Sten Lindgren writes in the SASIG Plenary minutes 2004-09-30 in Gothenburg that the Plenary made the following statement ”XMTD approved the content of the ENGDAT V3 document; the Plenary also gave their approval, document enclosed. It is going into rollout very shortly. The ENGDAT V3 document needs some update on formal information like copyright notice, version handling identification and Change Request form.” This says that the implementation is approved and how the final formal information of the ENGDAT V3 publication is to be done (Sten Lindgren, 2004, SASIG Plenary, 2004, Gothenburg).

The second example is that Mr Lutz Voelkerath presents at the SASIG PDQ WG Meeting Gothenburg 2004 that the SASIG-PDQ Future Strategy is the rollout of PDQ V2.0 in year 2005 to harvest the benefits of PDQ checking with PDQ V2.0 and how to best utilise the checking tools with the new checking possibilities (Lutz Voelkerath, 2004, SASIG PDQ WG Meeting, 2004, Gothenburg).

The Common Denominator for this part is described with the following text: “The standard stakeholders and customers in the business area stipulate in the Technical

Specification that is attached to there Request For Quotation that the standard is to be used as a delivery demand for the requested order.

Marketing presentations are designed and marketed.

Education material is designed and taught."

3.5.2 Column Sense-making

The first example chosen for the matrix box Implement/Sense-making is that Mr. Mike Strub writes in the SASIG XMTD WG Minutes Stuttgart 2003 that it was decided to create a common presentation to market ENGDAT V2 with Mr. Henner Stengel, VDA, as editor. The objective is that this presentation will be done in each country and demonstrate how ENGDAT V3 is an enabler of advantages for communication and interoperability of product data (Mike Strub, 2003, SASIG XMTD WG Minutes, 2003, Stuttgart).

The second example chosen is that Mr. Mike Strub writes in the SASIG XMTD Minutes Paris 2006 that XMTD WG presented for the Plenary that articles about ENGDAT V3 have been published by VDA, Odette Sweden and GALIA in order to raise awareness about how to improve global interoperability through the use of ENGDAT V3 (Mike Strub, 2006, SASIG XMTD Minutes, 2006, Paris).

The third example is that Mr. Joakim Hedberg writes in the SASIG XMTD WG Plenary report Detroit 2006 under the heading Liaison projects from Odette OFTP V2 working group that "Test rally is running, Standard to be approved in November and presented in the Odette Conference, end November 2006 and Roll out is planned in January 2007". The reason for the SASIG plenary interest in OFTP2 is that OFTP2 is an enabler for global interoperability of product data by being a secure transfer mechanism via the globally available Internet (Joakim Hedberg, 2006, SASIG XMTD WG Plenary report, 2006, Detroit).

The fourth example is that Mr Sten Lindgren writes in the SASIG Plenary Meeting minutes 2004 that it was presented by the PDQ WG and approved by the Plenary that "PDQ is now switching to deployment and roll-out activities and this will be the focus during 2005. The group will make a survey to monitor the success of the initiative and identify the improvement potential/business case for giving feedback to the sponsors of the development and analyse how to make more improvements" (Sten Lindgren, 2004, SASIG Plenary Meeting minutes, 2004, Gothenburg).

The fifth example is that Mr Oscar Roscha presents in the SASIG PDQ Plenary Report Paris 2006 that marketing has been done by articles in Industry Magazines about why a PDQ presentation on Odette Conference 2006 was found not necessary to get the information about PDQ spread (Oscar Roscha, 2006, SASIG PDQ Plenary Report, 2006, Paris).

The Common Denominator for this part is described with the following text:" The Supplier CEOs evaluate the Business Case of investing in hardware, software as well as education of personnel to fulfill the customer standard obligations when creating the Quotation for the potential customer".

3.5.3 Column Negotiation

The first example chosen for the matrix box Implement/Negotiation is that Mr. Mike Strub writes in the SASIG XMTD Minutes SASIG Paris that the XMTD WG assigns a task to its delegates from the respective national association activities about "data exchange current practices, status, and aspirations". This shall be done as input to the next meeting and is likely intended as a help for creation of a migration plan on the next meeting to make a coordinated presentation of how the plans for the implementation of ENGDAT V3 look (Mike Strub, 2006, SASIG XMTD Minutes, 2006, Paris).

The second example chosen is that Mr. Joakim Hedberg writes in the SASIG XMTD WG Plenary report Detroit 2006 that in the SASIG XMTD WG (2006-10-19) in Detroit was presented, under the title Liaison projects from Odette OFTP V2 working group, that "Test rally is running, Standard to be approved in November and presented in the Odette Conference, end November 2006 and Roll out is planned in January 2007". OFTP2 is interesting for SASIG Plenary as an enabler of global interoperability of product data by being a secure transfer mechanism via the globally available Internet (Joakim Hedberg, 2006, SASIG XMTD WG Plenary report, 2006, Detroit).

The third example is that Mr. Joakim Hedberg writes in the SASIG XMTD Plenary report that XMTD WG wishes to discuss the possible implementation of the ENGDAT V3 and OFTP V2 into Autoweb services to be able to communicate with Autoweb customers. It is proposed that this issue be solved by a "Meeting with Autoweb" (Joakim Hedberg, 2006, SASIG XMTD Plenary report, 2006, Detroit).

The fourth example is that at the SASIG Plenary (2004-09-30) in Gothenburg the following were reported by the PDQ WG on a slide as open issues:

- Release of SASIG PDQ guideline Version 2.0
- content in the copyright paragraph
- Details reg the SASIG Homepage
- "Go" or NoGo" for the 2005 schedule
- AIAG participation (English native editor)
- Chairman 2005 (AIAG, GALIA/Odette-Sweden)
- "virtual" meetings

This was done by the PDQ WG to get things cleared by the SASIG Plenary about how to handle these issues. (Lutz Voelkerath, 2004, SASIG PDQ WG Meeting, 2004, Göteborg).

The Common Denominator for this part is described with the following text: "The standard stakeholders and customers in the business area stipulate in the Technical Specification that is attached to there Request For Quotation that the standard is to be used as a delivery demand for the requested order."

3.6 Process step Use

Table 3.5 The Process Step Use

	Design Creating and choosing design alternatives	Sense-making Attaching meaning to design alternatives	Negotiation Agreeing between designs, fixing the actor network
Use	Once the investment is made there are no more design issues for connecting a new business party using the standard other than to make the integration of one more party in the standardization net. Best practice documents are designed and taught.	The standard stakeholders and customer as well as the supplier-net using them get the return payment of the standard developed according to the business case calculation.	An easy agreement task as both business parties use the same standard, implementation is invested and the personnel are educated.

3.6.1 Column Design

The Common Denominator for this part is described with the following text: "Once the investment is made there are no more design issues for connecting a new business party using the standard other than to make the integration of one more party in the standardization net.

Best practice documents are designed and taught."

3.6.2 Column Sense-making

The first example chosen for the matrix box Use/Sense-making is that Mr. Joakim Hedberg writes in the SASIG XMTD WG Plenary report Detroit 2006 that the SASIG XMTD WG stresses the importance of "product data exchange" because "infrastructure is a prerequisite for data exchange". This issue is what the Plenary is requesting

action about to solve ”the China/India issue” (Joakim Hedberg, 2006, SASIG XMTD WG Plenary report, 2006, Detroit).

The Common Denominator for this part is described with the following text: ” The standard stakeholders and customers as well as the supplier-net using them get the return payment of the standard developed according to the business case calculation.”

3.6.3 Column Negotiation

The first example chosen for the matrix box Use/Negotiation is that Mr. Mike Strub writes in the SASIG XMTD WG Meeting minutes that XMTD WG approves the by Nils Johansson, created and presented “Odette Sweden subset ENGDAT V3 that has been created on the agreement “Odette Sweden Common ENGDAT V2”. This has been done in order to gain acceptance from automotive OEMs in Sweden. This is considered necessary by Odette Sweden and assures that the mandatory items are not ignored. This acceptance by SASIG requires creating a subset that is accepted by Swedish OEMs’ wish to use ENGDAT V3 by creating a subset (Mike Strub, 2005, SASIG XMTD WG Meeting minutes, 2005, Fukuoka).

The Common Denominator for this part is described with the following text: ” An easy agreement task as both business parties use the same standard, implementation is invested and the personnel are educated.”

3.7 Process step Feedback

Table 3.6 The process step Feedback

	Design Creating and choosing design alternatives	Sense-making Attaching meaning to design alternatives	Negotiation Agreeing between designs, fixing the actor network
Feedback	The work group design a change request routine and present it to the board as well as needed request routine requirements. Post standard requirements are designed of improved standard requirements of maintenance that is escalated to the board as an initiative to start up development of new edition or version of this standard. Study obstacles to exchange from the supplier perspective, to design appropriate Education & Promotion.	The Board evaluates the presented change request routine and assigns funding for the request routine. The board evaluates the issue of stopping old standards and initiating new ones.	Activities to reach a common agreement to proactive commitment of using and marketing the presented change request routine. Agree on funding of resources according to the Organization Law necessary to fulfil the change the standard request routine. Agree on when to stop using old versions and initiate new ones. Study obstacles to exchange from the supplier perspective, Education & Promotion.

3.7.1 Column Design

The first example chosen for the matrix box Feedback/Design is that Mike Strub writes in the SASIG XMTD WG meeting minutes that Mr. Nils Johansson, Odette Sweden provided a White Paper. The White Paper was about how ENGDAT XML might harmonize with e.g. JADM, OAGIS, UML, etc. (Mike Strub, 2005, SASIG XMTD WG, 2005, Sindelfingen).

The second example chosen is that Mr. Joakim Hedberg writes in the SASIG XMTD WG Plenary report Detroit 2006 that there is a “Maintenance Task Force e.g. ENGDAT V3.1” with Mr. Joakim Hedberg, Odette Sweden as Task Force Leader to take

care of issues that are to be inserted within ENGDAT V3.1 (Joakim Hedberg, 2006, SASIG XMTD WG Plenary report, 2006, Detroit).

A third example is that Mr. Mike Strub writes in the SASIG Plenary Minutes Tokyo 2003 that Mr. Hidetaka Motooka, JAMA reports about PDQ Version 1.1 publication approval. This writing shows that a maintenance process is in action, and one effect is the publication of a new revision of PDQ Version 1 (Mike Strub, 2003, SASIG Plenary Minutes, 2003, Tokyo).

The Common Denominator for this part is described with the following text: " The work group design a change request routine and present it to the board as well as needed request routine requirements.

Post standard requirements are designed of improved standard requirements of maintenance that is escalated to the board as an initiative to start up development of new edition or version of this standard.

Study obstacles to exchange from the supplier perspective, to design appropriate Education & Promotion."

3.7.2 Column Sense-making

The first example chosen for the matrix box Feedback/Sense-making is that Mr. Mike Strub writes in the SASIG XMTD WG meeting minutes Sindelfingen 2005 that Mr. Nils Johansson, Odette Sweden presents a white paper "that evaluates and/or reviews standards which ENGDAT XML might harmonize with e.g. JADM, OAGIS, UML, etc.*see PREAMBLE below" to enlighten the SASIG XMTD on how this can be done (Mike Strub, 2005, SASIG XMTD WG meeting minutes, 2005, Sindelfingen).

A second example is that at the SASIG Plenary meeting Stockholm 2007 Mr Lutz Völkerath reports that "thefollowing activities are on-going in the PDQ WG."

GALIA: CATIA V5 DX project, PDQ conference in May, maintaining the ISO contact (OR)

JAMA/ PDQ questionnaire, articles

JAPIA: JAMA Forum (incl. PDQ)

Odette S: decided to start national WG 3 participating SASIG PDQ Meeting, PDQ introduction with Lutz Völkerath April 19

VDA: prepare and chair SASIG PDQ M. Budget for Meetings, WWW & (Lutz Völkerath (2007-04-19) SASIG PDQ WG Plenary presentations (2007), SASIG, Stockholm, Sweden). This is to be seen as a status report and examples of how different National Organisations are at different positions in the race but are still aiming at the same result, viz. reducing costs using automatic check programs (Lutz Völkerath, 2007, SASIG Plenary meeting, 2007, Stockholm).

The Common Denominator for this part is described with the following text: ” The Board evaluates the presented change request routine and assigns funding for the request routine.

The board evaluates the issue of stopping old standards and initiating new ones.”

3.7.3 Column Negotiation

The first example chosen for the matrix box Feedback/Negotiation is that Mr. Mike Strub writes in the SASIG XMTD WG meeting minutes Fukuoka 2005 that VDA present its opinion, that VDA wants a JADM-compliant standard that is planned to take 2-3 meetings, but it should be referred to ENGDAT V4 to clarify that VDA has a positive attitude towards JADM as an enabler of making ENGDAT a more truly global standard enabling use of different syntaxes whose entities with semantic meaning are based on JADM (Mike Strub, 2005, SASIG XMTD WG meeting minutes, 2005, Fukuoka).

The second example is that Mr. Oscar Roscha reports to the SASIG Plenary Report Paris 2006 that tests are ongoing with “CAD Vendor: Dassault Systèmes and 4 Checker Vendors: Armonicos, Datakit, Transcat and Spring”. This can give a positive feedback to all parties — standard developers, CAD Vendors and Checker Vendors — on how activities can be made to work harmoniously and be improved (Oscar Roscha, 2006, SASIG Plenary Report, 2006, Paris).

The third example is that Mr. Takamasa Tanaka writes in the SASIG Plenary meeting minutes Sindelfingen 2005 that Mr. Lutz Völkerath, VDA presents from the PDQ WG that ”Some amount of budget (e.g. 1000$ per each organization) might be needed for establishing www.SASIG-PDQ.com by PDQ-WG itself based on the status on October 7th, 2005.” As the issue could not be solved immediately it was to be treated so that a “Final decision is to be made on e-mail communication between WG (LV) and SASIG Plenary (AL, TT)” (Takamasa Tanaka, 2005, SASIG Plenary meeting minutes, 2005, Sindelfingen).

