Internet - Millenium Mantra for Metalcasters

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Abstract

The metal casting industry is waking up to the immense opportunities offered by the Internet, and the impending threat of survival if they fail to embrace it. Internet is useful not only for broadcasting information (about an organization’s products and services), or obtaining similar information (about customers as well as competitors), but also for engaging in mutual transactions (business-to-business electronic commerce), all at high speed and low cost. This paper describes our research work in four key areas related to web-enabled computer-aided casting: information, education, consultation and interaction. These are being implemented at the portal web site www.metalcastingworld.com. We have also developed a Casting Data Markup Language for managing and exchanging casting development project data over the web among different team members. The technology is designed to be truly easy-to-use and widely available, to benefit even small companies in remote areas. The prototype implementation has received very encouraging feedback and seed support from the industry.

Keywords: casting, computer-aided design, concurrent engineering, electronic commerce, Internet, world-wide-web.

1 Introduction

Growing faster than telephone and television, Internet has become the most important aspect of the worldwide communications revolution, connecting a variety of devices ranging from personal computers and mobile phones to factory machines and kitchen refrigerators in a ubiquitous ‘world wide web’, accessible by virtually anyone, anywhere, anytime.

The Internet is transforming the way we exchange information with other humans or devices, for business or personal work. This is beginning to impact virtually all aspects of our lives, including education, work, travel and entertainment. As a result, new businesses are emerging and old ones are getting transformed. Even the saying “change is a constant”, does not seem to be true any more; the rate of change seems to increasing without any limit in sight!

The first part of this paper reviews the current applications of Internet to the metal casting industry. We will see how several organizations are using this medium for information exchange with others. The second part of the paper describes our work in Internet-based computer-aided casting, which is meant for immediate application in the industry. This work is in four areas: information, education, consultation and interaction. The last part describes how in future, we can manage collaborative casting development projects on the web, using a standard ‘self-describing’ language for exchanging project data among team members. The different parts of the paper, as well as the sections in each part, are organized such that readers who are more aware of Internet technology can skip ahead.

2 Current Applications

Here we describe three basic applications of Internet: (1) getting general business information about other organizations by visiting their web-sites, (2) setting up a web-site for broadcasting such information to others for marketing purposes, and (3) engaging in business-to-business transactions through a common network or web portal.
2.1 Getting Information

Internet is the most powerful medium for obtaining general information about an organization – almost instantaneously and at virtually zero cost. Equipped with the basic equipment (computer, telephone connection and a modem), a browser programme (such as Microsoft Explorer and Netscape Navigator) and an account with an Internet Service Provider (such as VSNL and Satyam), the user can connect to any site on the Internet by typing its web address (for example, http://www.microsoft.com).

The web-sites are classified according to the type of the organization. Thus ‘.com’ refers to commercial, ‘.org’ refers to professional, ‘.gov’ refers to government and ‘.edu’ refers to educational organizations [1]. Other types of top level domain names have recently become available (for example, ‘.biz’ for businesses, ‘.coop’ for non-profit cooperatives and ‘.pro’ for professionals). There are also over 200 two-letter country domains (such as ‘.in’ for India).

Many organizations related to metal casting have already established their presence on the Internet, and many more are coming up (Fig.1). This includes engineering OEMs, casting suppliers (foundries), suppliers to foundries (material, equipment, tooling), software vendors, consultants, government research organizations, professional organizations, technical journals, engineering colleges and training institutes.

A typical web-site of an organization describes its profile, objectives (vision and mission), products and services offered, facilities, quality policies and contact address. Other information may include financial data, jobs available, sample products or projects, some informative content (articles) and free downloads (presentations, sample software, etc.). Many sites also have links to other related sites (such as customers and partners), making it very easy to jump to those web-sites by simply clicking on the respective names instead of remembering and typing their addresses in the browser. It is also usually possible to invoke an electronic mail program by clicking on the e-mail address displayed in the web page, compose a message and send it to the other end, instantaneously. It is no surprise that traditional postal communication is now referred to as ‘snail-mail’.

Most web-sites are structured to facilitate easy access to desired information. The main page (the first page displayed in the browser after typing the web address) usually provides links to various sections, which in turn provide links to details in individual pages. This makes it easy for a ‘visitor’ to quickly reach any page with the minimal number of mouse clicks – every second counts!

Thus it takes only a few minutes to visit the web-site of an organization and scan through the information available there, at a cost (usually) comparable to a local phone call. Any interesting or useful page can be printed out for future reference. Thus a foundry manager can know more about other foundries worldwide, new potential customers (casting buyers), material or tooling suppliers, conferences, interesting articles, training programmes and more, all at a convenience and cost unmatched by any other medium.

