Customised environmental reporting

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Abstract: Customisation of corporate environmental reports to the information needs of a target group or an individual is a growing topic. Hence, based on a deeper understanding of addressee orientation, the technical possibilities for target group tailoring or (by reducing the size of the target group to one individual) addressee orientation are examined. Firstly, system customisation comprehends the possibilities of adapting an information system to a user. This part of addressee orientation enables the system to alter to accommodate the user's needs. Secondly, user modelling makes it possible to build a representation of the user's needs in the system that can be used to control the system customisation. These two characteristics of addressee orientation lead into a typology of nine possible combinations.

One of these combinations which gives huge possibilities to the user and provider and is also easy to implement is in focus in the second part. Using up-to-date internet technologies an ICT-architecture is developed, customised to individual needs for corporate environmental reporting systems.

Keywords: addressee orientation, Cocoon Publishing Framework, corporate environmental reporting, individualisation, personalisation, target group tailoring, XML.

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1 Introduction

Every time information is transferred from one individual to another, the two individuals adapt to the special needs of each other. If someone asks a question, the answer will be adapted to the question, the individual customises the answer to the needs of the questioner. But if we ask an information system for specific information needed in the actual situation, the system will give us standardised answers, that perhaps have nothing to do with the question or the context of the question. So it is important for improved communication between information systems and individuals, that the answers of the system are customised to the addressee's needs.

2 The information demand

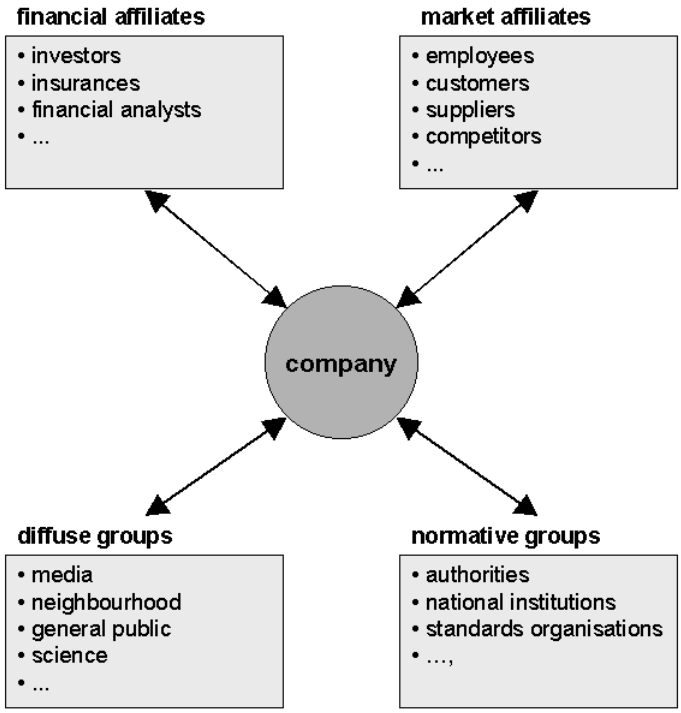
Before going into the technicalities of how to realise an addressee-orientated corporate environmental report (CER), it is necessary to find out who the addressees of a CER are and their particular information demand.

The addressees of a CER are groups or individuals that have no direct right to the information. Insiders, the board of directors, the workers' council or the environmental officer have those rights of information and are not dependent on the general CER. These groups are probably not the primary addressees of a CER.

Different empirical studies [1] identified several groups of possible addresses for a CER. According to these studies and in combination with the results of our own deductive analysis it is possible to identify at least eight possible groups of addressees. These groups can again be condensed to certain types of addressees (Figure 1).

According to these groups of addressees the information demand of the groups can be identified deductively by analysing the decision situation and the intention of the users. In addition, they are verified by analysing the empirical studies mentioned above. In the following, two groups will be presented in a more detailed manner. A complete presentation of all identified groups can be found in [2]. The two groups are customers and suppliers, because 'an increasing number of corporate buyers are demanding comprehensive environmental and social information on the products or materials they purchase – a practice that has become known as supply chain auditing' [3].

Figure 1 Possible addressees of a corporate environmental report [2]



2.1 Customer's information demand

The situation of the customer (especially major customers) is dominated by a decision concerning the raw materials and supplies, considering aspects of cost and quality. The aspect of quality also concerns the ecological behaviour of the supplier [4]. An efficient environmental management system can be a decisive element in the choice of a supplier. A customer therefore, has the following information demand:

- information about the environmental impact during the life cycle of the product
- information about the fulfilment of legal requirements
- information about environmental management systems and certification or audits
- information about state-of-the-art environmental protection and of R&D activities
- information about cooperation with other market participants.

Customers prefer a complete and detailed report covering a period of 3–5 years, in addition to short 'updates' or newsletters about changes or innovations.