The fourth example is that Mr Alexandre Loire writes in the SASIG Plenary Meeting minutes Stockholm 2007 that the following discussion took place between Mr Lutz Völkerath, VDA in the role as the PDQ WG presenter of the PDQ WG issues and the Plenary: ”Ensure concrete offer/request and concrete statements of all members in case of significant new input (e.g. CATIA V5 DX)?"

Plenary position: Yes

May we check whether tool vendors having successfully performed the PDQ conformance test use the SASIG logo?

Plenary position: No

This discussion is interpreted as that the PDQ WG want to have the financing ready before a new standardization project begins and that the providers of check software

see it as an advantage to use SASIG logo for certified products, i.e. Questions about how to finance new standardization projects before starting and how to motivate PDQ check providers to certify themselves as having lived up to the SASIG requirements. (Alexandre Loire, 2007, SASIG Plenary Meeting minutes, 2007, Stockholm).

The Common Denominator for this part is described with the following text: ” Activities to reach a mutual agreement to proactive commitment by using and marketing the presented change request routine. Agree on funding of resources according to the Organization Law necessary to fulfil the change in the standard request routine.

Agree on when stop using old versions and initiate new ones.

Study obstacles to exchange from the supplier perspective, Education & Promotion.”

3.8 Process step Terminate

Table 3.7 The process step Terminate

	Design Creating and choosing design alternatives	Sense-making Attaching meaning to design alternatives	Negotiation Agreeing between designs, fixing the actor network
Terminate	A 3rd valid standard version is going into use status	Maximum 2 valid ”major” versions	Decision of old standard termination

3.8.1 Column Design

The first example chosen for the matrix box Terminate/Design is that Mr. Nils Johansson assumes that the proposal Mr. Joakim Hedberg, Odette Sweden makes in the SASIG XMTD WG Plenary report Detroit 2006 must also have been prepared in the SASIG XMTD WG. The wordings in the SASIG Plenary minutes are that SASIG XMTD WG presents the following proposal to the Plenary: ”The Plenary is to make a statement about document versions at a higher level, covering all SASIG work products. This statement should include a limitation of a maximum of 2 valid ”major” versions (e.g. 2.0, 3.0) of any document current at any time. This would mean, for example, that we could support 2.0, 2.3 AND 3.0 and 3.1 simultaneously for a given document”. This presentation was made to get a clear ruling for the decision on how the termination of a SASIG standard should be done (Joakim Hedberg, 2006, SASIG Plenary minutes, 2006, Detroit).

The Common Denominator for this part is described with the following text: ” A 3rd valid standard version is going into use status”

3.8.2 Column Sense-making

The first example chosen for the matrix box Terminate/Sense-making is that Mr. Joakim Hedberg writes in the SASIG XMTD WG Plenary minutes Detroit 2006 that the following was reported from the SASIG XMTD WG. The description in SASIG Plenary minutes is that the following is reported as presented from SASIG XMTD WG: ”The Plenary is to make a statement about document versions at a higher level, covering all SASIG work products. This statement should include a limitation of a maximum of 2 valid ”major” versions (e.g. 2.0, 3.0) of any document current at any time. This would mean, for example, that we could support 2.0, 2.3 AND 3.0 and 3.1 simultaneously for a given document.” This presentation was made to get a clear ruling for the decision on how the termination of a SASIG standard should be done (Joakim Hedberg, 2006, SASIG Plenary minutes, 2006, Detroit).

The Common Denominator for this part is described with the following text: ” Maximum 2 valid ”major” versions “

3.8.3 Column Negotiation

The first example chosen for the matrix box Terminate/Negotiation is that Mr. Mike Strub writes in the SASIG XMTD Minutes Paris 2003 (participation list shows it ought to be the SASIG Plenary Minutes) that Plenary discusses and comes to the conclusion that: “We should limit versions to V1, V2, and etc. V1.1 could be seen as a technical corrigendum of V1, because it contains only minor changes to V1.” This has the semantic meaning that V1.1 can be available without causing a version to be terminated. A termination rule is to terminate a specific version if two versions with a higher version number of the same standard are in use. (Mike Strub, 2003, SASIG XMTD Minutes, 2003, Paris).

The Common Denominator for this part is described with the following text: ”Decision of old standard termination.”

3.9 Summary of the process within SASIG

The development of common global standards in the automotive industry can be both technically and politically a complex process. This is something that certainly everyone involved experienced. (Sten Lindgren, 2010-12-07, “To develop standards for product data communication in the automotive industry”, <www.odette.se>, 2010-12-07)

General description standards lifecycles within SASIG review what has been said about the three standards.

Our model suggests that each activity is essential for standardization. Sometimes they overlap, while in other instances they can be clearly separated. The SASIG XMTD WG ENGDAT V3 provides an example of a situation where design, sense-making, and negotiation took place concurrently. During the early stage of the standardization

process several designs were proposed. Several meetings were to be conducted about designing the common denominator for design, creating the necessary sense-making Business Case to be accepted by the SASIG Plenary and Negotiation regarding using an XML-syntax. The Odette Sweden proposition of improvement by defining all message entities to JADM in order to make possible modelling to any syntax e.g. XML, EDIFACT, and still having the possibility to interpret message entities between them while retaining the semantic meaning was postponed to the next version of the standard. XML is an eXtendable Markup Language that can be used for describing messages, e.g. EDI messages.

The simultaneous need for integrating negotiation and a design space into the standardization effort shows how technological, social, economic and political rationales became intertwined through the intersections of the standardization activities. A SASIG self-developing process is in progress. The goal for this process is to identify issues triggered by suggestions from the different stakeholders. The result is described in the SASIG by Laws, Guidelines and Memorandum of Understanding. The SASIG organization not only developed standards but also introduced activities to harmonise the different standards used.

Table 3.8 Summary of the model applied to the SASIG and ODETTE process. Step Initiate to Implement

	Design Creating and choosing design alternatives	**Sense-making** Attaching meaning to design alternatives	**Negotiation** Agreeing between designs, fixing the actor network
Initiate	The ad hoc work group sets up the initial technical specification and a project plan including needed resource allocation for the standardization issue	The Board evaluates the ad hoc work; group presentation including Business Case calculation	Activities to reach a common agreement to proactive commitment of using and marketing the presented standard. Agree on funding of resources according to the organization law necessary to fulfil the standard development project up to status Use and Maintenance.
Develop Standard	The work group investigates state of the art of closely related technical specifications. Based on the study and the standardization issue, the specification of the standard is done. The specification as well as guidelines for using the standard are documented in a publication.	The Board evaluates the publication and guidelines presented.	Negotiation between the parties results in a common agreement of how to publish the document. The agreement, that has to be legally signed, includes rules of how to publish, copyright and distribution.
Develop Products	The software provider design department creates the necessary software to fulfil the requirements in the published standard documentation.	The Software Developing Companies' CEOs evaluate the Business Case of developing and selling software for published standard documentation.	An interoperability testing of the different software providers is done supervised by standard organisation. If the solution has the required negotiation skill to pass it will be certified by the standard organisation according to this standard
Implement	The standard stakeholders and customers in the business area stipulate in the Technical Specification that is attached to there Request For Quotation that the standard is to be used as a delivery demand for the requested order. Marketing presentations are designed and marketed. Education material is designed and taught.	The Supplier CEO evaluates the Business Case of investing hardware, software as well as education of personnel to fulfil the customer standard obligations when creating the Quotation for the potential customer.	The standard stakeholders and customers in the business area stipulate in the Technical Specification that is attached to there Request For Quotation that the standard is to be used as a delivery demand for the requested order.

Table 3.9 Summary of the model applied on the SASIG and ODETTE process. Step Implement to Terminate

	Design Creating and choosing design alternatives	**Sense-making** Attaching meaning to design alternatives	**Negotiation** Agreeing between designs, fixing the actor network
Implement	The standard stakeholders and customers in the business area stipulate in the Technical Specification that is attached to there Request For Quotation that the standard is to be used as a delivery demand for the requested order. Marketing presentations are designed and marketed. Education material is designed and taught.	The Supplier CEO evaluates the Business Case of investing hardware, software as well as education of personnel to fulfil the customer standard obligations when creating the Quotation for the potential customer.	The standard stakeholders and customers in the business area stipulate in the Technical Specification that is attached to there Request For Quotation that the standard is to be used as a delivery demand for the requested order.
Use	Once the investment is made there are no more design issues for connecting a new business party using the standard than to integrate one more party in the standardization net. Best practice documents are designed and taught.	The standard stakeholders and customer as well as the supplier-net using them get the return payment of the standard developed according to the business case calculation.	An easy agreement task as both business parties use the same standard, implementation is invested and the personnel are educated.
Feedback	The work group design a change request routine and present it to the board as well as needed request routine requirements. Post standard requirements are designed of improved standard requirements of maintenance that is escalated to the board as an initiative to start up development of new edition or version of this standard. Study obstacles to exchange from the supplier perspective, to design appropriate Education & Promotion.	The Board evaluates the presented change request routine and assigns funding for the request routine. The board evaluates the issue of stopping old standards and initiating new ones.	Activities to reach a common agreement to proactive commitment of using and marketing the presented change request routine. Agree on funding of resources according to the Organization Law necessary to fulfil the change in the standard request routine. Agree on when to stop using old versions and initiate new ones. Study obstacles to exchange from the supplier perspective, Education & Promotion.
Terminate	A 3rd valid standard version is going into use status	Maximum 2 valid ”major” versions	Decision of old standard termination

4 Improving the Usability of the Model

The Motorola Six Sigma methodology is a tool used to reduce variations in processes with the goal of reaching 99.9997% defect free production processes. The process shows that when the amount of variation is lowered, the Sigma Value indicating higher quality increases. (Brassard et al., 2002, pp 1-4.)

A very interesting future study about standardization initiatives would be to investigate the complete exchange of data activity including the whole Automotive Supplier network, to find out how to create and use standards for securing and optimising the whole flow.

4.1 LMS - Lifecycle Management of Standards

4.1.1 The flow of LMS - Lifecycle Management of Standards

"As a Six Sigma team member, you will most likely work on improvement teams using the DMAIC method. To use this method successfully, you must first be familiar with the goals and outputs of each step, as well as the correct approach to take during each step and the tools necessary to complete your work" (Brassard et al., 2002). In this flow, DMAIC is the acronym for Define, Measure, Analyze, Improve and Control. An acronym for the Lifecycle of the Standardization process vertical levels should (in the same methodology using the first letter of each process step) be IDDIUIT, standing for the process steps Initiate, Design, Develop, Implement, Use, Improve and Terminate.

These IDDIUIT process steps are presented vertically in the study matrix, where the procedure is in the down direction.

Each process step proceeds from left to right, with iteration within the steps in the mission part.

To use the IDDIUIT method you must first, as in the DMAIC method, be familiar with the goals and outputs of each step, as well as the correct approach to take during each step and the tools necessary to complete your work. In the IDDIUIT, as in DMAIC, the Prerequisites for starting the process are an issue that the organisation is

thinking will get a more positive Business Case if using the respective methodologies IDDIUIT and DMAIC to solve the issue.

In IDDIUIT, as in DMAIC, the respective process steps are Prerequisites and provide the Input to the next step in the process.

In the case of IDDIUIT each part process is described in one horizontal step. These horizontal process steps contain the following parts: *Prerequisite*, *Mission* and *Objective*. The Prerequisite is presenting the criteria to be fulfilled to pass the Gate and be handled by the process. A Gate is the rules necessary to be fulfilled to go on with a new process step. The Objective is presenting the criteria to be fulfilled to pass the Gate of being the delivery of a process step.

The Mission step during each process part is divided in three parallel iteratively ongoing activities: Design, Sense-making and Negotiation. The Design is a process of "Creating and choosing design alternatives". The Sense-making is the process of "Attaching meaning to design alternatives". The Negotiation is the process of "Agreeing between designs, fixing the actor network".

"Flowchart Why use it? To allow a team to identify the actual flow or sequence of events in a process that any product or service follows. Flowcharts can be applied to anything from the travels of an invoice or the flow of materials, to the steps in making a sale or servicing a product." (Brassard et al., 2002, p. 116).

The IDDIUIT is actually a process Flowchart described in a Table or matrix. The flow as described in this study begins at the upper left corner named "Issues from the Maintenance Routine", moves to the right and yields the resulting "Agreed Fundings" described in the frame furthest to the right.

Inside the process step Mission an iterative flow takes place. This iterative flow has the objective to create and deliver an output according to the criteria of the outgoing gate of this process step. This output becomes input for the next vertical process-part downwards: Develop Standard with the prerequisite "Founded Work Group" and Objective "Published Standard and Guidelines".

This process of inGates and outGates follows on each vertical level, and ends when the process comes to the lower right corner: "Old standard is terminated".

To shorten the lead time for the whole process it is possible to use the Concurrent Engineering methodology by working iteratively on the Drafts of output from earlier steps in the process. Then there are processes like Use that may continuously create new issues to be taken care of by the Improve process step.

Note that in general output from one step is also to be assumed to be a prerequisite for the next process step, even if it is not written in the left column for the next step.

If the whole process is printed out, the process steps are cut out horizontally. Then a long horizontal paper strip of the process can be taped together. On this paper strip the

output of the previous step will appear as input to the next step together with the prerequisites described in the left column of each horizontal process step. An alternative is to present the IDDIUIT in the form of one or several concurrent engineering processes.

4.1.2 The semantic meaning of the words in the table of the LMS - Lifecycle Management of Standards

The words of the process steps in the LMS are Prerequisite, Mission, Objective, Design, Sense-making and Negotiation

Prerequisite has the semantic meaning to be the needed input for this process step. Mission – The work to be done – describes what activities must be created by this process step by using the prerequisite to deliver the process step objectives. Objective has the semantic meaning to be the resulting output from the mission process-step. Design is meaning - Creating and choosing design alternatives. This has the semantic meaning to study the technical state of the art in order to create the most cost-effective technical solution. Sense-making means Evaluation of Standard Benefits. This has the semantic meaning to evaluate how a described technical solution is to be valued in the Business perspective. Negotiation – Common Agreement –means to find a solution that the parties can agree on even if there are several stakeholder opinions.

