Experimental on-line platform for product conceptual design: OpenDesigNet

Plataforma experimental para el diseño conceptual de productos OpenDesigNet

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ABSTRACT

This paper highlights the need for using specialised on-line collaborative environments by designers and product engineers who increasingly use Web 2.0 technology to search for information. Although there are professional channels and networks, there is no specific platform which helps during a new product's conceptualisation phase. Open communication must thus be promoted and encouraged amongst design professionals and companies to form working groups thereby allowing them to work collaboratively in the most open and creative phase of product design, i.e. conceptualisation. The OpenDesigNet (ODN) experimental platform has been developed so that designers and small- or medium-sized companies (SMC) can access on-line collaborative tools to support the creation and promotion of new on-line products and assess their immediate social impact. This article presents some of the results obtained during the validation phase involving a platform satisfaction survey of design engineering students and has led to a first-hand assessment of the new platform's potential impact on their professional future.

Keywords: product engineering, Web 2.0, collaborative environments, product design, Open Source.

RESUMEN

Este artículo muestra la necesidad futura del uso de entornos colaborativos, especializados en la red para los diseñadores e ingenieros del producto, que cada vez más, utilizan las tecnologías Web 2.0 para la búsqueda de información. De hecho, aunque existen canales o redes profesionales de carácter general, no existe una plataforma específica que les ayude en la fase de conceptualización de un nuevo producto. Por lo tanto, se hace necesario promocionar y fomentar la comunicación abierta entre los profesionales del diseño y las empresas, para formar así, grupos afines que permitan trabajar de manera colaborativa durante la fase más abierta y creativa de un producto: la conceptualización. La plataforma experimental OpenDesigNet ODN ha sido desarrollada para que las PYMES y los diseñadores dispongan de herramientas colaborativas on-line de apoyo, que generen la creación y promoción de nuevos productos en la red, evaluando su impacto inmediato a nivel social. El artículo muestra parte de los resultados obtenidos en la fase de validación, que se realizó mediante una encuesta de satisfacción sobre la plataforma en estudiantes de Ingeniería y de Diseño, que ha permitido evaluar de primera mano el posible impacto de la nueva plataforma en su futuro profesional.

Palabras clave: ingeniería de producto, Web. 2.0, entornos colaborativos, diseño del producto, Open Source.

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Introduction

Industries throughout the world have found it necessary to participate in global designs involving collaboration amongst international actors to ensure better competitive advantages (Rodgers & Clarkson, 1998). Future product engineers will thus have to face challenges regarding the use of on-line collaborative tools orientated towards the integrated management of design involving participation in multidisciplinary teams distributed around the world (Yuanyuan *et al*., 2008). Collaborative design therefore represents a methodology which enables many designers to participate in designing a part or product (Marion, 2008), and often provides an opportunity for a product's final users to judge such design so that it meets their real needs (Quertani & Gzara, 2008). Web 2.0 Internet communication tools promote collaboration and the quick and efficient exchange of information about industrial products amongst the users of a community or identified social network, based on user communities and services, such as social networks, blogs or Wikis (Joslin *et al*., 2003). Such tools also support product development phases by acting as communication platforms between product designers or other specialists to make a product more efficient compared to a traditionally designed product (Putnik *et al*., 2008; Zhan *et al*., 2003). Engineering design students should acquire skills such as good information management using

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their knowledge of on-line collaborative tools (Uchihira *et al.*, 2007), security protocols with a client, on-line document management and monitoring current technology trends in the materials and processes field (Bai *et al.*, 2005; Carbone, 2005).

Collaborative design work

Design in the field of new products has undergone profound methodological changes, due mostly to the computerisation and digitisation of traditional industrial processes (Pibernat-Domenech & Chaves, 1989). For example, the industrial development of technology, called computer-aided design (CAD), has led to the virtualisation of management and creating product-related information from the very moment of conceptualisation.

