Web based foundry knowledge base

A. Stawowy a,*, A. Maciol a, R. Wrona b

a Faculty of Management, AGH University of Science and Technology, Gramatyka 10, 30-067 Krakow, Poland
b Faculty of Foundry Engineering, AGH University of Science and Technology, Reymonta 23, 30-059 Krakow, Poland
*Corresponding author. E-mail address: astawowy@zarz.agh.edu.pl

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Abstract

The main assumptions and functions of proposed Foundry Knowledge Base (FKB) are presented in this paper. FKB is a framework for information exchange of casting products and manufacturing methods. We use CMS (Content Management System) to develop and maintain our web-based system. The CastML – XML dialect developed by authors for description of casting products and processes – is used as a tool for information interchange between ours and outside systems, while SQL is used to store and edit knowledge rules and also to solve the basic selection problems in the rule-based module. Besides the standard functions (companies data, news, events, forums and media kit), our website contains a number of nonstandard functions; the intelligent search module based on expert system is the main advantage of our solution. FKB is to be a social portal which content will be developed by foundry community.

Keywords: Application of Information Technology to the Foundry Industry, Product Development, web-based systems

1. Introduction

A lot of websites developed for foundry industry and society exist in the internet area. We can divide them into five categories:
1. all-purpose sites, where foundry problems are only a part of the content,
2. theme sites, covering almost all foundry areas and problems,
3. enterprises’ sites, presenting companies’ offers from and for foundry industry,
4. associations’ sites, depicting activities of national and global foundry associations,
5. magazines’ sites, presenting papers, articles and events.

Below we present some of the example sites from above mentioned groups:
1. yellow pages, industrial sites, e.g. www.pkt.pl, www.4metal.pl, www.metalportal.pl,
3. all foundry companies have their own sites, e.g. www.dolmet.pl, www.odlewniepolskie.pl, www.abifoundry.com,
4. www.caef.org (The European Foundry Association), www.stowarzyszenie-stop.pl (Polish Foundrymen’s Association), etc.

We have examined several web repositories which have led us to the following conclusions:
– all sites offer incomplete and partial knowledge of foundry industry and technological problems,
– a lot of sites have very good assumptions which are not confirmed by their contents,
– there is only few examples of modern layouts and design which provides evidence for using outdated technology to web developing.

One of the results of our research grant is to be web-based system framework for information exchange of casting products and manufacturing methods. The system – in our intentions – has
to fill a gap between research activities and companies and customers’ needs.

This paper continues in Section 2 with an explanation of the methods of web developing. Section 3 gives the details on our Foundry Knowledge Base. Section 4 presents the main module of our solution. The conclusions are drawn in Section 5.

2. The methods of sites developing

In the field of websites developing, the standard approach is commonly accepted which follows the system development life cycle (SDLC) through investigation, analysis, design, implementation and maintenance stages [1].

A typical development process consists of the following steps:
1. the developer analyzes the client requirements,
2. the developer prepares the site structure (site map) and web design,
3. the developer creates page templates for every type of the page (home page, solutions, products, news, etc.),
4. the content editor creates new pages – she/he enters text and images into the page templates defined by developer,
5. the testing team makes investigation to ensure that the website works as intended and downloads quickly.

The site administrators, editors, and users maintain the site to provide actual and coherent content.

The newest and powerful method for websites development is to use a content management system (CMS) which is designed to simplify the publication of web content to websites, in particular allowing content editors to submit content without requiring technical knowledge of HTML or the uploading of files [2]. Usually CMS is implemented as a web application for creating and managing HTML content and employs server-side programming (like PHP or ASP.NET) together with SQL databases. In effect, the CMS allows to manage content of dynamic websites. Unlike static websites that use static HTML files stored on the disk, a dynamic websites display content from the database or XML files. CMS does not pre-render static HTML pages; instead, it renders the content in real time, when it is requested by the visitor [3]. This process is illustrated in Figure 1.

The main advantages of dynamic website with content management system include [4]:
- saving time and money by developing the dynamic website faster through WYSIWYG easy content editing,
- focus on the client's business needs instead of core infrastructure,
- providing users with additional functionality, such as newsletters, forums, and others that would be difficult and expensive to develop.

Moreover, if developer needs to add extra functionality, she/he can:
- create her/his own modules,
- add her/his own code to the pages,
- modify default system behavior using custom handlers and providers.

Taking into account all the mentioned advantages we decided to use CMS from Kentico Software to develop our web-based Foundry Knowledge Base.

3. An overview of Foundry Knowledge Base

The aim of our research is to build a web system, which collects information from foundry area and supports decisions making about whether, how and where it is possible to manufacture the certain part. We have planned to use CastML – XML dialect for description of casting products and processes – for storing all necessary data [5]. As we have discovered that it is possible to define the technological knowledge in the form of relational databases, we have decided to use relational database and SQL with the rule-based reasoning system to construct the complete knowledge ensuring the data integrity and integration. So CastML is used for information exchange only.

Web-based Foundry Knowledge Base has several standard and non-standard functionalities which are accessed from main menu. The home page of FKB is presented in Figure 2.