4.2 Initiation of new standardization issue

Table 4.1 *The Process Step Initiation*

Initiation				
Prerequisite	**Mission** - *The work to be done*			**Objective**
The needed input for this process-step	**Design**	**Sense-making**	**Negotiation**	The result to be delivered
Issues from the Maintenance Routine	Requirements Specification	Business Case Evaluation	Funding Agreement Process	Agreed Fundings

The input for this process step called “Issues from the Maintenance Routine” has the semantic meaning that an initiative is taken with the idea that an existing issue is suitable for solution as a Standard Development Initiative.

The process step Design – Requirements Specification – has the semantic meaning that an “Ad Hoc WorkGroup” with participation from all parties prepares a “Requirement Specification” that contains the issues of all involved parties.

One methodology to be used in this process step is "Focused Problem Statement Narrowing the problem definition. Why use it? To narrow the focus of a problem so that you can use your time and resources most effectively in finding a solution."(Brassard et al., 2002, page 124). This is done by examining the state of the art of existing solutions and deciding what existing solutions are to become candidates for the standard solution.

A second methodology to be used in this process step is "Interrelationship Digraph (ID) Looking for drivers & outcomes. Why use it? To allow a team to systematically identify, analyze, and classify the cause-and-effect relationships that exist among all critical issues so that key drivers or outcomes can become the heart of an effective solution."(Brassard et al., 2002, page 147).

The chosen standard candidates are studied and a common list of all items to be covered in the presupposed standard is produced and agreed on. These common lists are to be taken back by the representatives to each of their standard consortium groups that they represent for second thoughts and review.

Sense-making – Business Case Evaluation – has the semantic meaning that the Plenary evaluates the Business Case as decision support if a funded Work Group to solve the issue is to be created. The methodology to be used is "y = f (x) Formula Identifying the key process drivers. Why use it? To determine what factors in your process (as indicated by a measure) you can change to improve the CTQs and, ultimately, the key business measures. What does it do? … Highlights the factor the team wants to change and what impact the change will have." (Brassard et al., 2002, page 263). CTO is an acronym for Critical To Quality.

In this step the formula y = f (x) is used to create a Business Case formula and make a calculation for the standard case using the parameters of the today issue and the predicted tomorrow issue in this niche.

Negotiation – Funding Agreement Process – has the semantic meaning that the parties agree on how to sponsor the standard development.

The methodology for this step is "Commitment Scale — Helping people commit to change. Why use it? To identify and secure the support of, and remove the resistance of, people and systems vital to the accomplishment of the work. What does it do? Identifies people or groups involved in or affected by a change. Explicitly states the level of commitment required by each person or group before you can implement the change successfully. Identifies the amount of work needed to bring people or groups to the level of commitment needed for you to implement the changes successfully. Helps you set priorities and develop appropriate communication plans for different people or groups." (Brassard et al., 2002, page 67)

The agreed rules are documented in ByLaws, MoU and JDA. "ByLaws. In the U.S., bylaws are the administrative provisions for the internal management of a corporation, for example shareholders' annual meetings, the board of directors, and corporate con-

tracts and loans." (<http://www.translegal.com/great-divide/bylaws>). "A memorandum of understanding (MOU or MoU) is a document describing a bilateral or multilateral agreement between parties. It expresses a convergence of will between the parties, indicating an intended common line of action. It is often used in cases where parties either do not imply a legal commitment or in situations where the parties cannot create a legally enforceable agreement. It is a more formal alternative to a gentlemen's agreement."(<http://en.wikipedia.org/wiki/Memorandum_of_understanding>). JDA is an acronym for Joint Document Agreement and is used to get a legal agreement about the copyright of published documents and how they are allowed to be published and used.

The output for this process-step called "Agreed Fundings" are the fundings budgeted and agreed by the different parties for the new standardization issue. This funding is to be calculating all the fundings from the process step "Design of Standard" to "Termination of Standard".

4.3 Design Standard

Table 4.2 The Process Step Design Standard

Design Standard				
Prerequisite	**Mission** - *The work to be done*			**Objective**
The needed input for this process-step	**Design**	**Sense-making**	**Negotiation**	The result to be delivered
Funded Work Group	Investigation, Integration and Specification	Evaluation of publication and guidelines.	Joint Document Agreement	Published Standard and Guidelines

The input for this process step called "Funded Work Group" has the semantic meaning that a WorkGroup is available to solve the issue. Design – Investigation, Integration and Specification – has the semantic meaning that State of the Art technologies are studied in order to find a technical solution of the issue. The appropriate technical solutions are used as input for the creation of a draft of the Standard and Guidelines.

One methodology to be used in this step is "Flowchart Picturing the picturing the process. Why use it? To allow a team to identify the actual flow or sequence of events in a process that any product or service follows. Flowcharts can be applied to anything from the travels of an invoice or the flow of materials, to the steps in making a sale or servicing a product. What does it do? Shows unexpected complexity, problem areas, redundancy, unnecessary loops, and where simplification and standardization may be possible. Compares and contrasts the actual versus the ideal flow of a process to iden-

tify improvement opportunities. Allows a team to come to agreement on the steps of the process and to examine which activities may impact the process performance. Identifies locations where additional data can be collected and investigated. Serves as a training aid to understand the complete process." (Brassard et al., 2002, page 116).

A second methodology to be used is available, and this is that "Odette have initiated the Joint Automotive Data Model, JADM, to provide a XML Schema and UML model, via XMI, for EDI messages."(Jonas Rosén, 2010, "Development of Industrial Information Systems based on Standards, Doctoral Thesis Production Engineering Royal Institute of Technology, Stockholm, 2010, page 59). Using the JADM to define the semantic of all items to be described within the coming standard makes it possible to standardise the meaning of the items so they can be used by modelling tools to model standards into different syntaxes, e.g. XML and EDIFACT. When the items in the different syntaxes have the same semantic source it will still be possible to convert items from one syntax to another. This globally defined semantic of the item will make it possible to bridge different variations, e.g. subsets and local standard applications, with "one to one correspondence".

The Sense-making – Evaluation of publication and guidelines – has the semantic meaning that Plenary decides how to handle the input from the Design Work-Group.

The methodology to do this is an "Activity Network Diagram (AND) Scheduling sequential & simultaneous tasks. Why use it? To allow a team to find both the most efficient path and realistic schedule for the completion of any project by graphically showing total completion time, the necessary sequence of tasks, those tasks that can be done simultaneously, and the critical tasks to monitor. What does it do? All team members have a chance to give a realistic picture of what their piece of the plan requires, based on real experience. Everyone sees why he or she is critical to the overall success of the project. (Brassard et al., 2002, page 27)

The plan for implementation is completed with a "To do list", where all the tasks for different parties within the Design process steps are specified as well as when the deliveries are to be made.

Negotiation – Joint Document Agreement – has the semantic meaning that all parties have signed a legally valid agreement on how to publish the Standard and Guidelines.

The method to be used is "Commitment Scale" (Brassard et al., 2002, page 67).

The agreed rules are documented in ByLaws, MoU and JDA.

The output of the process-step called "Published Standard and Guidelines" is the Standard and Guidelines that are frozen and published. This is one of the prerequisites for the next process step, Develop Product(s) for the standard.

4.4 Develop Product(s)

Table 4.3 The Process Step Develop Product(s)

Develop Product(s)				
Prerequisite	**Mission** - *The work to be done*			**Objective**
The needed input for this process-step	**Design**	**Sense-making**	**Negotiation**	The result to be delivered
Funded Product Development	OSI modular open standard	Product Market Business Case	Certification for Interoperability	Published Products for Sale

The input for this process called "Funded Product Development" has the semantic meaning that an initiative is taken by the software development companies that are willing to transform the published Standard and Guidelines into Software able to handle them. Design – OSI modular open standard – has the semantic meaning that the software is modularized according to the OSI standard. The OSI reference model consists of seven electronic service and segment levels which, starting from the bottom with Physical media for OSI, are: 1. Physical, 2. Data Link, 3. Network, 4. Transport, 5. Session, 6. Presentation, 7. Application. These service levels are grouped so levels 1 - 3 handle Network service; 4 – 7 Telematic service (Tineke Egyedi, 1996, Shaping Standardization, 1996, Rotterdam, p. 177).

A tool to be used in the process step Develop Product(s) is "Jackson Structured Programming or JSP [which] is a method for structured programming based on correspondences between data stream structure and program structure." (<http://en.wikipedia.org/wiki/Jackson_Structured_Programming>)

Sense-making – Product Market Business Case – has the semantic meaning that the Software Creators use a Business Case calculation of the Product before deciding on the development of the software for the published standard.

One methodology to be used is "y = f (x) Formula Identifying the key process drivers. Why use it? To determine what factors in your process (as indicated by a measure) you can change to improve the CTQs and, ultimately, the key business measures. What does it do? … Highlights the factor the team wants to change and what impact the change will have." (Brassard et al., 2002, page 263).

Negotiation – Certification for Interoperability – has the semantic meaning of a process between the standard publishing organisation and the software providers concerning an interoperability test created by the standard publisher for the software producers to fulfil. When the software provider has fulfilled the interoperability test, it will be

published on the standard publisher web page showing other parties who is certified for interoperability concerning this standard.

An additional helpful methodology is that the Open Standard Suppliers use "Commitment Scale — Helping people commit to change. Why use it? To identify and secure the support of, and remove the resistance of, people and systems vital to the accomplishment of the work. What does it do? Identifies people or groups involved in or affected by a change. Explicitly states the level of commitment required by each person or group before you can implement the change successfully. Identifies the amount of work needed to bring people or groups to the level of commitment needed for you to implement the changes successfully. Helps you set priorities and develop appropriate communication plans for different people or groups" (Brassard et al., 2002, page 67). For getting legal right for open standard communication for everybody it is necessary to have agreed rules that are documented in ByLaws and MoU. This rules needs to make clear that all software suppliers that are applying to the standard enable communication using the open software. This should also be valid for their customers who have chosen a VAN-solution where the VAN-company charge the suppliers for the customer CAD-communication cost. If this is not done there are suppliers who have invested in the open standard that will also have to pay fees for local standard. The supplier needs if making Request For Quotation to invest in not open standard solution if this is prescribed in the Request For Quotation attached Technical Specification Business Rules of the customer. When this happen this becomes transaction cost that is to be added to the supplier costs calculated in the Request For Quotation.

The output of the process step called "Published Products for Sale" has the semantic meaning that software for the published product is available for purchase on the open market. This is a prerequisite for the process step Implement.

4.5 Implement

Table 4.4 The process step Implement

Implement				
Prerequisite	**Mission** - *The work to be done*			**Objective**
The needed input for this process-step	**Design**	**Sense-making**	**Negotiation**	The result to be delivered
Stakeholders Coordinated Deployment	Technical Specifications	Suppliernet Business Case Evaluation	Customer Demand	Deployment in supplier network

The input for the process called ”Stakeholders Coordinated Deployment” has the semantic meaning that the stakeholders fulfil the commitments from project step Initiate to implement the standard in a coordinated way. This influences the supplier network since the suppliers have the possibility to spread the investment costs for using the open standard towards all customers or presumptive customers that have committed to use the new standard.

Design – Technical Specifications – has the semantic meaning given in the demand the customer is making concerning using the open standard within the Technical Specifications that are attached to the customer Request For Quotation.

The methodology to be used in this process step is “The Control Step Goals and Outputs. The goal of the Control step is to maintain the gain you have made by standardizing your work methods or processes, anticipating future improvements, and preserving the lessons you learn from this effort. The outputs of the Control step include the following: Documentation of the new method. Training of fellow employees in the new method. A system for monitoring the consistent use of the new method and for checking the results. Completed documentation and communication of the results, learnings, and recommendations.”(Brassard et al., 2002, page 22)

Sense-making – Supplier-net Business Case Evaluation – has the semantic meaning of the Business Case Evaluation that the suppliers make when handling the Request For Quotation.

The methodology to be used is “y = f (x) Formula Identifying the key process drivers. Why use it? To determine what factors in your process (as indicated by a measure) you can change to improve the CTQs and, ultimately, the key business measures. What does it do? … Highlights the factor the team wants to change and what impact

the change will have" (Brassard et al., 2002, page 263). The supplier company calculates whether if open standard is used, the investment on the order is to be shared depending on how many of the supplier customers are expected to respect using the open standard. If an OEM specific VAN is used, these costs are to be fully calculated in the Quotation for this customer. OEM is the Original Equipment Manager, i.e. the highest level of the customers in the automotive supplier chain. A Value-added Network (VAN) is a hosted service offering that acts as an intermediary between business partners sharing standards based on proprietary data via shared Business Processes. The offered service is referred to as "Value-added Network Service".(<http://en.wikipedia.org/wiki/Value-added_network>, 2010-12-07). In such cases the hosting service company, that is a supplier for OEM, charges the suppliers. The suppliers is in this case bound to use the VAN-solution from the VAN-supplier because it is specified in the Technical Specification requirements that is attached to the OEM Request For Quotation. This is a way to distribute a part of the IT costs of the OEM to the suppliers who, to survive, have raised the price of the delivered products.

Negotiation – Customer Demand – has the semantic meaning of the negotiation between the supplier and customer about how to handle the demands in the Technical Specifications attached to the OEM Request For Quotation.

The methodology to use in this process step is to "When negotiating, always look for win-win solutions, and present them as such." (<http://ezinearticles.com/?Three-Negotiation-Techniques&id=397691>). In the business negotiation it is always possible for the supplier to offer different prices if open standard can be used where the investment could be shared, compared to using a non-standard solution and thereby find a Win-Win Solution because the purchaser has the objective to fulfil the purchasing budget before fulfilling the requirements of EDI communication in the Technical Specifications.