More computerised tools have become increasingly available to help product engineers during any stage of project development and communication with a client or company (Ivañez Gimeno, 2000). Product development and communication tasks have led to the concept of collaborative design itself undergoing changes in perspective since the 1980s according to the technological advances made over the past 30 years. The first generation of CAD tools for producing two-dimensional objects provided formal and objective information regarding a product but few opportunities for exchanging information across platforms and they had little scope for development regarding their subsequent implementation in a business environment.

Advances in graphical technology gave way to more sophisticated and specialised CAD programmes allowing an engineer to plan and diversify product information from a graphical and technical point of view; this could then be extrapolated to an industrial setting through CAM, CAE and CIM technologies where studying problems involving exchanging data and information flow within a company had already begun. Collaborative design started its development as a theory applied to manufacturing with the second generation of CAD tools in the early 1990s. With the acceptance of the need to address problems and analyse product verification by integrating manufacturing processes and product life-cycle, CAD systems (Ren *et al.*, 2010) posed the need to share and verify information and technical data and transfer this to product manufacture and involve on-line communication protocols throughout the development process (Winblad *et al.*, 1993).

CAD software technology currently offers applications such as lifecycle product management (LPM) facilitating information control and providing new knowledge for project development. Companies creating LPM sometimes offer on-line information management services integrated in working groups within a company.

Such systems share project technical information, graphics and documentaries, incorporating collaborative and communicative tools (forums, video conferencing, chats, etc.) typical of web 2.0 (Lau & Mak 2003). They may also include specific applications optimising and generating specialised information directed at manufacturing and production (Xu & Liu, 2003).

Regarding applications, Dassault Systemes' DS ENOVIA[4], Autodesk's Buzzsaw[5], Siemens' Team Center[6] or PTC's Windchill[7] all offer collaborative environments or specific modules on a sales level, these being very expensive for small- or medium-sized companies (SMC) and only large companies can thus afford them. The applications are largely of a closed nature and are centred on the collaborative administration and sharing of all of a company's intellectual assets. This allows for controlling and optimising product design, development and manufacturing, thereby making business and life-cycle analysis tools available for product development.

However, these applications do not cover web searches for opportunities with professionals, outsourced workers or business people who want to work on a common project, such aspect being fundamental for freelance or contracted professional designers working for an SMC. Aspects related to a search for business opportunities, business contacts within SMCs, businesses for outsourcing or creating on-line multi-disciplinary groups should be carefully planned, even before designing a product.

An environment must be created on the internet where designers and engineers can evaluate, analyse and conceptualise product viability before such product has actually been designed and, once conceptualised and formalised during its first stages, it can be seen as restrictive or open to consumers regarding previous assessment.

The latter aspect has undergone the most significant change regarding new product development. Recognising the need for people from different technical disciplines, geographical locations and speaking different languages to communicate before, during and after a new project has forced design and engineering schools to encourage interdisciplinary technical and personal skills concerning organisation and management for raising awareness of the importance of digital communication areas inside and outside a university environment which can be extrapolated to future business environments (ANECA, 2006).

Industrial systems and processes in Spain have evolved in parallel with other European countries in terms of education and business involvement in the use of new technology and its methodological use regarding resources earmarked for new product development (DDI, 2005; DDI, 2008). Spanish MSC have undergone necessary computerised updating concerning industrial processes and resources over the last few years, thereby allowing it to become competitive on a European and worldwide level (COTEC, 2008).

Technological development regarding new digital platforms has thus allowed Spanish SMC to generate R+D+I orientated knowledge at a European level which has been aimed at very mature or old sectors (i.e. furniture and related industries) whose progress towards new technology has currently stalled due to economic recession (Pérez, 2007).

Web 2.0 technology for new product organisation and information management

Web 2.0 or post-Web 2.0 technology has provided tools, resources and applications in the social communication area and has become more permissive in recent decades. The democratisation of on-line communication environments has given way to the rise of direct industrial and professional communication with users through interest groups' collaborative environments. Such interest groups have undergone a significant change in the development of collaborative environments for people having common interests in business or professional environments.