2.2 Supplier's information demand

The supplier is in a situation of choosing between several possible customers, especially concerning details of contracts and the (dis-)continuing of existing business relations. The

suppliers are interested in long-term cooperative business relations, so they mostly demand environmental information concerning the evaluation of risks for the relationship:

- information about the fulfilment of legal requirements
- information about production and the processes used in production
- information about future development and actual R&D activities
- information about environmental management systems and certification or audits.

The information demand of suppliers is often not met through a regular CER, therefore additional information is needed. Information about the general economic and ecological performance can be found in the CER, especially for the acquisition of new customers.

The need for such addressee orientated CER is understandable. In the following, we will first discuss how a general information system can be used for addressee orientation and then how a system for addressee orientated CER can be realised.

3 Addressee orientation

Since the computers were first used, it has been the individual who has adapted himself to the information systems and not vice versa. Information systems have a restricted vocabulary that can be used for communication and this causes a problem in communication. The customisation of software to the needs of the user (i.e. the individual) is a central point in making the computer adaptable to the user [5]. This implies the question, 'how can the information system customise itself or can be customised to the situation and the user'. This first part of addressee orientation is called 'system customisation'.

Secondly, the whole information society is no longer restricted by the capacity of the information and communication technology (ICT), but the capacity of the human being for understanding and processing information [6]. However, much of the accessed information is not relevant for the user: it is already known or is not relevant for solving the problem. It is necessary, therefore, that the information system 'knows' the user who has requested the information. This requires a model of the user. The process of gathering information about the user is called user-modelling.

In the following, the processes of system customisation and user-modelling will be examined.

3.1 System customisation

There is one central question in the process of system customisation: Who does the customisation? There are several possible actors: Most authors distinguish between customisation by the system (system-driven) and by the user (user-driven). But there is a third possible actor, the developer of the system [7].

The process itself can be divided into four steps [8]:

1 the initiative to kick off the customisation

2 the suggestion of alternatives of customisation

3 the decision that leads into the customisation

4 the execution to do the changes.

All these steps can be done by a different actor. That leads to 81 possible combinations. The 'extremes', i.e. the combinations where all the steps are done by the same actor, are the criteria for system customisation:

- if the developer of the system does all four steps, the system is called an *adapted system*
- if the user does the four steps, the system is called an *adaptable system*
- if the system itself does the four steps, the system is called an *adaptive system*.

There are no discrete boarders between these three extremes. Depending on the function of the information system, the best solution is perhaps to combine features of an adapted, adaptable and adaptive system [9].

In the context of internet-based environmental reporting, an *adapted system* is comparable to a set of static webpages or a static PDF file. The author of these pages writes the report in a manner, he considers best for a possible user. Of course it is possible to create several static versions of the report for different groups of users. But it is difficult to create and maintain more then one set of static reports.

An *adaptable system* has some degrees of freedom which the user can employ to modify the system. The user decides whether an adaptation is necessary and also executes the adaptation with tools that change the system's characteristics [10]. The user is therefore no longer restricted by the developer's decisions. On the other hand, this advantage is bought at the price of increased cognitive stress for the user, who has not only to do his work, but also has to manage the adaptation of the information system.

As noted in the introduction, individuals use automatic methods to adapt to each other while they communicate. So called *adaptive systems* also have this ability to change their characteristics automatically according to the user's needs [10]. Adaptive systems do not need the tools for the user to initiate and execute a modification, they simply initiate and perform the changes and modifications on their own. This means, that they have to have mechanisms to gather information about the user, the user's situation and the user's tasks by analysing the dialogue between user and information system. This implies a user model for storing this information.

3.2 User modelling

The goal of user modelling is to enable an information system to adapt to an individual. So the central question is, what information is needed about the user to adapt the system and how can this information be gathered, used and stored [5]. In literature, there is another term for user modelling, often used as a synonym: user profile. While a user model is employed for all users, a user profile is a certain and specified instance of this model for a particular user or group of users. In the following, we will first have a short look at the acceptance of user modelling by the user himself. Then we will examine the information stored in user models.

The use of user models or user profiles may sometimes cause problems which stem from the user's fear of losing control or of abuse of the information. It is, therefore, necessary to gain user's trust in the system. There are five requirements for a user model to gain user's trust:

- *Comprehensibility:* The user knows about the user model and he should understand why information about him is being gathered.
- *Privacy:* The user should feel safe and secure. If he feels as if he is being kept under surveillance, he will perhaps not use the system or will give wrong information about himself.
- *Control:* The user should have a certain control over his personal profile. The user should be able to make corrections or modifications to his profile or delete the whole profile.
- *Transferability:* A user model should be transferable to other information systems, so that the user has only to enter his data once.
- *Fast Modelling:* A user will not want to get asked for information a long time before using a system, as it is necessary to get fast access to the system.