The output of this process step called "Deployment in supplier network" is spreading the open standard in the supplier network.

4.6 Use

Table 4.5 The Process Step Use

Use				
Prerequisite	**Mission** - *The work to be done*			**Objective**
The needed input for this process-step	**Design**	**Sense-making**	**Negotiation**	The result to be delivered
Standard Deployed at level De Facto Standard	Existing Implemented Standard	Evaluation of Standard Benefits	Common Agreement	Harvesting the Standard Benefits

The input for the process called ”Standard Deployed at level De Facto Standard” has the semantic meaning that the open standard is spread in the network to the level where it is assumed that most of the parties in the network are using it. “A *de facto standard* is a custom, convention, product, or system that has achieved a dominant position by public acceptance or market forces (such as early entrance to the market).

Design – Existing Implemented Standard – has the semantic meaning that is has become a common methodology so you expect other parties to have already made the investment when starting a Request For Quotation activity.

The methodology to be used is the “Kano Model for categorizing customer needs. Why use it? Helps to describe which needs, if fulfilled, contribute to customer dissatisfaction, neutrality, or delight. (Brassard et al., 2002, page 158).

Sense-making – Evaluation of Standard Benefits – has the semantic meaning that it is now possible to evaluate the Business Case Calculation. This is done by comparing the Business Case Calculation done in the process-step Initiate with the result of Savings obtained when the Lifecycle Management of Standards process has reached the process-step Use.

A methodology to be used is “y = f (x) Formula Identifying the key process drivers. Why use it? To determine what factors in your process (as indicated by a measure) you can change to improve the CTQs and, ultimately, the key business measures. What does it do? … Highlights the factor the team wants to change and what impact the change will have.” (Brassard et al., 2002, page 263)

Negotiation – Common Agreement – has the semantic meaning that all agree on the effect of the benefits of the standard in Use.

A methodology to use in this process step is to “When negotiating, always look for win-win solutions, and present them as such”. (Three Negotiation Articles). In the

business negotiation it is always possible for the supplier to offer different prices if it is possible to use open standard, where the investment could be shared, compared to using a non-standard solution and thereby find a Win-Win Solution because the purchaser has the objective to fulfil the purchasing budget before fulfilling the requirements in the Technical Specifications.

The output of this step is ”Harvesting the Standard Benefits”, which has the semantic meaning the effect for the companies and the network concerning the bottom result of the company business.

4.7 Improve

Table 4.6 The Process Step Improve

Improve				
Prerequisite	**Mission** - *The work to be done*			**Objective**
The needed input for this process-step	**Design**	**Sense-making**	**Negotiation**	The result to be delivered
Issues from the experience of using the standard	Maintenance Routine	Evaluation Maintenance Issues	Funding of Maintenance issues	Maintenance upgrading or new standard issues

The input for the process step called “Issues from the experience of using the standard” is upcoming issues from error corrections or desired improvements derived from the standard working in process step Implementation or Use.

Design - Maintenance Routine – has the semantic meaning to be a routine to take care of incoming maintenance issues.

The methodology to be used in this step is “Cause & Effect/ Fishbone Diagram. Find & cure causes, NOT symptoms. Why use it? To allow a team to identify, explore, and graphically display, in increasing detail, all of the possible causes related to a problem or condition to discover its root cause(s). What does it do? Enables a team to focus on the content of the problem, not on the history of the problem or differing personal interests of team members. Creates a snapshot of the collective knowledge and consensus of a team around a problem. This builds support for the resulting solutions. Focuses the team on causes, not symptoms.”(Brassard et al., 2002, page 263) This looking for the basic problem signals that Troubleshooting is done in the form of problem solving applied to repairing failed products or processes.

Sense-making – Evaluation Maintenance Issues – has the semantic meaning to evaluate the Business Case of fixing the maintenance issue either by creation of a new standard revision or, if it is major maintenance issue, by creating a new standard version.

The methodology to be used is "y = f (x) Formula Identifying the key process drivers. Why use it? To determine what factors in your process (as indicated by a measure) you can change to improve the CTQs and, ultimately, the key business measures. What does it do? … Highlights the factor the team wants to change and what impact the change will have." (Brassard et al., 2002, page 263) Another methodology to help solve this kind of issue is to create a Task Force dedicated to the problem.

Negotiation – Funding of Maintenance issues – has the semantic meaning to find how to share the funding for fixing the Maintenance issue(s).

The methodology to be used in this step is "Prioritization matrices — Weighing your options". Why use it? To narrow down options through a systematic approach of comparing choices by selecting, weighting, and applying criteria. What does it do? Quickly surfaces basic disagreements so they may be resolved up front. Forces a team to focus on the best thing(s) to do, and not everything they could do, dramatically increasing the chances for implementation success. Limits "hidden agendas" by surfacing the criteria as a necessary part of the process. Increases the chance of follow-through because consensus is sought at each step on the process (from criteria to conclusions). Reduces the chances of selecting someone's "pet project". (Brassard et al., 2002, p. 189)

The output of this process step, "Maintenance upgrading or new standard issues", has the semantic meaning that either a maintenance upgrading has been done or a new issue standard will be sent to the Work-Group responsible for this standard.

4.8 Terminate

Table 4.7 The Process Step Terminate

Terminate				
Prerequisite	**Mission** - *The work to be done*			**Objective**
The needed input for this process-step	**Design**	**Sense-making**	**Negotiation**	The result to be delivered
Issue from the deployment of new version of active standard	A 3rd valid standard version is going into use status	Maximum 2 valid ”major” versions	Decision of old standard termination	Old standard is terminated

The input to the process step called “Issue from the deployment of new version of the active standard” has the semantic meaning that information arrives that the standard with a version-number 2 steps higher has come into the process step Use, which has the semantic meaning that a standard with version-number 2 steps higher is commonly used.

Design – A 2-steps-higher valid standard version is going into use status.

One methodology that helps this is that the design of the 2 step higher valid standard is backwards compatible. “In the context of telecommunications and computing, a device or technology is said to be backward or downward compatible if it can work with input generated by an older device. If products designed for the new standard can receive, read, view or play older standards or formats, then the product is said to be backward-compatible; examples of such a standard include data formats and communication protocols. Jocularly referred to as "hysterical raisins" i.e., a homophone like phrase for "historical reasons".”

(<http://en.wikipedia.org/wiki/Backward_compatibility>, 2010-12-14).

Sense-making – Maximum 2 valid “major” versions – has the semantic meaning that an agreement has been reached in the Plenary that a maximum of 2 versions of a standard are going to be in use simultaneously. The business case for this is calculated and approved. A methodology for this is “y = f (x) Formula Identifying the key process drivers. Why use it? To determine what factors in your process (as indicated by a measure) you can change to improve the CTQs and, ultimately, the key business measures. What does it do? … Highlights the factor the team wants to change and what impact the change will have.” (Brassard et al., 2002, p. 263)

Negotiation – Decision on old standard termination – has the semantic meaning that the Plenary is taking a decision on how the termination of the old standard is going to happen.

The methodology for this step is “Commitment Scale — Helping people commit to change. Why use it? To identify and secure the support of, and remove the resistance of, people and systems vital to the accomplishment of the work. What does it do? Identifies people or groups involved in or affected by a change. Explicitly states the level of commitment required by each person or group before you can implement the change successfully. Identifies the amount of work needed to bring people or groups to the level of commitment needed for you to implement the changes successfully. Helps you set priorities and develop appropriate communication plans for different people or groups. (Brassard et al., 2002, page 67) The agreed rules are documented in ByLaws, MoU and JDA. “ByLaws. In the U.S., bylaws are the administrative provisions for the internal management of a corporation, for example shareholders’ annual meetings, the board of directors, and corporate contracts and loans.” (<http://www.translegal.com/great-divide/bylaws>).

The output of this process step is “Old standard is terminated”.

4.9 The LMS - Lifecycle Management of Standards Table

Table 4.8 The Process LMS - Lifecycle Management of Standards

Lifecycle Management of Standards for the Steps – Initiate, Design, Develop, Implement, Use, Improve and Terminate				
Prerequisite	**Mission** - *The work to be done*			**Objective**
Process-step: The needed input for this process-step	**Design**	**Sense-making**	**Negotiation**	The result to be delivered
Initiate: Issues from the Maintenance Routine	Requirements Specification	Business Case Evaluation	Funding Agreement Process	Agreed Fundings
Design: Funded Work Group	Investigation, Integration and Specification	Evaluation of publication and guidelines.	Joint Document Agreement	Published Standard and Guidelines
Develop: Funded Product Development	OSI modular open standard	Product Market Business Case	Certification for Interoperability	Published Products for Sale
Implement: Stakeholders Coordinated Deployment	Technical Specifications	Suppliernet Business Case Evaluation	Customer Demand	Deployment in supplier network
Use: Standard Deployed at level De Facto Standard	Existing Implemented Standard	Evaluation of Standard Benefits	Common Agreement	Harvesting the Standard Benefits
Improve: Issues from the experience of using the standard	Maintenance Routine	Evaluation Maintenance Issues	Funding of Maintenance issues	Maintenance upgrading or new standard issues
Terminate: Issue from the deployment of new version of active standard	A 3rd valid standard version is going into use status	Maximum 2 valid ”major” versions	Decision of old standard termination	Old standard is terminated

5 Conclusions

This chapter presents a summary and an evaluation of the research results. Further, the research contribution is described.

5.1 Summary and Evaluation of the results

The aim of this thesis has been to provide a description and understanding of the process of developing and maintaining an international standard, and point out lessons to be learned from this process to favour future work and deepen the understanding of the lifecycle of standards.

The research methodology applied was to apply qualitative evaluation techniques on participatory case studies concerning the development of three standards within the SASIG organisation namely ENGDAT V3, OFTP2 and PDQ V2. The author has been an active member of the committees that have developed the standards studied and could contributed with own experience.

A composite model for the lifecycle management of standards was created based on the work described in (Söderström, 2004) supplemented with the D-S-N process described in (Fomin, 2003). The composite model was then further developed into a modelling process using Six-Sigma methodology (Brassard, 2002), with requirements for input and output conditions for each process step.

The presented model was verified applying the methodology for qualitative research presented in (Creswell, 2003) on the SASIG and Odette Sweden protocols from 2000-2007 and by the author's own experiences during standardization work on the global EDI standards ENGDAT V3, OFTP2 and PDQ V2.

The developed process model, *LMS-Lifecycle Management of Standards,* can be applied for the development of global EDI standards in the automotive industry. The model can also be generalized to describe the standardization process where the development of software is included.

5.2 Future research

The author’s suggestion is that industrial future research and development and specifically the further development of EDI tools for the automotive industry should concen-

trate on how to coordinate the open standard ENGDAT, OFTP, PDQ and STEP AP214 CC6 for asynchronous PDM to PDM communication.

Future standardization modelling work should focus on the further development and verification of the developed LMS –Lifecycle Management of Standards process model. I am confident that the LMS –Lifecycle Management of Standards process model developed can be expanded beyond the global product data interoperability standard for the Automotive Industries.

6 Summaries of the appended papers

Paper A – Creating a Business Case for Product Data Management – A Transaction Cost Approach

"The information technology process described in this paper seems to be a good illustration of what is actually the essence of the meaning of the transaction cost approach (Williamson 1981). At the same time the case also illustrates the difficulties in measuring that same transaction cost when it is dynamic over time and involves several actors and, last and foremost, is a technological development (and adoption process) in itself.

Analyzing the business case creation at Volvo Cars IT, we can conclude that IT is both a means to compress transaction cost and a part of the transaction cost itself. The ENGDAT system is developed to decrease costs for transfer of product data, but of course involves introduction costs.

The first observation regards the dynamics within the case. Since the case of ENGDAT is an on-going process over time and in interaction among several actors, there is never a single decision or a single business case.

The second interesting observation is thus that the business case is developed along the way as technological development proceeds. There is thus inter-dependence between the technological development and forming the base of decision that regards its development.

The third conclusion, following the first and second, is that the business case is part of the project or makes up the development project in itself.

In a development project of the kind investigated in this paper there is never a final goal by which the outcome can be measured. Information technology is under continuous development and thus never totally finished. Even more important to recognize is that the business case is about making product development more effective and efficient. The measurement is thus relative, and consists of continuous improvements.

Lastly we want to point to the 'fact' that there are both 'hard' and 'soft' dimensions within a business case. The soft dimension includes, for example, intangible values, relational improvements, strategic alignment and competitive power. The hard dimen-

sion includes income increase and cost reduction, and it may be that the income dimension is forgotten or disregarded."

Paper B – Managing the eXchange or Data in the Extended Enterprise

"ENGDAT version 3 will make the global exchange of product data in the automotive industry easier and faster. Enhanced with STEP AP214 CC6, it will enable the automatic transfer of complete assemblies between EDM/PDM-systems. Large assemblies like an engine containing 300 parts sent automatically as an assembly between EDM/PDM-systems will save substantial lead time and manual work at the receiver of the data.

UML (Unified Modelling Language) will be used for the basic definition of ENGDAT Version 4. Thus applications based on XML and EDIFACT can be automatically produced from the same source, accelerating the development of communication products based on the new standards.

The global adoption of these standards contributes to the globalisation and the agility of the future networked organisations."

Paper C – A Global Standard for eXchange and Management of Technical Data

"Global standard achieved on this level but imperfect interoperability is an important and extensive problem.

- Implementation differs too much and these differences are not properly represented in the specification.

- Publication and presentation of the specification (XML) is not fully "global".

To cope with this there is a possibility for SASIG XMTD WG to make a harmonization utilizing UN/CEFACT ISO/TS 1500 CCTS."

7 Glossary

BACKWARD OR DOWNWARD COMPATIBLE: A telecommunications and computing device or technology that can work with input generated by an older device.