2.2 Broadcasting Information

Any organization can set up its own web-site, which serves as a virtual extension of its physical existence, useful for marketing its products and services. The first (and perhaps the most difficult) step is to register a domain name, which must be unique, close to the company name, short and easy to remember. This can be done online, at accredited registrars (such as networksolutions.com and register.com).

Getting a domain name has become so difficult now that the names of new companies are decided after searching, deciding and registering a domain name first. Often ‘cyber-squatters’ register the domain name of well known companies (which do not yet have web-sites), hoping to sell the rights later at an exorbitant fee. It is now possible to legally ‘evict’ such cyber-squatters by proving that the activities of the registering organization are more closely related to the domain name.

After registering the domain name, the basic structure, content and style of the web-site must be designed, developed and tested. The web pages are written using the Hyper Text Markup Language (HTML), which can also handle links to images, other HTML pages and even simple programs (for example, sending an automatic ‘thank you’ e-mail to visitors who provide their names and e-mail addresses). Then the web pages are uploaded and hosted on a web server (computer connected to the Internet). Finally, the web address is sent to public Internet directories (called Domain Name Servers) along with the actual Internet address of the server. This
ensures that visitors typing the address in their browsers are automatically connected to the server for displaying the relevant web pages.

After establishing a web-site, its address must be advertised: on letterheads and visiting cards, through e-mails to known contacts and even by advertisements. It is important to update the web-site on a regular basis, especially if any information gets obsolete (product line, phone numbers, job openings, etc.). A large number of foundries have established their web-sites, ranging from a simple one-page site to comprehensive multi-layer sites (Fig.2).

From registering the domain name to getting a simple web-site operational can take less than a week, at a cost of a few thousand rupees. However, implementing a good web-site requires considerable effort -- it can take several months and can be very expensive. Since a web-site is likely to be one of the first sources of information about an organization (especially for overseas customers), it is extremely important to make a good first impression. In cyberspace, as they say, competition is only a click away!

2.3 B2B Transactions

Regular business-to-business transactions include advertising or viewing a requirement, contacting potential buyers or suppliers, sending or receiving quotes, short-listing potential suppliers, confirming or receiving orders, monitoring the progress of orders, shipping, invoicing and making or receiving payments. While e-mail has dramatically reduced the time taken for sending or receiving the relevant documents (compared to the conventional ‘snail-mail’), there is no automatic correlation between the documents, resulting in users repetitively entering redundant data (for example, address or order number).

The Internet coupled with Enterprise Resource Management (ERM) or Customer Relationship Management (CRM) systems [2], enables integrating the above transactions. With this, the processing time for all transactions is a fraction of the time taken by conventional means, and overall costs are reduced by 5-15% [3]. The B2B Electronic Commerce has therefore emerged as the most important application of Internet in terms of value.

To provide above facilities in a web-site, it must be suitably designed with adequate security features. An automobile OEM would like to ensure that a competing OEM does not have access to the details (drawings, material specs, etc.) of his requirements advertised on the web. Since it is quite difficult and expensive to set up such facilities in individual web-sites, or even a dedicated networked connecting partners (because business partners change all the time!), a new type of web-sites has emerged: vertical portals.

A general portal essentially provides a ‘gateway’ to the web (links to individual web-sites), as well as a variety of content (news, interesting and useful articles) and services (search engine, e-mail, bulletin boards and discussion forums). Examples of popular general portals include indiatimes.com, rediff.com and yahoo.com. Vertical portals, also called vortals, are industry-specific portals focusing on a particular sector such as chemical, electrical, fasteners and textile industry. In the last few months, several casting portals have been set up, and more are coming up. Examples include castingsworld.com, clickafoundry.com, foundryonline.com, indiancastings.com, indocastings.com and metalworld.com (Fig.4).

Most of the casting portals provide a detailed list of foundries (ferrous and non-ferrous), suppliers to foundries (material, equipment and tooling), service organizations and others related to casting. Value-added services include web-page creation (if not existing already), posting of requirements (casting buyers, used equipment sellers, job openings, etc.) and tracking of responses to a posting. These portals usually require an organization to register as a member to avail of their services.

3 The Dhatu Project

The Computer-Aided Casting Lab at IIT Bombay was set up to determine, develop, demonstrate and disseminate software applications for the metal casting industry. The aim is to provide intelligent and user-friendly programs to casting buyers and suppliers for better and faster decision-making, leading to significant reduction in defects, lead-time and cost.

As a part of the above vision, we initiated a project (nicknamed Dhatu), to create a web portal dedicated to computer-aided design, manufacturing and management of cast products. The portal focuses on four key aspects: information, education, consultation and interaction for casting buyers and suppliers. These are implemented as different sections of the web-site metalcastingworld.com (Fig.4).
3.1 WebCast: Worldwide Information

The WebCast section provides links to the web sites of various organizations related to computer-aided casting. The user can simply click on the name of the organization, which will open a new browser window showing the contents of its web-site. Thus the user does not have to remember the domain addresses of the listed organizations.