Because the information stored in a user model is needed for system customisation, the information depends on the function of the information system. That implies, that the selection of information stored in the model is very important for the success of system customisation. Therefore, it seems advisable to integrate all possible information in the user model, but this mostly fails. Some information could not be measured directly and thus has to be measured indirectly, so there are at least three types of information which have to be stored in the user model [11]:

- firstly, information about *user conventions*, i.e. information about individual preferences for the user interface and user guidance
- secondly, information about *user competence* like cognitive or sensomotoric skills and competence or experience with using the system
- lastly, the information about *user intention* stored in the user model helps to adapt the system to the user's assignment.

The main function of the user modelling component of an information system is to gather this information about the user. In the next step, methods to build a user model are examined.

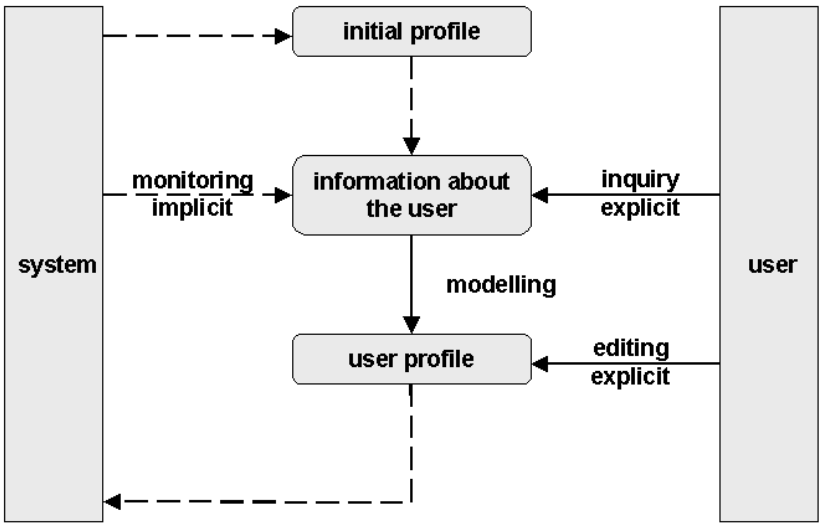
It is not a trivial task to gather information about the user to build the profile of a 'real' user in the system. First of all, the system needs a starting point for the modelling. There are three possibilities for this initial profile:

- A rather simple method is an *empty instance of the user model*, that is filled with information while working with the system.
- Better and more user-friendly is the possibility of *transferring an existing user profile* from another system and assuming the common parts of it.

- If there is no other system that can 'donate' a user model, it is also possible to set the *new user as the average user*. The system implies that the new user has similar preferences to existing users. This can be a generic user profile set as a default by the system designers or it can be based on a statistical analysis of existing users.

This initial profile can be improved by implicit or explicit methods to fit better with the preferences and characteristics of the user (Figure 2).

Figure 2 Gathering information for a user profile [2]



Explicit methods of gathering information depend on the willingness of the user to give information about himself. They are based on self-evaluation and a willingness to provide information. For information about social background or personal data such as name or postal address, an explicit question or form filling regarding the profile is not evitable. Explicit methods are often detached from the 'normal' interaction with the system.

A weakness of such explicit methods is the additional time necessary to answer the questions that can be negative for system acceptance.

Implicit methods for gathering information about the user are based on monitoring (user behaviour and history of using the system). The strength of this approach compared to the explicit methods can be seen in the fact that the user is not aware that the system is changing the profile. The user doesn't 'waste' time filling in forms or answering questions. In addition, the psychological effects that can interfere with the results of an explicit request do not arise. A weakness is the large amount of data that has to be analysed to gain trustworthy information about the user.

In practice, both methods have to be combined to gain precise and trustworthy information about the user and to provide a user-friendly and easy-to-use system.

An interesting way of gathering information about users is the use of *stereotypes* [2]. This idea is an analogy from psychology: individuals build stereotypical models, and if a

key stimulus comes from another human, the individual assumes a bundle of characteristics. A stereotype is a combination of characteristics that appear conjointly and depend upon each other.

Stereotypes can be used for building a well-fitting initial profile for a new user. The different stereotypes are presented (i.e. the groups of addressees of a CER) and the user is asked to associate himself with a particular stereotype. Another possibility is the automated association by analysing the users' interaction: if a 'key stimulus', the so called trigger, appears, the system associates the user with a certain stereotype.

4 Typology of addressee orientation

Addressee orientation is a combination of system adaptation and user modelling. As noted above, system customisation realises an adaptation of the system to the user's needs, and user modelling collects the information required for this adaptation.

In literature and in practice such systems are also called personalised, individualised, customised or one-to-one systems. Personalisation, individualisation or customisation are often considered as synonymous, but the systems themselves realise the adaptation to users' needs in very different ways. The following typology of addressee orientation is, therefore, presented for greater accuracy of discrimination.