The standard functions are as follows (menu captions are highlighted in bold face):
1. list of firms with geographical localization, the list consists of foundries, suppliers, customers and R&D firms,
2. categories (channels) of information, we identified 13 groups: automation, molding and pouring, materials, equipment, metals and alloys, heat treating, environment and health care, planning, designing, quality control, information systems, artificial intelligence, melting; the list is open and it can be extended by website users,
3. forum groups; each forum group may have multiple forums on particular topic, the forums are organized into threads,
4. events and news to provide information on exhibitions, conferences, meetings etc.
5. media gallery containing videos, photos, pictures from foundry area.
The non-standard functions are as follows:

1. **articles base** grouped into mentioned above categories,
2. **Wiki**, users’ contributions to foundry knowledge in form of short articles,
3. **I-search**, intelligent module for casting process selection, it is an expert system which employs Inference with Queries method [6]; the details on this module are given in the next section.

### 4. Intelligent search module

The main module of our solution is an application which uses rule-based expert system and relational database for the selection of casting process taking into account the economic and technological customer needs [7]. For efficient knowledge representation we use the concept of attributive rule-based systems. Thus, it is possible to use the relational databases tools (SQL) for storing and editing the knowledge rules and also for solving the basic selection problems in rule-based system. Our original idea is to design database structure in such way that any source of knowledge can be classified into many categories. Due to that and users friendly interface the user can find any information in the way which follows his/her needs.

The sources of knowledge about foundry technology are technical standards, monographs and handbooks. The knowledge is presented in the form of tables interrelating various pieces of information about the respective technologies and parameters of ready products, possible to obtain when these products are made by a selected technology, with rules determining the economic conditions of process effectiveness. The rules are presented in the form of tables. The inference consists in finding out – by searching in tables comprising various technical parameters – a set of technologies possible for use in a given case, then selecting from this set the technology which is thought to be the best and most effective in realization of a specific customer order. The technological processes written down in the knowledge base include: casting in sand moulds, die casting, shell casting, continuous casting, investment process, centrifugal casting. The set of technical parameters depends on the type of casting and comprises the following properties: type of cast material, casting wall cross-section, porosity, dimensional tolerances, roughness, surface quality, etc.

The choice of technology also depends on commercial and production parameters, such as: batch size, availability of foundry patterns, technical specifications, etc. All information necessary for the inference process is written down in the form of relational databases.

Our solution assumes the possibility of examine simplified procedure of design process based on costs evaluation. We assume that information about customers order will be input manually or from XML documents. System – after rough analysis of a problem – suggests user the technological solutions possible to use.

The user chooses some solution and realizes the process of simplified design. The final result of such session is presentation with manufacturing process assumptions and evaluated costs. User can repeat this procedure many times for different available technological solutions. Because working objective of the system is evaluating the customer’s order cost, reasoning process is based on the model of variable casting costs. Costs of charge, costs of mould production, energy and labour costs have a main influence on castings’ cost. The costs of production quality depending on number of faults which can appear in process are also important. It is necessary to remember that casting is often only one phase of full production process. The more precise is the shape of the final product, the lower are the costs linked with mechanical working. So cost evaluation needs a solution of following particular tasks: charge qualifying, choice of mould technology, confirmation of size of raw casting with allowance, define the type of heat treatment and finishing method. In relation to mould technology it is necessary to solve particular problems such as the process and materials used for chills, models, and cores preparing.

The main function of the system consists in designing the simplified technology of casting. The process is driven through the set of standard forms which input the values for inference engine. The designing process is illustrated in treview form. The user is able to analyze the decision taken at each phase of the process in relation to input data. The exemplar guide for pressure die casting of Al-Mg alloy is presented in Figure 3. The final output is technological document containing product model, forming method, material data, the variable costs of each operation, and anticipated cost of mechanical working.

![Fig. 3. An exemplar guide for pressure die casting of Al-Mg alloy.](image-url)
It can be observed that the same result may be achieved in different ways. The place of particular object in the presented treeview is related to its parent relationship in knowledge base. At the same time, all child objects of a given parent are presented. This is not redundancy; due to the relationships involved each object is stored only in one place. The exemplar object is WWW document which URL address is stored in knowledge base. The types of other objects are marked with the proper icons.

The interface of inference engine working in information query mode is presented in Figure 4.

Fig. 4. Interface of the inference system utilized in information search mode

5. Conclusions and further works

The presented web Foundry Knowledge Base is in prototype phase now. We use CMS and ASP.NET tools for system developing; this choice seems to be very effective and flexible at all stages of system life cycle. We believe that the website will be moved to production server in a few months.

Besides the standard functions (companies data, news, events, forums and media kit) our website contains a number of nonstandard functions (articles base, Wiki, search module). The intelligent search module based on expert system and SQL is the main contribution of our solution. Preliminary results confirm that the idea of knowledge modelling fulfil the authors’ expectations. Flexibility of knowledge and open structure of the system guarantee the possibility of knowledge extension.

FKB is also a social portal which content will be developed by foundry community.

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References