The list includes universities, government and R&D organizations, CAD/CAM consultants and service bureaus, software vendors (solid modeling, process planning, simulation, rapid prototyping, etc.), professional organizations and journals/magazines. For convenience, the organizations are classified based on their physical location: America (covering North and South America), Asia (including Japan and Australia) and Europe.

Future improvements to this section include a short description of the sites, and a possible rating of the sites by visitors. This will be useful to users for immediate reference and deciding whether the site is of interest to them before taking a detailed virtual tour.

3.2 EduCast: Online Continuing Education

Metal casting is a knowledge-intensive industry. Foundries face the twin challenges of retaining younger engineers and retraining senior engineers. Continuing education about the latest technologies is one way to meet both these challenges.

The immediate motivation for web-enabled continuing education came from a series of workshops conducted during May-December 2000, in which nearly 150 engineers were provided theoretical and practical exposure to computer-aided casting. The EduCast section was conceived to extend the reach of such continuing education programmes to virtually anyone, anywhere, anytime.

The section essentially comprises lecture material (in the form of presentation slides and explanatory text), links to on-line articles, abstracts of technical papers in computer-aided casting published worldwide, virtual field trips (through links to relevant web-sites) and links to subject experts (Fig.5). An on-line quiz mechanism has also been developed and tested. Additional features in future may include bulletin boards, discussion rooms and applets (small application programs) for on-line exercises in casting design and analysis.

The EduCast is being used to supplement the regular courses taught at IIT Bombay in Casting and Molding Technology (M.Tech.) and Manufacturing Engineering (B.Tech.). It is also recommended as a supplement for (a) open workshops conducted by IIT or any other capable organization, in which participants are from several different organizations, and (b) in-house workshops conducted for a specific organization. It is planned to further supplement these (EduCast and hands-on workshops) with regular examinations, leading to (graded) course certificates from IIT Bombay for industry participants.

3.3 CadCast: CAD/Simulation Projects

Solid modeling and casting simulation have proven benefits. The solid model of the cast component is useful for accurate weight estimation, stress analysis, tool design (pattern or die), NC process planning (for tooling manufacture), casting simulation and automated inspection. Casting simulation enables quality assurance coupled with yield optimization [4]. It also enables engineering OEMs to improve their designs for castability, making them more compatible with the process and less sensitive to process variations [5]. All these lead to improved quality, shorter lead-time and lower cost.

However, the high cost (initial as well as annual maintenance), need for qualified engineers and lack of adequate local technical support prevent many small and medium enterprises from taking immediate advantage of CAD/Simulation technology. This has led to a number of organizations (including software vendors and their representatives) offering CAD/Simulation services on a project-by-project consulting basis.

A typical project starts from a customer sending the casting drawing to the consultant, along with material and process specifications. The consultant estimates the complexity of the casting (which influences the effort required for solid modeling and analysis) for quoting the charges. After confirmation, the solid model is created and verified, followed by casting simulation and optimization. Finally, the results are delivered to the customer against payment. While the actual work of solid modeling and simulation takes 3-5 days for low to medium
complexity castings, the entire project takes 2-3 weeks because of communication delays, defeating one of the main advantages of simulation – shorter development time.

The CadCast section provides a facility for CAD/Simulation users and consultants to exchange all necessary data in the shortest possible time over Internet (Fig.6). This has been achieved by designing online forms for initiating and specifying a project, automatic generation and sending of e-mails informing the status of the project and uploading/downloading facilities for drawing, model and results. We have also developed an automatic complexity estimator applicable to 2D drawings (in DXF format) as well as 3D models (in STL format), which has been implemented in CadCast. At present, the uploading/downloading facility is limited to small files because of bandwidth constraints.

3.4 InterCast: Buyer-Supplier Interaction

While many portals provide facilities for posting a buyer’s requirement, and allowing potential suppliers to respond to the RFQ (request for quote), there is no mechanism for evaluating the buyer-supplier compatibility. This is particularly needed when a large number of suppliers respond to an RFQ.

The InterCast facility is based on an algorithm for casting buyer-supplier compatibility evaluation developed by our group [7]. It uses Analytical Hierarchy Process to systematically assign weights to 15 evaluation criteria, which include design, process, quality and cost/delivery capabilities. To use the facility, buyers and suppliers first provide details of their organizations by filling up forms available online. Then a buyer can initiate a RFQ and provide the necessary details about the product (material, geometry, quality, etc.). Automatic e-mails are generated and sent to suppliers with basic compatibility (metal, weight and process), inviting them to respond to the RFQ. Based on their response, the compatibility evaluation program is initiated and the results sent to the buyer for taking a final decision.