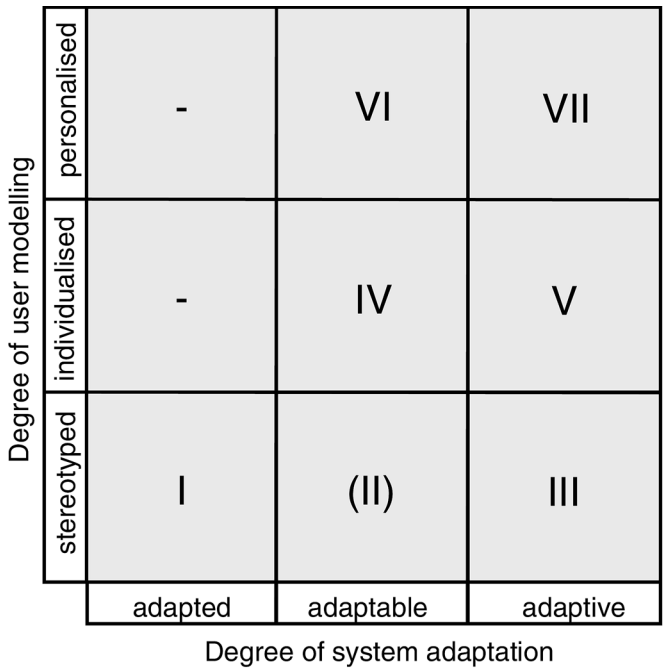
First of all, it is necessary to improve accuracy of terms in the field of user modelling. Sometimes, it is helpful or necessary to differentiate between personalisation and individualisation, i.e. to know the addressee as a real person and not only as an anonymous user. In other cases, it is not even necessary to differentiate between every user, for example to fit the offer of information to the needs of specific user groups. To cover this wide scale, we distinguish between three stages of user modelling:

- *Stereotyping* is the subsumption of addressees in specific groups with an equal or comparable need of information, for example employees, investors, customers or suppliers.
- *Individualisation* means an identification of a concrete user with individual characteristics such as a specific need for information or specific settings. Individualisation is not bound to a concrete person.
- *Personalisation* includes the identification of a concrete person in the real world. Using personalisation it is possible to establish a real relationship with the user and to employ this for dialogue or further fine tuned communication.

The second degree for this typology is that degree of system adaptation. This degree corresponds to the types of system customisation presented: *adapted, adaptable* and *adaptive* systems. As a result, the degree of addressee orientation and the degree of user modelling are arranged in a matrix with nine possible combinations. This typology of addressee orientation can be the general conception for designing addressee orientated information systems (Figure 3).

Adapted systems can only be stereotyped systems. It is only possible to adapt those systems while designing the system, so it is only possible to fit the system to the needs of the group of future users that have been identified by a system's designer. Adapted systems, that have been adapted to the needs of one particular user or one person are only useful in exceptional cases. For that reason, the two cells in the matrix are empty.

Figure 3 Typology of addressee orientation [2]



Adapted/stereotyped systems (I) use a canonical user model to fit the need for information about a group of users. It is of course possible to realise several versions of an adapted/stereotyped system for target group tailoring.

In an *adaptable* system the user can customise the system to his needs. *Adaptable/stereotyped* systems (II) are only useful in exceptional cases, if the group uses the systems in a concerted way or one member of the group has special privileges to customise the system. *Adaptable/individualised* systems (IV) store an anonymous user model for each user. The user can control the system behaviour with his individual profile. In practice, such systems are realised for example in internet catalogues like 'MyYahoo'.

If the user gives further personal information to the system that shows a relationship between the user of the profile and a real person, the system is an *adaptable/personalised* system (VI). Examples of such systems are online shops and internet banking. These systems have long term user profiles that are reused in each session in which the user employs the system.

Adaptive systems are self adapting to users' needs. If the users are managed in several groups and the systems analyses the behaviour of all users of the group to adapt the stereotyped user profile, the system is an *adaptive/stereotyped* system (III). Such systems use statistical methods to analyse the behaviour and interaction to fit the stereotyped profile to the 'average user'.

If all users have their own anonymous profile, the system is an *adaptive/individualised* system (V). Those systems have similar advantages to adaptable/individualised systems, but the user is not directly involved in the system adaptation.

Adaptive/personalised systems (VII) have similar features to adaptable/personalised systems, with the same method of system adaptation as adaptive/individualised systems.

This typology of addressee orientation provides help in structuring a systematic and useful design of addressee orientated information systems. For an addressee orientated corporate environmental reporting system, all these systems are possible. However, in the following, the focus is on adaptable/individualised systems:

- These systems have the benefit of an individual customisation of the system to the user and give him some degrees of freedom in system adaptation.
- The problem of how to analyse the user's behaviour and interaction with the system can be ignored.
- An adaptable/personalised system is very easy to upgrade, but it can only be done under the consideration of national regulations for data security and privacy.
- The system, as presented below, can be upgraded to an adaptive/individualised or an adaptive/personalised system by adding a component for user behaviour analysis.