[4] http://www.3ds.com/products-services/enovia Last visit October 2013
[5] http://www.autodesk.com/products/buzzsaw Last visit October 2013
[6] http://www.plm.automation.siemens.com/en_us/products/teamcenter/ Last visit October 2013
[7] http://es.ptc.com/product/windchill/ Last visit October 2013

Communication platform and product promotion by design engineers and professionals in their own social networks has become a focal point for trends and flows of increasingly selective opinion. New product information organisation and management in companies has undergone significant changes regarding the physical location of information. Some information is digital today and may be shared, evaluated and commented on-line in a conventional and fluid manner (Skelton & Thamhain, 2005) using Web 2.0 technology and following basic criteria in the field of communication and information exchange orientated towards the problem of developing new products. However, very few developed technologies have been found taking the following premises into account (Royo *et al*., 2011):

- Creating a professional environment orientated towards promoting design services for professionals;
- Creating a professional environment enabling the controlled and verifiable exchange of design project-related data;
- Creating a personalised environment for designers enabling contact with SMCs;
- Dynamising a corporate communication environment enabling a company to know about and look for design services;
- Making future product engineers aware of the use of new communication environment-based technology on Web 2.0; and
- Promoting industrial sector professional, design and business services having a low level of competitiveness which will help stimulate markets.

OpenDesigNet.ODN experimental platform

An experimental digital platform was thus developed using OpenDesigNet[8] (Figure 2). ODN was conceptually based on a collaborative environment orientated towards the specific area of engineering product design. An ODN platform is structured in four modules; user area, collaborative design workshop, business unit and design explorer (Figure 1).

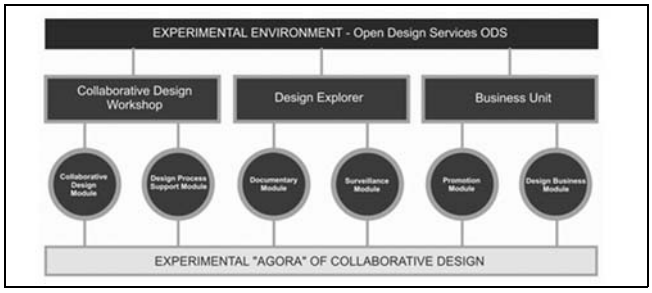

Figure 1. OpenDesigNet platform overall structure

The user area allows users to customise their profiles within the platform at wither public or private level. A user can enter information concerning their professional and personal profiles and access specific applications such as bulletin boards, internal mail, news editing, creating portfolios, creating interest groups, etc...

The collaborative design workshop area allows a user to create and manage design projects from the platform by using a collaborative on-line work environment to assist users in developing the documentation required during each phase of conceptualising a new product.