The final version of InterCast will have the RFQ in two parts: basic and detailed. The basic part of RFQ will be accessible to all compatible suppliers, whereas the details (including a drawing) will be accessible only to suppliers short-listed by the buyer. This provides the minimum level of security to prevent unauthorized access to project details by an OEM’s competitors.

4 Web-Based Engineering

A typical casting project, starting from product design to final inspection and shipping, involves several engineers in different organizations (or departments). It is well known that engineers spend over 50% of their time in searching, verifying and transmitting information, leading to a significant loss of productivity. Internet provides a powerful platform for managing casting project data by a team of engineers, irrespective of their physical location. Also, by providing a central repository of data (which can be freshly duplicated whenever required), problems associated with redundancy and conflicting versions can be eliminated.

We are developing a web-based casting project management facility for collaborative engineering by product designers, tool-makers and foundry engineers. The backbone of the facility is a common ‘self-describing’ language to store casting project data. This is described first, followed by implementation details.

4.1 Casting Data Markup Language

The Casting Data Markup Language (CDML) is a template for storing casting project data in a simple yet systematic way. It is compatible with the rapidly emerging XML standard for web-enabled databases [7].

The CDML is adapted from a hierarchical tree structure developed in an earlier investigation [8]. It comprises about 100 nodes in a parent-child-grandchild structure. The top node is called PROJECT, which has seven children: ADMIN, PRODUCT, TOOLING, PROCESS, MATERIAL, QUALITY and CONFIG. Each of these may have children: for example, ADMIN has children OEM, TOOLMAKER, FOUNDRY, COST and SCHEDULE. Similarly TOOLING has children PATTERN, MOLD, CORES, FEEDING and GATING. Some nodes are up to 6 levels deep (great-great-great-great-grand children of top node). The tree structure enables quick browsing and reaching any desired node.

The nodes of the CDML tree are associated with different data blocks, which are also stored in XML format. Each data block comprises several pairs of field names and their values. It also stores the date and time of its creation or last updating. Most data blocks have links to a 2D image or a 3D model. For example, an
EQUIPMENT block may have a link to a picture of the equipment, and the PRODUCT block may have a link to a solid model of the part.

The first version of CDML handles about 3000 different pieces of data. It is possible to add new nodes or new fields (in a data block) in later versions. Also, the separation of the node structure from the data blocks enables restructuring of the tree without modifying any associated programs using the data.

4.2 Casting Project Management System

The system is designed to provide facilities for creating, viewing, modifying, updating, importing and exporting casting project data (stored in CDML) over the Internet from any location worldwide. A prototype version is under developed in our lab. After initial testing, it will be implemented at the metalcastingworld.com portal.

To initiate a new project, an engineer uses a standard browser to log into the web server (currently a lab computer) and provides a unique name for the project. The system automatically creates a new folder and copies the standard CDML tree and data blocks with default values into the project folder. The user can then browse through the entire tree and view any data block (Fig.7).

To modify the default values, the user may either edit them manually or copy the values from another source. The various sources of data include standard libraries provided on the web-site (such as material composition and properties), customized libraries created on the user’s computer (such as customer’s profiles and addresses), and the results of a software program (such as cost or schedule data).

The project folder is protected by a login and password to prevent unauthorized access. These can be decided by the person initiating the project, who then communicates the same to other engineers working on the project. It is also possible to restrict the rights to view or edit individual data blocks.

With such a facility, product designers, tool-makers and foundry engineers will be able to quickly exchange the relevant information with each other. This will minimize the unproductive “waiting-time” between different activities, compressing the total lead-time for a casting project from weeks to days. It will also encourage and facilitate early collaborative efforts to improve the product-process compatibility.

5 Conclusion

Internet – representing the communications revolution sweeping the globe – offers immense opportunities and challenges to metal casting industry. We have seen how it is useful for obtaining or transmitting business information and for engaging in business transactions. The web portal metalcastingworld.com developed by us provides a facility for information, education, consultation and transactions in the area of computer-aided casting. The Casting Data Markup Language enables casting life-cycle engineers in web-based casting project management and collaborative engineering.

While prototype implementations of the above projects have received very encouraging feedback from practicing engineers, considerable effort is required for scaling up and maintaining these systems for widespread use in the industry. Casting buyers, suppliers and other organizations related to metal casting need to form collaborative ventures and proactive consortiums to adopt, adapt and integrate the new technologies with their current best practices. The casting industry must collectively surf the Internet wave and surge forward in the new Knowledge Economy.

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