5 Architecture for a customised environmental reporting system

The corporate environmental reporting system presented here is using a new internet technology family called XML (eXtensible Mark-up Language). This technology family comprises technology for defining mark-up languages, for transforming documents into other documents, for formatting and displaying documents, and so on.

The base of an internet-based corporate environmental reporting system using XML is a so called Document Type Definition (DTD). This is a document in which the general structure of an environmental report is stored. The DTD can be understood as a book of rules where the elements of an environmental report are defined, and their dependencies are modelled. Such a DTD was developed by Lenz [2] using a modificated method of Schraml [12].

It is first necessary to identify the information needed for an environmental report. There are three sources of possible elements for an environmental report: standards like EMAS II or ISO 14001, the needs of the addressees of the report and so-called existing instances, i.e. paper-based reports and reports available on the World Wide Web (WWW).

The possible elements for the DTD found in these three sources have to be searched to find the *relevant elements* for the DTD. This means that redundancies have to be eliminated or that elements found in existing instances but are not mentioned in standards or are not relevant to satisfying the addressees' needs, are deleted from the list. The relevant elements are implemented in a DTD. At the moment, the DTD developed by Lenz is in the process of standardisation with two other DTDs [13].

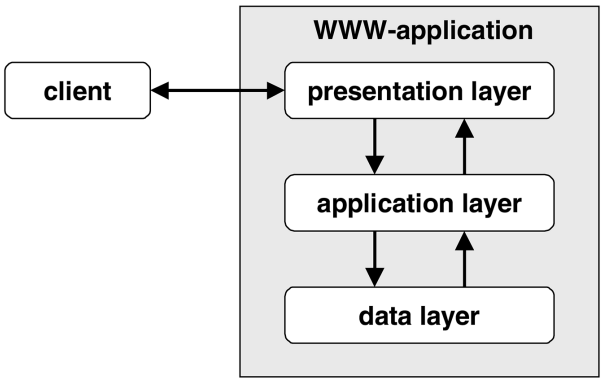
To use this DTD in an adaptable information system, it is appropriate to build up an ICT-infrastructure able to do the necessary customisations in documents. For advanced internet applications, a three layer architecture (3-tier-architecture) is recommended: The user gets access to the system through a client software. This could be an internet browser like Netscape Navigator or Microsoft Internet Explorer. This client contacts the *first layer* of the information system via the internet. This layer, the presentation layer, has the functionality needed to present the information to the client. In

terms of internet-based information systems this is the so called web server. This server has the functionality to manage the request of multiple clients and transfer the request to the next layers. It also has the function of transfering the results of the requests back to the clients.

The *second layer*, the application layer, has the logic needed to transform or operate the data stored in databases. In this layer, all operations to individualise or personalise the data are completed.

The *third layer* is the data layer. Databases store the information needed in the information system. In this case, the environmental report is stored here, and of course the user profiles and further data to present the data on several media (Figure 4).

Figure 4 3-tier-architecture for www-applications



In the following, the internet-based corporate environmental reporting system is currently in a prototypical stage, developed using the Apache web server in the presentation layer. This web server is widely used and has been developed by the Apache Software Foundation [14]. This foundation also initiated the development of the 'Cocoon Publishing Framework'. This framework is used to build the application layer. The framework is very flexible because of its modular design and easily extensible for more complex systems. The data layer is based on a database that can store XML documents [15].

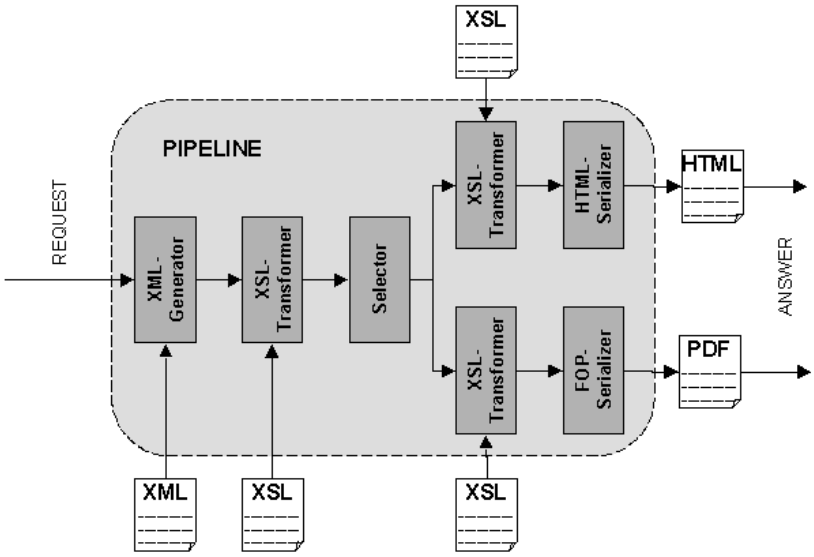
The application layer software, the *Cocoon Publishing Framework* (Cocoon), is a Java written modular XML publishing framework. Cocoon can read XML documents from different sources and is able to transform or format XML documents. For database connectivity, Cocoon uses the JDBC (java database connectivity) implemented as a pool of drivers for connectivity to different types of databases.