BIAS: To evaluate and act upon the world and find that it is the only right way

BUSINESS CASE: A Sense-making that captures the reasoning for initiating a project or task. It is often presented in a well-structured written document, but may also sometimes come in the form of a short verbal argument or presentation. The logic of the business case is that, whenever resources such as or effort are consumed, they should be in support of a specific business need. An example could be that a software upgrade might improve system performance, but the "business case" is that better performance would improve customer satisfaction, require less task processing time, or reduce system maintenance costs. A compelling business case adequately captures both the quantifiable and unquantifiable characteristics of a proposed project. evaluate and act upon the world and find that it is the only right way.

BYLAWS: The administrative provisions for the internal management of a corporation, for example shareholders' annual meetings, the board of directors, and corporate contracts and loans.

CONCURRENT ENGINEERING: A work methodology based on the parallelization of tasks (i.e. performing tasks concurrently).

CONSTRUCTIVISM: A theory of knowledge that argues that humans generate knowledge and meaning from an interaction between their experiences and their ideas.

DE FACTO STANDARD: A custom, convention, product, or system that has achieved a dominant position by public acceptance or market forces.

JACKSON STRUCTURED PROGRAMMING JSP: A method for structured programming based on correspondences between data stream structure and program structure.

MEMORANDUM OF UNDERSTANDING MOU: A document describing a bilateral or multilateral agreement between parties. It expresses a convergence of will between the parties, indicating an intended common line of action. It is often used in cases where parties either do not imply a legal commitment or in situations where the parties cannot create a legally enforceable agreement. It is a more formal alternative to a gentlemen's agreement.method for structured programming based on correspondences between data stream structure and program structure.

OBJECTIVITY: A measurement that can be tested independent from the individual scientist (the subject) who proposes them. It is thus intimately related to the aim of testability and reproducibility. To be properly considered objective, the results of measurement must be communicated from person to person, and then demonstrated for third parties, as an advance in understanding of the objective world. Such demonstrable knowledge would ordinarily confer demonstrable powers of prediction or technological construction.

SCHRÖDINGER'S CAT: A thought experiment, usually described as a paradox, devised by Austrian physicist Erwin Schrödinger in 1935. It illustrates what he saw as the problem of the Copenhagen interpretation of quantum mechanics applied to everyday objects. The thought experiment presents a cat that might be alive or dead, depending on an earlier random event.

SOFTWARE DEVELOPMENT PROCESS: A software development lifecycle structure imposed on the development of a software product.

VALUE ADDED NETWORK VAN: A hosted service offering that acts as an intermediary between business partners sharing standards based or proprietary data via shared Business Processes. The offered service is referred to as "Value-added Network Service".

8 Acronyms and Abbreviations

AP	Application Protocol
AS2	Applicability Statement 2 – a secure transfer protocol using SSL
AIAG	Automotive Industry Action Group
CA	Certificate Authorities
CAD	Computer-Aided Design
CAE	Computer-Aided Engineering
CAM	Computer-Aided Manufacturing
CAX	Computer-Aided (design, manufacturing, engineering, etc.) system
CC	Conformance Class
CCTS	Core Component Technical Specification
CRL	Certification Revocation List
DMU	Digital Mock Up
DSM	Digital Shape Model, the math data that describes a certain component.
EDI	Electronic Data Interchange
ENGDAT	Engineering Data
ENGPART	Engineering Partnerdata
ENX	European Network Exchange
EXTER	External Communication of Technical Information: the support system for handling the communication of technical information, implemented at Volvo Car Corporation since 1991. This system contains two main databases: the Math Model Database and the Partner Database.The reasons for establishing the EXTER system were: • Reduce cost per unit

- Increase quality through establishing agreements specifying communication parameters that are stored and retrieved digitally (The Partner Database).
- Improve traceability by establishing a journal function of all transfers of technical information.

FDX Ford Data eXchange

Galia Groupement pour l'Amélioration des Liasons dans l'Industri Automobile, see www.galia.com/

IKDC Ingvar Kamprad Design Centre, Lund University, Sweden

ISDN Integrated Services Digital Network

IP Internet Protocol

JADM Joint Automotive Data Modelling

JAMA Japan Automobile Manufacturers Association

See www.jama.org

JAPIA Japan Auto Parts Industries Association

See www.japia.or.jp

JDA Joint Document Agreement

JIBS Jönköping International Business School, Sweden

LMS Lifecycle Management of Standards

MoU Memorandum of Understanding

NIST National Institute of Standards and Technology

See www.nist.gov

ODETTE Organisation for Data Exchange by Tele Transmission in Europe.

Odette Sweden The Swedish National Organisation, member of ODETTE and SASIG

OAG Open Application Group Inc.

OEM Original Equipment Manufacturer

OFTP Odette File Transfer Protocol

OSEV3 The Odette Sweden ENGDAT V3 Subset

PDM Product Data Management

PDQ Product Data Quality

PLM	Product Lifecycle Management
RFC	Request for Comments
RFQ	Request For Quotation
ROI	Return On Investment
RSA	Encryption methodology developed by Rivest, Shamir, Adleman
RP	Rapid Prototyping
SASIG	Strategic Automotive product data Standards Industry Group,
SFTP	Secure Shell File Transfer Protocol
SGML	Standard Generalized Markup Language
SSL	Secure Sockets layer
STAR	Standards for Technology in Automotive Retail
STEP	STandard for Exchange of Product Data
SWA	Secure Web Access
TCA	Transaction Cost Analysis
TCP	Transmission Control Protocol
TS	Technical Specification
UN/CEFACT	United Nations Centre for Trade Facilitation and Electronic Business
VAN	Value Added Network
VDA	Verband der Automobileindustrie See http://www.vda.de/
WG	Workgroup
X.25	a connection-oriented packet switched network services, for synchronous data traffic
XML	*Extensible Markup Language.*
XMTD	*Exchange and Management of Technical Data.*

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Appended Papers

CREATING A BUSINESS CASE FOR PRODUCT DATA MANAGEMENT – A TRANSACTION COST APPROACH

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Abstract

Today, in order to justify business technology investments, people in charge of technological progress are to a great extent demanded to create and present a business case that outlines how the firm is going to get returns on the investments made. This paper aims at describing the development of a business case for product data management at Volvo Car Corporation and their work in implementing ENGDAT, a data exchange standard for product data exchange. The paper outlines the costs associated with implementation and the savings expected after implementing ENGDAT based on a transaction cost approach. We find that this is a case of transaction cost (reduction). We also find that the dynamics within the real process is a challenge to making operational the transaction coast approach.

Key words: product data management, transaction cost approach, business case, action research, Volvo Car Corporation

Introduction

The automotive industry has often been referred to as the 'industry of industries' (Drucker 1946) as it is an industry that is in the forefront of management practice and technological development. Due to its importance, a lot of scholarly attention has been given to the industry over the years (e.g., Womack, Jones et al. 1990; Lamming 1993). In most countries where the automotive industry is present with production, the scale and scope of the industry is shown by the significance on the country's general economic performance. In Sweden, for example, with more than 1200 individual companies and an annual turnover of more than € 11 billion, the automotive industry is one of the largest and most important industries. However, the automotive industry in Sweden and elsewhere is facing problems with of overcapacity and decreasing profitability. To cope with increasing pressure from competition and diminishing margins, one trend in the industry has been to move production to low salary countries (e.g., Karlsson 2003). Another trend has been to try to enable increased efficiency in product development through production of new car models based on generic platforms (e.g., Meyer and Lehnerd 1997). A third trend has been to cut lead times in product development through supplier involvement (e.g., von Corswant and Fredriksson 2002). These current trends implies that in order to cope with the development, coordination of activities both within firm boundaries across continents and across firm borders and continents becomes critical (e.g., Hultman and Axelsson 2005). When dealing with the challenges of coordination and collaboration, information technology has become a key ingredient for actors in the automotive industry (e.g., Volpato and Stocchetti 2002; Sánchez Martínez and Pérez Pérez 2004).

During the last two decades we have seen an increasingly growing flora of information and communications technology applications have emerged, basically to reduce the costs of transaction and to create smooth links within and between firms. For example, e-marketplaces and e-commerce (e.g., Howard and Holweg 2004), electronic data interchange (e.g., Rassameethes, Kurokawa et al. 2000), enterprise resource planning (e.g., Motwani, Akbulut et al. 2005), radio frequency identification (e.g., Strassner and Fleisch 2005), collaborative platforms and virtual collaboration (e.g., May, Carter et al. 2000) and so on. In addition, research has shown that how to exploit IT is one of the most important current concerns among managers and executives in purchasing and supply (Carter, Carter et al. 2000). Today, in order to justify business technology investments, for example of the kind described above, people in charge of technological progress are to a great extent demanded to create and present a business case that outlines how the firm is going to get returns on the investments made. Therefore, we can see a growing number of literatures within the area of business case creation, mainly of the normative type (e.g., Remenyi 1999; Keen and Digrius 2003). From a descriptive perspective, there is still a lot of work to be done. There are, however, a few scholarly empirical contributions on business case creation (e.g., Ross and Beath 2002; Maklan, Knox et al. 2005). Despite these recent of empirically and descriptive contributions to the field, more in depth case studies seem to be lacking. In this paper, we adopt the definition of a business case as defined by Remenyi (1999): "A justification for pursuing a course of action in an organizational context to meet stated organizational objectives or goals. A business case frequently involves assessing the value of an investment in terms of its potential benefits and the resources required to set it up and sustain it, i.e., its on-going costs."

This paper describes the development of a business case for product data management at Volvo Car Corporation (Volvo Cars). The empirical context is the development and investments associated with ENGDAT (ENGineering DATa), a technology developed for transaction cost compression in product data management. Our purpose is to explore how ENGDAT, seen from the perspective of Volvo Cars, can be interpreted as a transaction cost inspired business case.

Introducing ENGDAT – a technology for transaction cost compression

As we already have discussed in the first section of this paper, the dynamics of the buyer-supplier relationship in the automotive industry has undergone significant changes during the last years. The increased need for collaboration and coordination also implies increased transaction costs. ENGDAT was the result of a European cooperation project driven by Odette International and its Swedish branch Odette Sweden. The basic driver behind the development of standardization for product data exchange is the number of interfaces that many firms in the industry have had to deal with and that exchange could be facilitated by including a message that revealed a description of the content in a batch of files being sent. The logic is that the stronger acceptance a standard way to communicate receives the less complex the transaction infrastructure becomes. The first industry recommendation of what the ENGDAT message should look like was published in 1994. Since then, two updated versions have been developed. In 2005, with the publication of ENGDAT version 3 (ENGDAT V3), ENGDAT had gone from being a region-specific standard, i.e. European, to a being a global application built on more sophisticated technology and therefore incomparable to the first version published in 1994.

In Europe, a solution for product data communication in the automotive industry is a technology called ENGDAT. Compared to Catia or Exter, that both are examples of software used at Volvo Cars, ENGDAT is not tangible software but rather a standard message for the transmission of product data. ENGDAT is a type of file, or message, rather than a specific software-file. The principle is that every time a package of product data files is sent between two users, there package is accompanied by an additional ENGDAT-file describing the content, the receiver and the sender. To show the need for transaction-cost compression, Volvo Cars recently reported at a product data management conference in Sweden that they transmitted approximately 40 gigabytes of data every month. At the same conference, the Swedish truck manufacturer Scania reported an almost quadrupled need to transfer CAD-data between its 1000 CAD-users during the years 1999-2003. Since the products dealt with are very complex, the volumes of data files are huge. According to an engineer at Volvo 3P, the unit responsible for product planning, product development, purchasing and product range management for the three truck companies, Mack, Renault Trucks and Volvo Trucks, a complete integrated CAD-model of a vehicle contains 15.000-20.000 separate files. In addition, since the development of a new car model is indeed costly, a split of the development costs of one car with another car model can make quite a difference on the returns of the investment. A common metaphorical description of ENGDAT is that it functions for file transfer as an envelope functions for a letter.

A transaction cost approach framework

In 1937, Ronald Coase (1937), posed an intriguing question that several years later would give him the Nobel Prize in Economics. The question that Coase posed was: *why are there firms?* In its simplicity, the question formed a school of thought applied in several fields of research except the one in which it had its origin, economics. The answer from Coase was: *because there are transaction costs!* Coase argued that prevalent research had treated firms as shadow figures in economics, yet they have significant importance. At the time when the article was published, the dominant perspective in economics was the classical economics and the general equilibrium approach. No one had really posed the challenging question of why firms exist. According to Coase, and what turned out to be the transaction cost approach, firms exist as an adaptation to the existence of transaction costs. Drawing on the work of Coase, a few seminal articles on transaction cost economics in the 1980's (e.g., Williamson 1981), the transaction cost approach has gained an increasing acceptance as a perspective not only in economics but also in other related disciplines. The basic unit of analysis within the transaction cost approach is the transactions taking place within a dyadic buyer-seller context.

The transaction cost approach asserts that organizations have two ways of organizing their activities – either through hierarchies or through markets (e.g., Williamson 1975; Williamson 1981). A key weakness of the transaction cost approach has been argued to be that those who have championed the approach have had difficulty to operationalize transaction cost constructs and propositions (e.g., Aldrich 1999). The concept of transaction costs were partly operational zed by Coase himself, but to the extent operationalization has been done within the transaction cost approach, credit is sometimes given to Dahlman (1979), who argued that transaction costs could be characterized into different types; search and information costs, bargaining and decision costs, and monitoring and enforcement costs. All these costs are further on explained as being derived from the need of information and therefore, all transaction costs are in fact information costs. Technological investments, either process- or product related, can either be general or transaction specific. If transaction-specific, they have very little relevance outside a particular buyer-seller relationship (e.g., Williamson 1985). The rationale for transaction-specific investment is that in certain relationships or in certain type of transactions, the costs of transaction creates a pressure to capitalize on the level of interaction through finding ways to find cost efficiency. Such investments, as other investments, would naturally involve both fixed and variable costs.