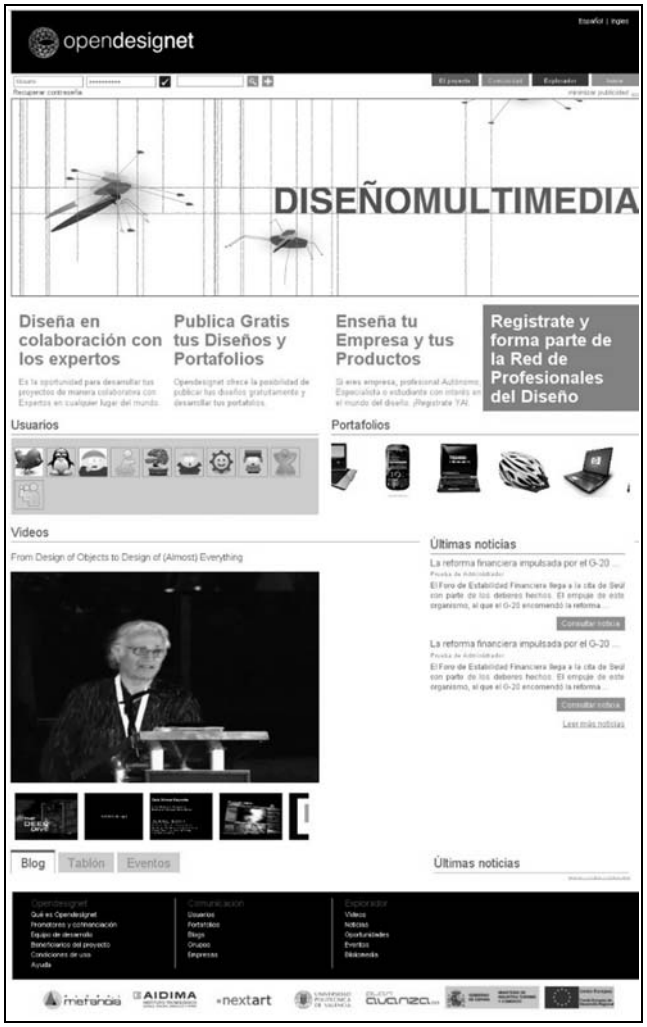

Figure 2. Main page OpenDesigNet interface

The business unit area allows a user to publicly or privately show designs created within or outside the platform helping to promote design services, including designers and SMCs through accessing product catalogues, offers and job applications or design services, etc...

The design explorer area enables users to experiment with solutions and applications related to computer aided design (CAD), instrumentally supporting the creation of design project graphical and textual documentation.

ODN platform architecture

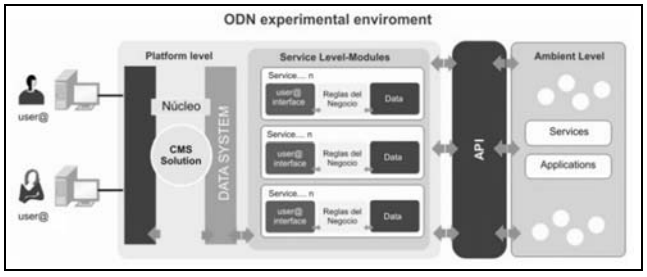

Figure 3. OpenDesigNet architecture

[8] http://www.opendesignet.com/ Last visit September 2013

Software architecture in an experimental environment made up of already existing free software solutions based on three levels of integration (Figure 3):

A platform level: this is the platform's core, having all the expected components of a common ExtJS-based interface;

A service level: this uses service-orientated architecture (SOA) integrating services. The development of each service is based on a three-layered model view controller (MVC), establishing division between user interface layer, business rules and access to data concerning MySQL; and

An environment level: this allows access to suppliers of public services through a bi-directional API and the generation of web services to provide the frontend with valuable information generated in the platform (access to data bases – ADOdb).

ODN platform survey assessment

Experimental development of any user-orientated digital platform requires a validation phase containing the profiles involved in its future use. Therefore, different surveys and experiments were developed with users allowing the purification of workflows and information, as well as the aesthetic and functional validation of the platform. The Universitat Politécnica of Valéncia revised the platform from an aesthetic and functional point of view and analysed management of final tasks.

The tasks were focused on future designers (graduates) whose knowledge about the Internet and new technologies would define them as potential expert users in digital environments and applications orientated towards industrial product design.

Orientation of the student profile survey was aimed at analysing their prior knowledge and use of available ICTs and satisfaction with collaborative tools established on the ODN platform. The survey was designed taking heuristic evaluation (HE) criteria into account (Nielsen, 1994) and Web usability evaluation process (WUEP) criteria based on user satisfaction with end-users (Younghwa & Kozar, 2012; Fernandez *et al*., 2013).

The questions posed evaluated overall aspects related to the ODN platform and the platform's collaborative tools (chat, forums, etc...). The criteria proposed for questions in the survey of students took into account students' predisposition regarding knowledge of the Internet and computer media. A set of criteria orientated towards three main blocks of questions was thus established; part 1 involved questions regarding general information about students, part 2 questions related to their knowledge and use of ICTs and part 3 questions for assessing the platform's satisfaction level.