Cocoon's application logic is a framework of modular components that can be arranged freely. A serial combination of such components is called pipeline. The pipeline starts with an *XML generator* that can read XML documents and transfer them into a serial format (SAX) that is used in the pipeline. The most important components are *XML transformers:* They can transform and modify the XML document given by the XML generator. At the end of the pipeline a *serialiser* rearranges the serial stream of data to a document. To implement a dynamic behaviour in the pipeline, *selectors* and *matchers* can

be added that can make decisions such as IF-THEN-ELSE commands in programming languages [16].

The components in a pipeline can read an XML document (like a universal environmental report), transfer and rearrange its content (i.e. an environmental report for suppliers) and transform the document into another form of presentation (i.e. an HTML document or a PDF file). Figure 5 shows the components of this pipeline.

Figure 5 Pipeline for a stereotyped corporate environmental report ([2], simplified)



It is interesting that the documents controlling the rearrangement and transformation are also XML documents. The language for defining this transformation is *XSL* (Extensible Stylesheet Language), a language defined in XML. These documents can also, therefore, be rearranged or transformed. This fact can be used for individualisation.

Using the system presented above as a base and introducing a second pipeline, it is easy to implement a reporting system for individualised reports: The XSL document for the transformation is not a static document, it is dynamic, generated in the second pipeline when it is needed in the first pipeline:

1 The XSL transformer in the first pipeline requests the XSL document for transforming the universal environmental report.

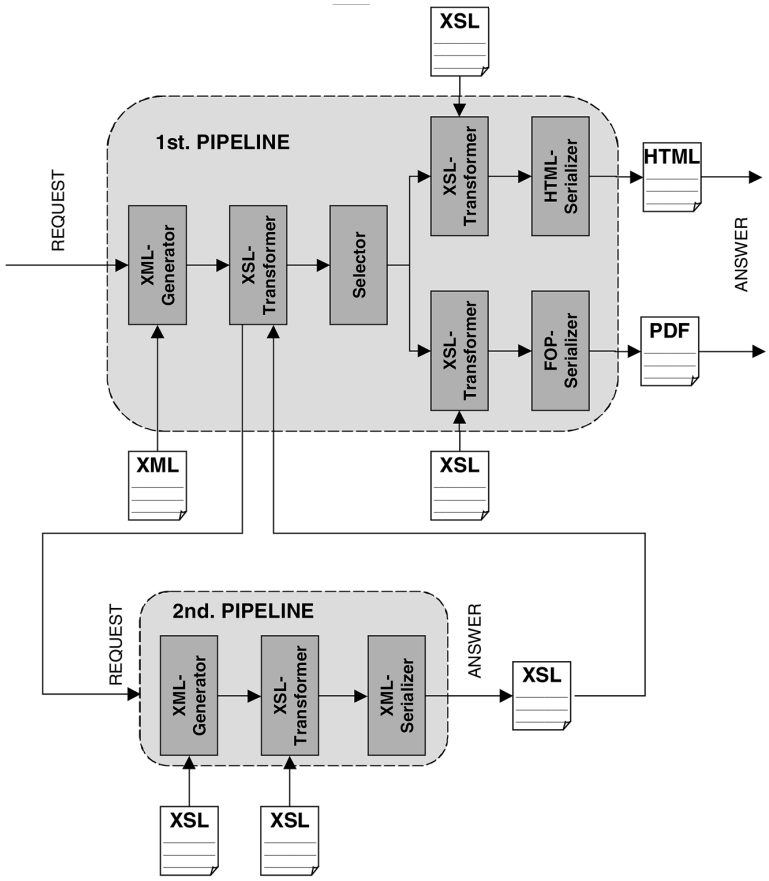
2 The second pipeline starts and the XML generator reads a universal XSL document for the group the user belongs to (i.e. an XSL document for investors, suppliers etc.).

3 An XSL transformer in the second pipeline transforms this universal XSL document into an individualised XSL document. This transformation is controlled by an XSL document which contains the preference of the user and that can be seen as a part of the user model.

4 The result of the second pipeline is an individualised XSL document that can transform the universal XML report to an individualised report. This XSL document is given back to the XSL transformer in the first pipeline.