The transaction cost approach has been widely applied within research on information systems (e.g., Ciborra 1987; Malone, Yates et al. 1987; Aubert, Rivard et al. 1996; Son, Narasimhan et al. 2005). The general purpose of these studies is to see how information technology can reduce imperfection and inefficiencies. For example, in the framework presented by Malone et al., (1987) in their seminal paper on electronic markets and electronic hierarchies, it is claimed that electronic interconnections stimulate three specific effects on inter-firm relationships. These effects are concluded to alter the traditional view of buyer-seller relationships. The effects are first, *the electronic communication effect*, second, *the electronic brokerage effect*, and finally *the electronic integration effect*. The authors argue that, through increased communication, costs of communication have decreased dramatically, and that buyers

are enabled to compare offerings more efficiently, which decreases the costs in the process of product or supplier selection. Further on, since information technology allows tighter coupling of the processes that create and use information, the costs of coordination between and within firms have decreased.

Methodology

Business cases are used as to form the base of decision for ongoing technological and product development cases as well as for purchasing decisions. Any business case is therefore quite difficult to get access to. A business case is also dynamic. It is under continuous development. Thus trust is an important maybe even a prerequisite means for a researcher to get access to a business case development process. In or case the process with Volvo was initiated several years ago for the purpose of learning about the of the information technology that was under development. Thereby a relationship was developed between the company representatives who are also a co-author in the paper. To some extent the pair of researcher and IT-developer can de described as working according to an action research approach when it comes to the technological process.

Along the process our interest for the business issues within the case developed. It was obvious that business considerations were taken into account along the process where several actors within the supply chain were involved as collaborators within the information technology.

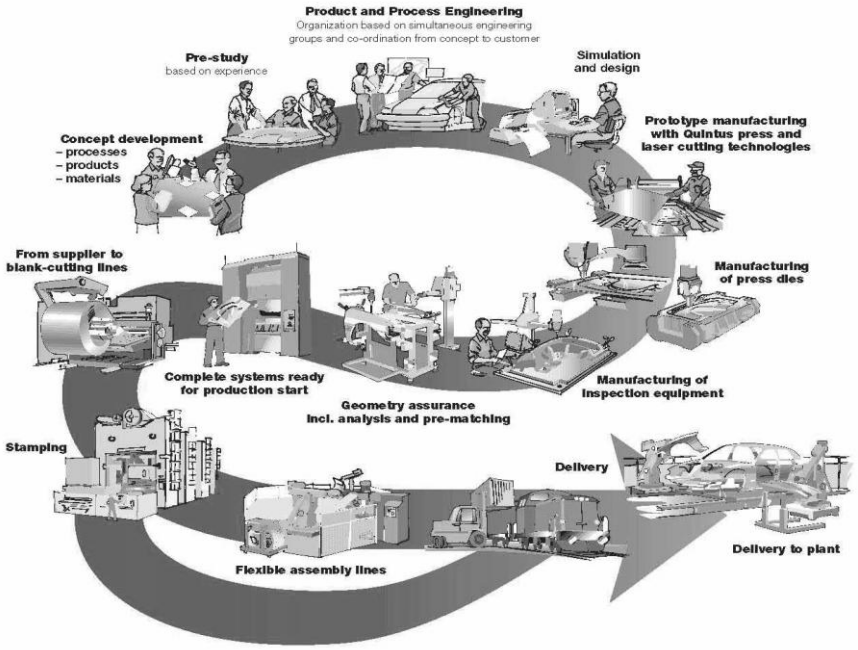
Qualitative data collection has been done during several meetings, personal and telephone interviews during the years 2004-2006. The data was analyzed using the theoretical propositions derived from the transaction cost approach. The interpretation was made using a qualitative approach to grasp the dynamics within the time perspective and the case complexity.

Product Data Management at Volvo Car Corporation

The prerequisites for product development in the automotive industry have changed dramatically during the latest decades. To reduce transaction costs associated with product development, the development of a new car is made with the help of product data management tools that enable engineers to communicate product data across firm and country borders. A general principle for product development is that if a firm need to undertake changes in components, the sooner these changes are made the better. The cost of changing a CAD-file is significantly lower than if a change has to be done in a physical car prototype. The use of digital prototypes has really created new opportunities for product developers and others in the industry to cut costs in product development. As it seems, major current problem in the automotive industry is the decreasing profitability. Among several cost saving strategies that the industry seems to apply has been alternatives to cut costs in product development. One way to cut costs in product development has been to increase the digitalization of product development. The more changes that can be made when the car is still on the drawing table, the lower the total costs of development. However, this change has increased

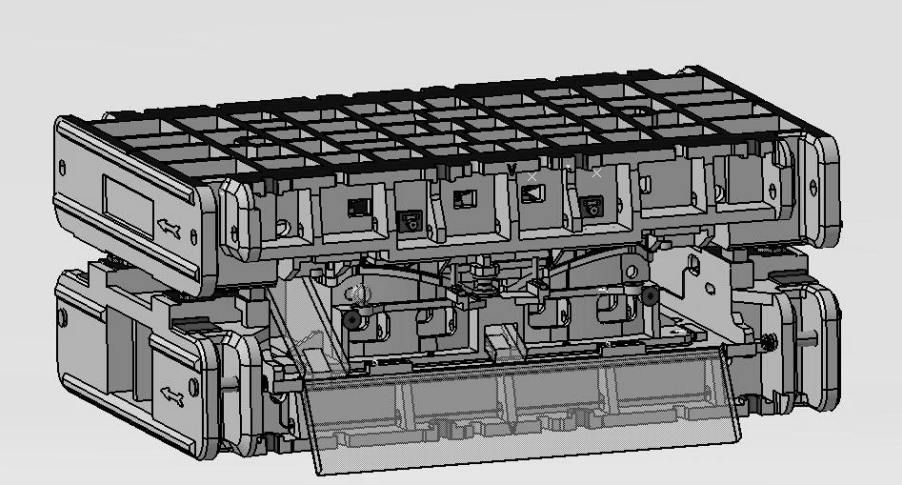
the need for process technology and has therefore created new costs, both transaction-specific and other costs.

Figure 1. From concept to component – an overview of the different phases of the development process at Volvo Cars (Source: Volvo Cars Body Components)



In modern product development, information technology is a key ingredient. At Volvo Cars, the product development process has been described as the process that goes "from concept to component" (Figure 1). In this process, a great deal of data is produced and transacted. In addition, several parties are involved in the process. At Volvo Cars, common practice is to gather component suppliers and component groups at Volvo Cars at physical meetings and phone meetings but also at e-meetings to discuss product development and product specifications. The reason behind this is the coordination challenge due to the complexity of systems sourcing (e.g., Gadde and Jellbo 2002). In the product development process, Volvo Cars has to take numerous interdependencies on both component and systems level from a technical, functional and physical point of view into consideration. During the ramp-up phase of a new car model, the frequency of these meetings is significant higher than during production phase although meetings are held on a regular basis throughout the lifetime of the specific component or system.

Figure 2. CAD-image representing a die tool design of an automotive body component (Source: Volvo Cars Body Components)



In product development, there are different types of IT systems to support the process and a common delineation is made between the content dimension and the transaction infrastructure dimension. In the content dimension we find systems that deal with creation and modification of CAD-data (e.g., systems that enable the creation of a digital 3D blueprint of a future automotive component, see Figure 2) and in the transaction infrastructure dimension we find systems that deal with the exchange of CAD-data (e.g., systems that enable secure exchange of CAD-files from one user to another). In addition to these dimensions, a distinction between users can also be made. There are in principle two different types of CAD-users at Volvo Cars. First, CAD is used by product developers to develop digital drawings and models of automotive components. Secondly, CAD is used by tool developers to create the tooling that is going to be used in the production of components shown in a CAD-file.

Creating a business case for product data management technology

The very existence of ENGDAT is a promise of efficiency and effectiveness. The pressure on the product development process within the automotive industry has been increasing as has the need to interact with suppliers during the process. Thus product development data has to be transformed and exchanged quickly, continuously, in volume between several actors in parallel. The information technology makes such distributed product development (Danilovic 2007). The case is a typical case of transactions cost problems. The distributed development process relies on the idea that each actor can optimize its own knowledge and ways of working and thereby hold total development cost for that activity as low as possible. There are future benefits and profits for the whole supply chain in terms of cost reductions (CR) as the development cost decreases due to more efficient exchange of product data. Also the development process becomes more effective over time as the ENGDAT system is continuously developed and thereby new cost can be avoided (CA). The promise also includes a future increased income as a result of more effective development process.

A business case for Volvo Cars and ENGDAT can be formulated as a function of the following variables:

$$Business\ case = ((CR_n + CA_n) + Inc_n) - (FC + VC_n)$$

Where expected cost savings over N years formulated in the business case equation as firstly as future cost reductions CR_n and secondly as future cost avoidance CA_n and where the expected income increase over N years is Inc_n. The investment is constituted both by a fixed cost FC and by variable costs distributed over N years VC_n. The upside of the business case is thus a result of future increased income, future cost reductions and future cost avoidance. Such a potential shall be compared and related to the fixed investment cost that the development and implementation of the ENGDAT system introduction causes. In addition there are upcoming and continuous development investments with the development of the ENGDAT system.

Discussion

The information technology process described in this paper seems to be a good illustration of what is actually the essence of the meaning of the transaction cost approach (Williamson 1981). At the same time the case also illustrates the difficulties in measuring that same transaction cost when the cost is dynamic over time and comprises several actors and last and foremost is a technological development (and adoption process) in itself.

Analyzing the business case creation at Volvo Cars IT, we can conclude that IT is both a means to compress transaction cost and a part of the transaction cost itself. The ENDAT system is developed to decrease cost for transfer of product data but of course involves cost to introduce.

The first observation regards the dynamics within the case. Since the case of ENGdat is an ongoing process over time and in interaction among several actors there is never a single decision or a single business case.

The second interesting observation is thus that the business case is developed along the way as the technological development is made. There is thus inter-dependence between the technological development and forming the base of decision which regards its development.

The third conclusion, following the first and second, is that the business case is part of the project or make up the development project in itself.

In a development project of the kind investigated in this paper there is never a final goal to which the outcome can be measured. The information technology is under continuous development and thus never totally finished. Even more important to recognize is that the business case is about making product development more effective and efficient. The measurement is thus relative and consists of continuous improvements.

Lastly we want to point to the ‘fact’ that there are both ‘hard’ and ‘soft’ dimensions within a business case. The soft dimension includes for example intangible values, relational improvements, strategic alignment and competitive power. The hard dimension includes income increase and cost reduction and as it may be that the income dimension is forgotten or disregard.

Managerial Implications

The foremost implication comes from our observation that a business case in information technology comprising several business actors in interaction is a dynamic case. Thus the management has to decide whether is should go for actual measurement of cost and revenue or for the promise of cost and revenue development. A transaction cost approach calls for measuring and comparing costs. And if these are potential as for all development and dynamic as for all interaction, the management might want to go for trying to describe and estimate the potential cost and revenue, which is to take quite another path. In the former case necessary and sufficient of resources have to be devoted to calculation and measurement. In the latter case resources have to be devoted to understanding of the development process and the communication thereof.

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Managing the Exchange of Data in the Extended Enterprise

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ABSTRACT: The quality in the exchange of technical data in the extended enterprise is mainly defined by the geometrical consistence of the transferred information. Methods and definitions that cover the remaining aspects of data exchange have to be developed. This article discusses a new standardization effort for the exchange management of technical data (ENGDAT version 3) and provides a methodology as well a set of tools to assess the status of communication effectiveness of data exchange in the extended enterprise.

1 INTRODUCTION

At the beginning of the automotive industrial era all necessary production facilities were acquired by the car manufacturer to guarantee the availability of the required resources. An excellent example of this was Ford Motor Company, which bought the entire production chain, from mines, forests and lumbering work all the way along the chain to the moment that the end product, the Ford automobile, rolled off the assembly line. Note that cars at this time contained many wooden parts.

Today, there is no automobile manufacturer that owns the entire chain. Manufacturers depend on close co-operation with their partners to assemble a high quality end product that the target consumer will choose and enjoy and, even more importantly, choose again. This close co-operation depends in turn on increasingly sophisticated communication networks where not only communication but *effective communication* is an absolute necessity to rolling the *right product* off the assembly line and into the showroom at the *right time* and at the *right cost*.

1.1 *Extended and Virtual Enterprise*

The need of close and effective co-operation across the value chain as well as globalization and increased competition require new forms of networked organizations. Independent enterprises, customers, suppliers, service providers as well as academic organizations and government agencies can form partnerships to enhance their ability to adopt and practice state-of-the-art manufacturing strategies and technologies. Virtual and extended enterprises are two emerging forms of such dynamic networked organizations. Virtual enterprises can be described as temporary consortiums of independent member companies and individuals, who come together to exploit a particular market opportunity while the extended enterprise focuses on long-term collaborative alliances (Browne 1999). The success of both the extended and the virtual enterprise relies heavily on the seamless and effectively facilitated information flow between the participating enterprises and the ability to analyze, measure, and improve communication.

1.2 *Product Data Quality*

Product data quality is fundamental in the intense exchange of information in the extended enterprise. Transfer problems between systems with different functionality or between partner companies disable the effective information flow necessary for the success of a networked organization. A simple definition proposed among others by SASIG (Strategic Automotive product data Standards Industry Group) is: "Product data quality is a measure of the accuracy and appropriateness of product data combined with the timeliness with which those data are provided to all the people who need it."

(Contero et al 2002) discuss several product quality definitions and standards and propose three levels of product data quality resembling the different levels and approaches that natural-language analysis uses, namely:

- *Morphological* – relates to the geometrical and topological correctness of the CAD model.
- *Syntactic* – evaluates the use of the proper modeling conventions.

– *Semantic/pragmatic* – considers the CAD model capability for reusing and modification.

In the extended enterprise these quality levels have to be complemented with additional criteria that evaluate the timeliness of the information flow. In order to be delivered product data have to be encapsulated, compressed, processed and conveyed to the right target through automated processes.

2 PRODUCT DATA EXCHANGE

2.1 *Information and data*

Successful product data exchange relies on the structure of the conveyed message and the proper messaging information. A minimal requirement is that organizational information about the recipient, the sender, the data format and the data context has to accompany the product data message as a standardised electronic delivery form.

During the last years several protocols and components have emerged prohibiting the global validity of exchanged product data.

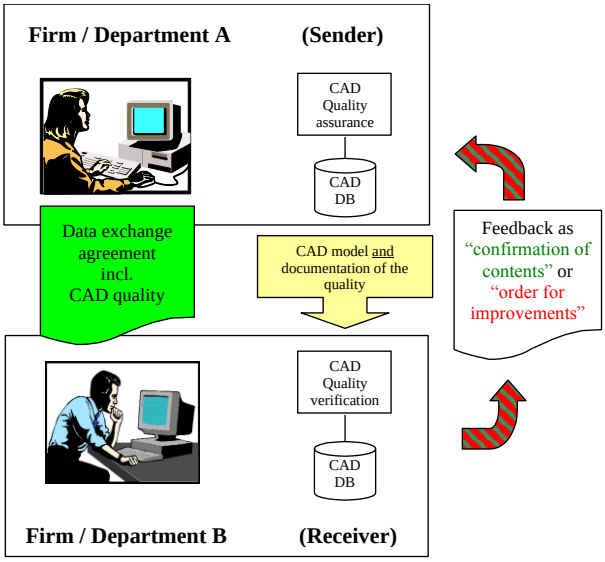

Figure 1. Product data exchange

In Europe, the ODETTE File Transfer Protocol (OFTP) and the ENGDAT message are widely used to transmit CAD/CAM data.

2.2 *ENGDAT (Engineering Data)*

There are several message sets provided by ODETTE and classified by business cycle. ENGDAT, a part of the design development cycle, is a syntaxed computer interpretable message that refers to one or more files with technical content, normally a CAD part or assembly. ENGDAT provides the means for automation of archiving, converting, guiding, routing and further process product data.

Odette has just released a recommendation for the use of ENGDAT when transferring PDM and CAD data together.

Now that powerful CAD systems have been established for developing products and means of production, it is becoming increasingly common for PDM data management systems to be integrated into the processes. The systems used to do this vary in their performance and functionality.

In order to exchange data between these systems, not only does pure CAD geometry data have to be transferred, but also additional information (e.g. part number, version, assembly structure, etc.).

Originally the developers of the ENGDAT format envisaged that transfer of such information would occur in the ENGDAT abstract. However, the scope is now far too small for today's needs.

This new recommendation is a supplement to the Engineering Data Message (ENGDAT) for a special case of use that will be very important in the near future.

The objective of this recommendation is to define rules for drawing up an ENGDAT message that allows the exchange of combined CAD and PDM information within an ENGDAT package, whilst avoiding redundant or contradictory information.

2.3 *Definitions*

The following terms are often used in the product data exchange process.

2.3.1 *Delivery Note*

"Delivery Note" is a generic reference to any file used to convey information about a series of other files comprising a technical data package. In this context, a delivery note is an ENGDAT message or file.

2.3.2 *Container File*

The form of data created or exported by some CAD systems may be in the form of a set of files – even for the design of a single item. One of these files is said to "contain" the other files, which it does by containing references to them. This file is the "container file". (The files within the container files are called "Contained Files")

2.3.3 *ENGDAT Message*

The ENGDAT message, in EDIFACT terminology, consists of the ENGDAT message, expanded by the information header segment and the information end segment of the EDIFACT engineering data frame.

2.3.4 *ENGDAT Package*

The ENGDAT package is the set of technical data files to be sent using an ENGDAT message, i.e. the delivery note and all files linked to the message by the name convention.

2.3.5 *Technical Data Package*

A Technical Data package is the generic phrase used to describe the set of technical data files to be sent using any delivery note, i.e. the delivery note and all technical data files linked to the message by the name convention. In this context an ENGDAT package is the specific kind of technical data package.

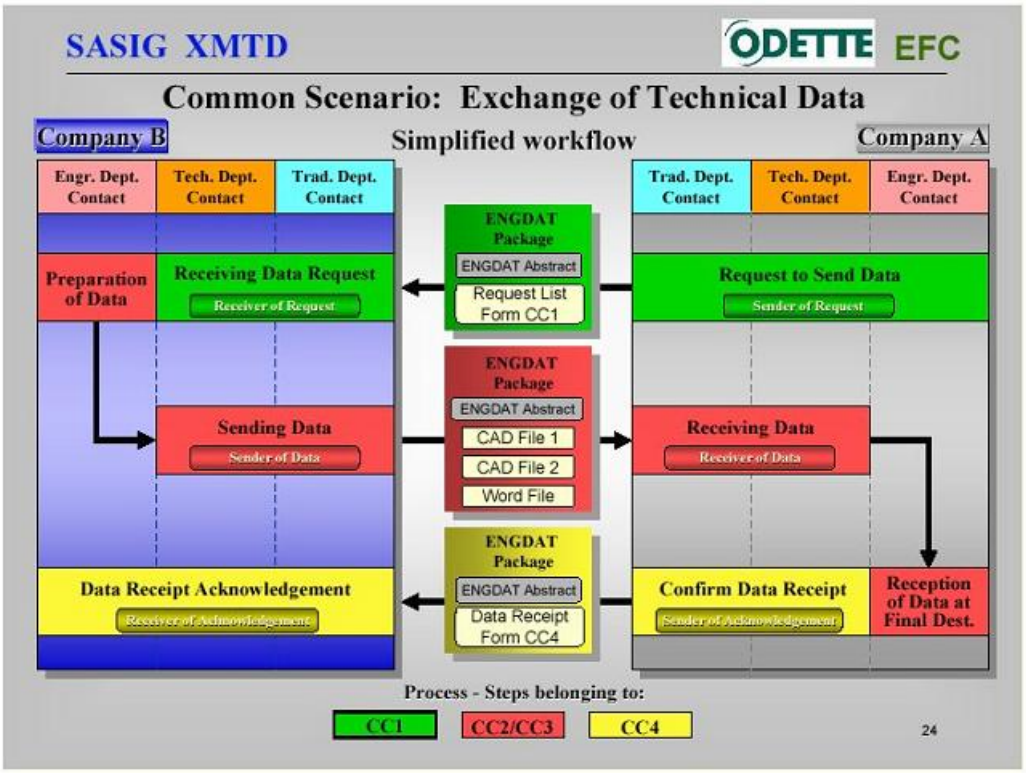

Figure 1. The exchange of technical data in ENGDAT version 3.

2.4 *ENGDAT version 3*

The development and acceptance of a global standard for the specification of product data exchange facilitates the smooth, effective and automated flow of information in the extended enterprises of the car-manufacturing sector. Standards widely used are ISO 10303-214 for the data content and ENGDAT for data delivery and routing.

A work group has been established with members from international standardisation bodies within the Automotive Industry. The initiative comes from SASIG (Strategic Automotive product data Standards Industry Group) whose members are standard organisations in U.S., Europe and Japan. The task of the workgroup is to define the demands for exchange of technical data starting from existing standardised processes, compare them and deliver a solution for the global process chain in the form of a revised ENGDAT specification. To achieve this goal a SASIG – XMTD (eXchange Management of Technical Data) WorkGroup was established.

Table 1. ENGDAT v.3 Enabling standards

	Enabling / Defining standard
ENGDAT version 3	Word
User interface	Browser, XMTD system
Business content	ENGDAT package
Syntax	XML
File transfer protocol	OFTP
Network protocol	ISDN, TCP/IP
Network service	VPN like ANX/ENX/JNX/XNX

The objectives of the new standard are:

– Expansion of the capacity of the exchange of technical data.
– Exchange of partner data.
– Creation of a symmetric solution so that automation will be possible by both the car manufacturer and the suppliers.

- Minimization of manually performed operations and the development towards further automation of the exchange of technical data.
- Increased security by several means as the exchange of identity and password.
- Technical confirmation of receipt on file transfer level. The sending and the receiving system should be able to confirm or to handle information on transparency of file transfer or not, irrespective of file transfer protocol, network protocol and network service.
- Validation of sender and receiver. The sending and the receiving system should be able to negotiate on authorisation to exchange files. OFTP satisfies these requirements.
- Identification of sender and receiver in such a way that the exchange reference together with a receiver is a unique entity. The file transfer protocol should support point-to-point connections where senders and receivers are verified. OFTP satisfies these requirements.
- Describe, trace and document data exchange activities using four conformance classes arranged in different levels CC1 – CC4
  - CC1: Data request
  - CC2: Basic functionality for sending data
  - CC3: Extended functionality for sending data
  - CC4: Acknowledgement for received data

Table 2. ENGDAT v.3 Description

Exchange	Reference explanation
Originator	Initial originator
Destination	Ultimate destination
Filename	ENG{Exchange ref}{No. files}{File No.}
Message identifier	ENG (ENGINEERING)
{Exchange ref}	EXCHANGE REFERENCE, {an17}
{No. files}	NUMBER OF FILES, {n5}
{File No.}	FILE NUMBER, {n5}

Word will be used for the basic definition of ENGDAT Version 3. This means there will probably not be any EDIFACT application for this version.

2.5 *ENGDAT ver 3 and beyond*

ENGDAT version 3 will make the global exchange of product data in the automotive industry easier and faster. Enhanced with STEP AP214 CC6 it will enable the automatic transfer of complete assemblies between EDM/PDM-systems. Large assemblies like an engine containing 300 parts sent automatically as an assembly between EDM/PDM-system will save substantial lead-time and manual work at the receiver of the data.

UML (Unified Modelling Language) will be used for the basic definition of ENGDAT Version 4. Thus applications based on XML and EDIFACT can be automatically produced from the same source, accelerating the development of communication products based on the new standards.

The global adoption of these standards contributes to the globalisation and the agility of the future networked organisations.

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A GLOBAL STANDARD FOR EXCHANGE AND MANAGEMENT OF TECHNICAL DATA

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Abstract: This paper explores the interactions within SASIG (Strategic Automotive product data Standards Industry Group) to create a global standard ENGDAT (ENGineering DATa) Version 3 for XMTD (eXchange and Management of Technical Data). The developmental process of the Automotive industry standardisation of a XMTD metadata technology is discussed. Finally, some basic standardizations problem and a methodology to create the ENGDAT Version 3 Subset are presented.

Keywords: Automotive, Data Exchange, Standardization.

1. KEY ACRONYMS

AIAG	Automotive Industry Action Group
CCTS	Core Component Technical Specification
ENGDAT	Engineering Data.
JADM	Joint Automotive Data Modelling
JAMA	Japan Automobile Manufacturers Association
JAPIA	Japan Auto Parts Industries Association
ODETTE	Organisation for Data Exchange by Tele Transmission in Europe.
OAG	Open Application Group Inc.
OEM	Original Equipment Manufacturer
OFTP	Odette File Transfer Protocol.
PDM	Product Data Management.
SASIG	Strategic Automotive product data Standards Industry Group.
SGML	Standard Generalized Markup Language
STAR	Standards for Technology in Automotive Retail
XML	Extensible Markup Language. See
XMTD	Exchange and Management of Technical Data.
OSEV3	The Odette Sweden ENGDAT V3 Subset
UN/CEFACT	United Nations Centre for Trade Facilitation and Electronic Business
WG	Workgroup

2. INTRODUCTION

Today, no automobile manufacturer owns the entire production chain. Manufacturers depend on close co-operation with partners to assemble a high quality end product that the target consumer will choose, enjoy, and, even more importantly, choose again. This close co-operation depends on increasingly sophisticated communication networks where *effective communication* is an absolute necessity to rolling the *right product* off the assembly line and into the showroom at the *right time* and at the *right cost.*

2.1 An increased need to share product data.

At a product data management conference in Sweden in 2005:
- Volvo Car Corporation reported an average increase of 70% of External Data eXchange for transfer CAD-data via ENGDAT during the years 1999-2004, from 400 to 1400 GB.
- The Volkswagen report showed that the transmission for Data exchange with external partners 2001 was 1343 GB with OFTP-partners and 280 GB with Online-Partners. By using the software Gedas ComSecure methodology this figures were changed so the amount of transmitted data 2004 was 634 GB with OFTP-partners and 677 GB with Online-partners, i.e. this year the amount of exchanged data was greater for online-partner than OFTP-partners.

Since the products dealt with are very complex, the volumes of data files are huge. At the product data management conference in Sweden in 2004 an engineer at Volvo 3P reported that, a complete integrated CAD-model of a vehicle contains 15.000-20.000 separate files. (Andersson et al., 2005)
A more effective use of information technology and communication is one of the major priorities of the automotive purchasing and supply chains. Due to the

high cost of the development of new models, interaction and collaboration is essential in the automotive industry. During the last fifteen years we have experienced an increasing number of joint ventures and mergers among automotive firms.
In Sweden with more than 1200 individual companies and an annual turnover of more than 11 billion Euros, the automotive industry is one of the largest and most important industries. (Andersson et al., 2005).
Automotive OEMs urge suppliers to invest in the same product data management systems as themselves. This trend creates unsymmetrical costs for the small-size suppliers that eventually have to invest and maintain several product data management and communication systems to fulfil the requirements of their customers. Under these circumstances this development can serve as a barrier rather than an enabler to assist new small enterprises in the supplier chain.
This paper focuses specifically on the development of the Odette Sweden ENGDAT V3 Subset that provides a more agile solution for the structured exchange of data.

3. PRODUCT DATA EXCHANGE

3.1 Information and data

Successful product data management (PDM) results in efficient product data exchange. The product data exchange relies on the structure of the conveyed message and the proper messaging information.
At a minimum, organizational information must accompany the product data message, i.e. information about the recipient, the sender, the data format and the data context. This information is best stated in a standardized electronic delivery form.