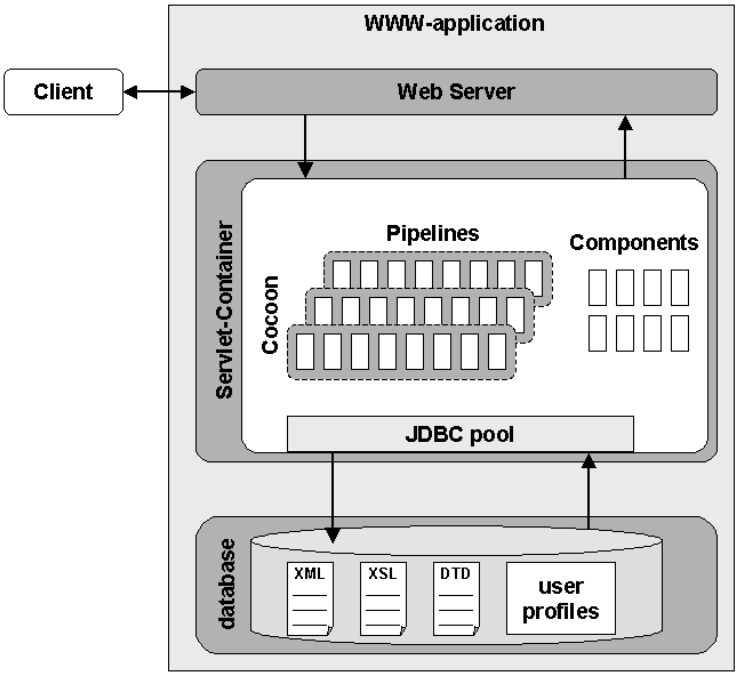
5 After this transformation in the first pipeline, the individualised report is again transformed to the media type requested by the user (Figure 6).

Figure 6 Dual pipeline system for an individualised corporate environmental report ([2], simplified)



The process revealed inside the pipeline is part of an overwhelming request-answer cycle. The request of the user (client) is handed over from the web server (presentation layer) to Cocoon (application layer). Cocoon analyses the request and starts the pipeline according to the request. While the pipeline is running, the data required is dynamically read or written from the data layer. The generated document is, after the pipeline is finished, handed back to the presentation layer, and from there back to the client. Figure 7 shows this request-answer-cycle.

Figure 7 Request – answer cycle of a corporate environmental reporting system using Cocoon



7 Possible system enhancements

As noted above, the system illustrated is a good base for personalised systems. The personalisation has only one technical consequence: the authentication of the user as a real person. To realise this authentication in a trustworthy environment, platforms like P3P (Platform for Privacy Preferences) can be used. Of course, national regulations for data security and privacy have to be respected.

The personalisation is interesting for real one-to-one contact with the user, so the user can be invited for dialogue or for participation in the reporting. Because of the amount of data for each user a personalised system is only interesting if the user employs the system in a long term perspective.

As said before, the pipeline transforming the universal report to an individualised (or personalised) report can give out the report on more than one media type. For example, the pipeline shown in Figure 5 can generate HTML and PDF documents. Of course it is possible to add further paths for other media types. Having personal information about the user it is possible to print personalised reports that can be send by mail or generate personalised interactive CD-ROM reports giving the user (and the creators of the report) more possibilities than the bandwidth-limited internet connection the users employ to access the system.

8 Conclusion

The typology of addressee orientation outlined gives an overview of the wide range of possible information systems for customised environmental reporting. Starting with adapted/stereotyped systems, which only realise target group tailoring for one group of users, more powerful systems were presented.

The system in focus has been an adaptable/individualised system, that gives very strong possibilities to both user and designer of the information system. This system, and of course its enhancements noted in the last part of the paper, can be realised using Cocoon ICT-architecture. A possible using a dual pipeline approach for individualisation based on stereotypes as initial profiles was shown.

References and Notes

1 The empirical studies are:

- Deloitte Touche Tohmatsu International (DTTI), International Institute for Sustainable Development (IISD), SusnatinAbility Ltd. (1993) *Coming Clean – Corporate Environmental Reporting. Opening up for Sustainable Development*, DTTI, London (UK).
- Fichter, K. and Clausen, J. (1994) *Wissenschaftlicher Endbericht zum Projekt Umweltberichterstattung*. Oktober 1994. Förderkreis Umwelt future e.V. unter wissenschaftlicher Leitung des Institut für ökologische Wirtschaftsforschung gGmbH (IÖW). Osnabrück, Germany.
- Schulz, T.M. (1995) *Ökologieorientierte Berichterstattung von Unternehmen*. Dissertation: Hochschule St. Gallen, Switzerland.
- Bergmann, U., Geer, J. and Vollmer, S. (1996) Erfahrungen aus der Praxis', in TUÜ Rheinland (Ed.) *Der TÜV-Umweltmanagement-Berater*. Wegweiser zur Zertifizierung. TÜV-Rheinland, Köln (Germany), pp. 1–23.
- Steven, M. and Letmathe, P. (1998) *Umweltmanagement in der Praxis – Teil II: Auswertung von EMAS-Erklärungen. Forschungsbericht* 20103198, Umweltbundesamt: Berlin (Germany).
- Fichter, K. (1998) *Umweltkommunikation und Wettbewerbsfähigkeit: Wettbewerbstheorien im Lichte empirischer Ergebnisse zur Umweltberichterstattung von Unternehmen*, Metropolis, Marburg (Germany).
- Isenmann, R., Lenz, C. and Müller-Merbach, H. (2001) Betriebliche Umweltberichterstattung im Internet – Der aktuelle Stand in Deutschland, *Praxis der Wirtschaftsinformatik*, Vol. 38, Issue 218, pp.97–107.
- Isenmann, R. (2001) 'Hypermediale Umweltberichte von Unternehmen: Bestandsaufnahme – empirische Befunde – Klassifikation' , in Tochtermann, K. and Riekert, W.-F. (Eds.): *Neue Methoden für das Wissensmanagement im Umweltbereich*. Metropolis, Marburg (Germany), pp.33–45.
- Braun, B., Geibel, J. and Glasze, G. (2001) Umweltkommunikation im Öko-Audit-System – von der Umwelterklärung zum Umweltforum, *Zeitschrift für Umweltpolitik und Umweltrecht*, Vol. 17, Issue 2, pp. 299–318.