3.2 ENGDAT (ENGineering DATa)

Contemporary CAD systems are parts of integrated product development systems in which PDM and XMTD systems are integrated. The systems used to achieve this integration fluctuate in their performance and functionality.
In order to exchange data between the systems used in product development and production, pure CAD geometry data must be enhanced with additional information (e.g. part number, version, assembly structure, etc.).
Originally, the developers of the ENGDAT format envisioned that transfer of such information would occur in the ENGDAT abstract. However, that scope has become too small for contemporary needs.
The new recommendation, issued by SASIG, "Exchange and Management of Technical Data Guideline ENGDAT V3" is a supplement to the ENGDAT message for a special application that could prove to be very important in the near future.
The objective of this recommendation is to define rules for creating an ENGDAT message that allows the exchange of combined CAD and PDM information within an ENGDAT package, while avoiding redundant or contradictory information.

3.3 Definitions

The following terms are often used in the product data exchange process.
Delivery Note
"Delivery Note" is a generic reference to any file that is used to convey information about the message, the sender, the receiver and the series of other files comprising a technical data package. In this context, a delivery note is an ENGDAT message or file.
ENGDAT Package
The ENGDAT package is the set of technical data files to be sent using an ENGDAT message, i.e. the delivery note and all files linked to the message by the name convention.
Technical Data Package
A Technical Data Package is the generic name used to describe the set of technical data files to be sent using any delivery note, i.e. the delivery note and all technical data files linked to the message by the name convention. In this context an ENGDAT package is a specific kind of technical data package.

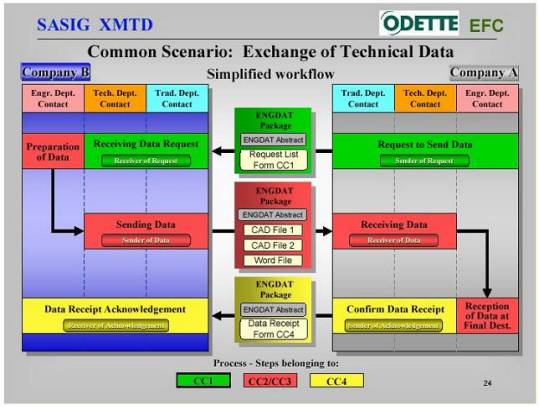

Fig. 2. The exchange of technical data in ENGDAT version 3 (SASIG, 2003).

3.4 ENGDAT version 3

A committee was established with members from international standardization bodies in the automotive industry. The initiative comes from SASIG whose members are organizations working with standards in the USA, Europe, and Japan. The task of the committee was to define the demands on the exchange of technical data starting from existing standardized processes, to compare them and deliver a solution for the global process chain in the form of a revised ENGDAT specification.

Table 1 ENGDAT v.3 Enabling standards .

	Enabling / Defining standard
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User interface	Browser, XMTD system
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File transfer protocol	OFTP
Network protocol	ISDN, TCP/IP
Network service	VPN like ANX/ENX/JNX/XNX

Description, tracing and documentation of the data exchange activities using four conformance classes arranged in levels CC1 – CC4
CC1: Data request
CC2: Basic functionality for sending data
CC3: Extended functionality for sending data
CC4: Acknowledgement for received data

Table 2 ENGDAT v.3 Description.

Exchange	Reference explanation
Originator	Initial originator
Destination	Ultimate destination
File name	ENG<time_stamp><free_reference_ code > <filecount><sequence_number>
Message identifier	ENG is literally the three capital letters as shown
<time_stamp>	YDDDhhmmss
YDDDhhmmss	Year:Day:Hour:Minute:Second
<free_reference_code>	a 5-characters code, which shall be completely filled and bilaterally defined between sending and receiving parties
<filecount>	a 4-digit number equal to the number of technical data files being exchanged, plus one more representing the ENGDAT delivery note itself
<sequence_number>	a 4-digit number representing the number in the ENGDAT Package for this file

3.5 Odette Sweden Common Engdat V2.

The application of ENGDAT V2.0 by major Swedish automotive companies in engineering data exchange is presented in (Bilsweden, 2004).

3.5 JADM - Joint Automotive Data Model.

Search for lower implementation costs of messaging technologies, either by the OEMs or suppliers, higher reactivity and integration with new internet-based ways of exchanging data is of main interest to the automotive industry.
The Odette XML group has been working in cooperation with its American colleagues of the AIAG and OAGi on the definition of a consistent, comprehensive development chain.
The purpose of this work was to create the specifications of a solution by expert users rather than software engineers. The result is the definition of a single, strict path expressed in UML empowered with automatic translation to XML. (Odette XML Work Group)

3.6 ENGDAT version 3 and the future.

A SASIG initiative driven by Odette Sweden intends to use JADM as the basic definition of ENGDAT Version 4. Using JADM, harmonisation of different automotive XML-syntaxes can be achieved by UN/CEFACT CCTS as a common entity source. This approach creates a bijection between the definition sets of different applications, accelerating the development of communication products based on the new standard.
The global adoption of these standards contributes to the globalisation and the agility of the future networked organisations.

4. OSEV3 - ODETTE SWEDEN ENGDAT V3 SUBSET

4.1 The Justification for a New Standard Subset

The changes between ENGDAT V3 and ENGDAT V2 are extensive. The use of previous versions of ENGDAT had been limited to the exchange of data that now are classified as conformance class 2 or 3. (SASIG, 2003).
ENGDAT V3 evolved from previous standards that had dispersed from one common definition.
When ENGDAT Version 1 was established it was considered that an upper limit ENGDAT package size of 999 files would be sufficient. The use of ENGDAT today for the exchange of packages between PDM systems has shown a need for increased package size. To implement the need of sending ENGDAT packages with more than 999 files the ENGDAT virtual filename <filecount> and <sequence_number> were extended from 3 to 4 positions making it possible to send up to 9999 files within an ENGDAT package. The Virtual File number must be fixed to 26 characters to comply with the specified transfer mechanism OFTP 1.4. The following solution was found in the SASIG XMTD WG meeting in Stuttgart summer 2003:
- decrease of the positions used to inform about the year from two to one position.
- decrease of the month-date information by one position by using day number within the year. Note: In OFTP V2 the Virtual File number is allowed to extend to 26 characters and hereby solve these problems.

4.2 A Comparison between SGML and XML

Both SGML and XML are "meta" languages because they are used for defining markup languages.
Conceived notionally in the 1960s – 1970s, the Standard Generalized Markup Language (SGML, ISO 8879:1986) gave birth to a profile/subset called

the Extensible Markup Language (XML), published as a W3C Recommendation 1998. This subset (XML) has received a wider usage than the original SGML standard.

4.3 Odette Sweden ENGDAT V3 Subset.

ENGDAT Version 3 Conformance Class 2
The result from the SASIG XMTD WG meeting in Detroit 2001 was a list that contained all the entities proposed by the participating standardization organizations. The Odette Sweden XMTD WG made a review on this list autumn 2001 in the Saab Automobile museum. This review ensured that all ENGDAT entities in use were represented and a special notation was made for the entities actively in use. The European SASIG XMTD WG meeting in Paris Autumn 2001 reviewed the common European proposal. To simplify the creation of software as well as the grouping and classification of the list from the SASIG XMTD WG meeting in Detroit a specific Conformance Class was created. All of the ENGDAT entities used by the Swedish automotive companies were represented within this Conformance Class 2: *Basic functionality for sending data*.

The draft of OSEV3
A draft of OSEV3 was created within the Odette Sweden XMTD WG December 2004 by mapping Odette Sweden Common ENGDAT V2 as master for the selection of the corresponding entities from ENGDAT V3 Appendix A.

The Odette Sweden XMTD WG review of OSEV3
The Draft of OSEV3 was reviewed by Odette Sweden XMTD WG. The final result was accepted on the Odette Sweden Steering Committee meeting April 2005.

The SASIG XMTD WG review of OSEV3
The Odette Sweden OSEV3 was presented and reviewed at SASIG XMTD WG meeting in Fukuoka May 2005. The review remark was not to use the entity Surname for both First name and Surname. This name entity was extended from one to two fields from ENGDAT V2 to ENGDAT V3 as using just one field for both caused problems. The solution was to correct the OSEV3 so name refers only to surname.

5. IMPROVING GLOBAL INTEROPERABILITY

5.1 Harmonizing with UN/CEFACT ISO/TS 1500 CCTS as Semantic Source.

The purpose of the International Trade and Business Process Group is to be responsible for business and governmental business requirements and content. This is achieved by initiating developments in the areas of process analysis, best practices, and international trade procedures. Where appropriate the UN/CEFACT Modeling Methodology is used to support the development of trade facilitation and electronic business solutions.

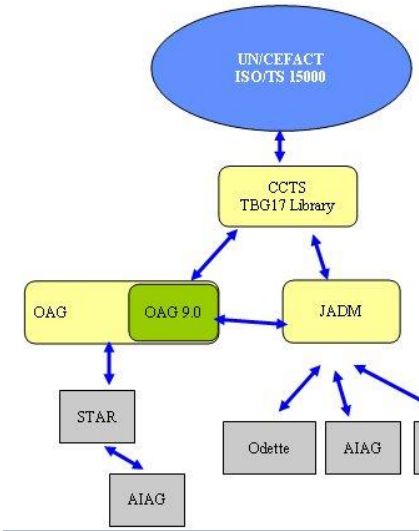

Fig. 3: *CCTS – Harmonizing with UN/CEFACT*

Figure 3 describes the possible solution of migration utilizing JADM and OAGI specifications to a higher level of harmonization. In this solution both JADM and OAG 9.0 use CCTS TGB17 Library as the Semantic Source. This means that a translation of an XML-message can be done between the different syntaxes JADM and OAG 9.0 maintaining the semantic.

5.2 Global agreement to harmonize EDI-standards with JADM.

AIAG, JAMA/JAPIA, Odette and STAR have signed a Memorandum of Understanding to use consistent standards to:

- express business process design
- define data entities
- define XML schema documents

The agreement includes;

- the creation of a Joint Automotive Data Model (JADM) that will finally provide consistent data vocabularies for all business transactions.
- Mutual selection of standards, methods and tools to semantically support all business domains: Engineering, Quality, Logistics, Financial, Retail, etc.

JADM Content Assumptions
JADM uses ISO 15000 UN/CEFACT Core Components (CCTS) as the mapping source for data entities
JADM uses UML/UMM to express business process and data definitions
Alignment and integration are assumed within JADM and OAGIS 9.0

The JADM main benefit is to provide an international standard directive for developing business content, including process definitions and data definitions, expressed in XML. The JADM sets the stage for the automotive industry to move toward seamless, interactive business communications and lays foundation for semantic interoperability.

5.3 Realization of OSEV3 with JADM.

The Automotive Industry within Europe has successfully deployed the Odette Standard ENGDAT as the infrastructure for eXchange and Management of Technical Data within the Extended Enterprise and aims to spread it globally. A global agreement confirms the efforts of Odette Sweden to harmonise the OSV3 standard with JADM. This realization is planned to be provided by Odette Sweden in the following steps:

1. Definition of the ENGDAT Version 3 Entities in UN/CEFACT CCTS
2. Use of the software tool Edifix to create the Data Model
3. Test that the model is following SASIG – Exchange and Management of Technical Data Guideline, ENGDAT V3 – Annex A

6. FUTURE ENGDAT DEVELOPMENT

The Odette Sweden Subset of ENGDAT V3 is a suitable candidate for benchmark tests during the development of the next version ENGDAT. Several enabling standards (shown in table 3) strongly influence the new version of ENGDAT.

Table 3 ENGDAT v.4: Enabling standards.

Layer	Enabling / Defining standard
9. Methodology	JADM
8. Entity Definition	UN/CEFACT CCTS
7. ENGDAT version 4	UML/UMM
6. User interface	XMTD system
5. Business content	ENGDAT package
4. Syntax	XML
3. File transfer protocol	OFTP V2
2. Network protocol	TCP/IP
1. Network service	VPN

The Joint Automotive Data Model (JADM) methodology provides a platform for the development of business communication in the automotive supply chain including process definitions and data definitions, expressed in XML.
The Entity Definition UN/CEFACT CCTS is the standard for the semantic data modelling.
The Unified Modelling Language (UML) is a graphical language for visualizing, specifying, constructing, and documenting of artefacts of a software intensive system. The UML presents a standard way to write systems blueprints, covering conceptual things such as business processes and system functions, as well as concrete things such as classes written in a specific programming language, database schemas, and reusable software components.
UMM – UN/CEFACT Modelling Methodology combined with a business process analysis results to formal process models, human readable documentation describing the core business process, its variations and interacting partners and a data model describing the structure of data to be interchanged to meet the requirements of the business process.
The User interface for the XMTD system is represented by the software that handles the XMTD standard, in this case ENGDAT V4. The system can be an in house system or provided by a software house. For logistic EDI this layer is called Enterprise Resource Planning system.
The syntax XML to be used is prescribed in Odette XML Recommendations.
OPTP V2 is an extension from existing OFTP to meet SASIG XMTD WG requirements. The file transfer protocol OFTP V2 extends the present OFTP features and is be a file transfer protocol for TCP/IP over Internet supporting VPN. Examples of VPN are ENX (European Network eXchange), ANX (Advanced Network eXchange), and JNX (Japanese automotive Network eXchange).

7. CONCLUSIONS

Global standard achieved on this level but imperfect interoperability is an important and extensive problem.
- Implementation differs too much and these differences are not properly represented in the specification.
- Publication and presentation of the specification (XML) is not fully "global".
To cope with this there is a possibility for SASIG XMTD WG to make a harmonizing utilizing UN/CEFACT ISO/TS 1500 CCTS.

8. FUTURE RESEARCH

Global companies in the automotive industry are implementing strategies to transform their organizations towards a collaborative design product development environment. One of the key activities in this process is the understanding of the sources of PDM information for exchange. Future research will therefore focus on methods to understand and clarify the sources of product data and their structure, and on the global solution for the standardization of IT-structure and the common vocabulary needed to improve business collaboration.

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