2 Lenz, C. (2003) *Empfängerorientierte Unternehmenskommunikation. Einsatz der Internet-Technologie am Beispiel der Umweltberichterstattung*, Eul, Lohmar, Köln (Germany).

3 WBCSD – World Business Council for Sustainable Development: *Signals of change - business progress towards sustainable development*. <http://www.wbcsd.ch/publications/signals.htm> (access 2000-08-01).

4 Schulz, T.M. (1995) *Ökologieorientierte Berichterstattung von Unternehmen*. Dissertation: Hochschule St. Gallen (Switzerland).

5 Woywod, A. (1997) *Verfeinerung von Expertisesystemen durch Benutzermodellierung*. Lang, Frankfurt am Main (Germany).

6 Krzeminski, M. (1998) 'Interaktivität und Vernetzung. Zur Rolle neuer Medien in der Unternehmenskommunikation', in Krzeminski, M. and Zerfaß, A. (Eds.) *Interaktive Unternehmenskommunikation: Internet, Intranet, Datenbanken, Online-Dienste und Business-TV als Bausteine erfolgreicher Öffentlichkeitsarbeit*, Institut für Medienentwicklung und Kommunikation, Frankfurt am Main (Germany), pp. 13–28.

7 Blank, K. (1996) *Benutzermodellierung für Adaptive Interaktive Systeme: Architektur, Methoden*, *Werkzeuge und Anwendungen*. Infix, Sankt Augustin (Germany).

8 Dieterich, H., Malinowski, U., Kühme, T. and Schneider-Hufschmidt, M. (1993) 'State of the art in adaptive user interfaces', in Schneider-Hufschmidt, M., Kühne, T. and Malinowski, U. (Eds.) *Adaptive User Interfaces: Principles and Practice*, North-Holland, Amsterdam (The Netherlands), pp.49–68.

9 Fischer, G. (1993) 'Shared knowledge in cooperative problem-solving systems – integrating adaptive and adaptable components', in M. Schneider-Hufschmidt, T. Kühme and U. Malinowski (Eds.) *Adaptive User Interfaces: Principles and Practice*, Amsterdam (The Netherlands), North-Holland, pp.49–68.

10 Oppermann, R. (1994) 'Adaptively supported adaptability', *International Journal of Human-Computer Studies*, Vol. 40, No. 3, pp.455–472.

11 Balzert, H. (1988) 'Trends und Perspektiven der Software-Ergonomie', in Balzert, H. (Ed.) *Einführung in die Software-Ergonomie*, de Gruyter, Berlin (Germany) *et al*., pp.345–374.

12 Schraml, T. (1997) *Operationalisierung der ökologiebezogenen Berichterstattung aus Sicht des Informationsmanagements: Konzeption eines Vorgehensmodells zur formalisierten Explikation logischer Dokumenttypmodelle im Rahmen der Umweltkommunikation von Unternehmen*. Dissertation: Technische Universität Dresden (Germany).

13 Isenmann, R., Lenz, C., Marx-Gómez, J., Amelung, M. and Arndt, H.-K. (2003) 'Standardisierung XML-basierter DTDs zur betrieblichen Umweltberichterstattung, in Heubach, D. and Rey, U. (Eds.) *Integration von Umweltinformationen in betriebliche Informationssysteme*, Shaker, Aachen, (Germany), pp.69–83.

14 Netcraft 'Web server survey'. <http://www.netcraft.com/survey/> (access 2002-09-29).

15 Apache 'Apache cocoon'. <http://xml.apache.org/cocoon/index.html> (access 2002-10-09).

16 Dodds, L. (2002) 'Introduction to cocoon 2'. <https://www6.software.ibm.com/developerworks/education/x-cocoon/index.html?> (access 2002-09-29).