The survey was conducted late on in the second quarter of the first year, since the students would have acquired a basic knowledge of what product design was all about. The survey was carried out with 106 first year Industrial Design students studying at the Universitat Politécnica of Valéncia (42 male and 64 female). The time involved in presenting/taking the survey was as follows:

- An informative presentation of the survey (5-10 minutes), involving a presentation of the intention of the ODN platform and the survey;
- An access phase and registration on the ODN platform (5-10 minutes), demonstrating main access to the platform and students were enabled quick registration to the platform by using e-mail and a password created by the students themselves. Once confirmation had been received, users were asked to access the area of their profiles and complete the application regarding their public and private profiles;
- A collaborative tools' access phase in the "my profile" area (20 minutes) involved students agreeing to the communication tools available within the personalised area, more specifically to three applications; a forum, a blog and the news area. Users were asked to perform specific tasks like viewing / answering a forum, viewing / answering a blog and seeing / creating a story/news; and
- A telematic survey phase (20 minutes) where the interviewer provided a link to access the on-line survey created by the students.

SPSS software was used for analysing survey results, based on methodological criteria such as frequency analysis of survey responses (without gender differences), averages and standard deviation concerning all questions, analysing correlation between variables, using the Chi-squared test and using contingency graphic charts to visualise compared answer distribution.

The overall results led to drawing the first conclusions related to each block of questions. A significant increase in women taking technical careers was found in part 1, as well as computer availability in 100% of cases.

Part 2 (concerning ICT management) revealed a high percentage of computer availability at home, accompanied by domestic users' knowledge of its use. Regarding Internet use and management of its applications, it was found that there was a great difference regarding average knowledge concerning the management of operating systems such as Windows compared to Open Source (OS) systems. However, a good range of knowledge regarding the use of e-mail, collaborative environments, browsers, social networking tools and on-line communication was seen.

Part 3 (designed to evaluate general satisfaction about the use of OpenDesigNet as a platform) revealed positive evaluation regarding all questions related to usefulness, use, learnability and satisfaction. However, the most significant evaluation concerned the tools and collaborative applications following the same criteria, which led to verifying students' acceptance of implemented applications on the platform as an aid to document management and communication regarding overall project design (Figure 4).

Conclusions

The most important conclusion reached concerned detecting great potential in developing new on-line collaborative environments for designers focused on improving multidisciplinary teams' communicative management with companies (SMC). The need to optimise resources and promote future products from the net within a product engineering environment will affect the way in which we currently establish communication with SMC and designers (i.e. graduates working in this area).

Novice designers know how to unravel the collaborative environments on the net at a social level, but do not know that this knowledge can be used in their profession (i.e. once they graduate) concerning communication with SMC, making communication and promotion concerning new products on the market more flexible. The survey revealed positive willingness regarding the use of platforms like OpenDesigNet by future designers and the acceptance of this type of virtual environment as an area for experimenting and collaborative work in designing and creating new products.

An important conclusion concerned the great potential in developing new on-line collaborative environments for professionals aimed at improving management and communication aspects between multidisciplinary teams and businesses. The need to optimise on-line resources and promote future products in the field of product engineering affects current communication between companies and designers.

Novice designers know how to function in collaborative environments on social networks but do not know that such knowledge can help them in their future careers with companies, streamline communication and promote new products on the market.

The survey indicated an overall positive willingness in using platforms like OpenDesigNet for future designers and the acceptance of virtual environments as an area for experimentation and collaborative work in designing and creating new products.

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References

ANECA., White book on Undergraduate Degrees in the field of Industrial Engineering., National Agency for Quality Assessment and Accreditation, 2006.

Bai, Y. W., Chen, Z. N., Bin, H. Z., Hu, J., Collaborative design in product development based on product layout model., Robotics and Computer-Integrated Manufacturing, Vol. 21, 2005, pp. 55–65

Carbone, T. A., Integrating operations and product development methodologies for improved product success using advanced product quality planning., Advanced Semiconductor Manufacturing Conference and Workshop, 2005 IEEE/SEMI, 2005, pp. 228-233. DOI: 10.1109/ASMC.2005.1438800.

COTEC, Foundation for Technological Innovation., Design and innovation. Design management in the company., COTEC documents on technological opportunities, 2008.

DDI, Society for the Development of Design and Innovation Ministry of Economy., Study the economic impact of design in Spain., 2005.

DDI, Society for the Development of Design and Innovation Ministry of Economy., Study the economic impact of design in Spain., 2008.

Fernandez, A., Abrahão, S., Insfran, E., Empirical validation of a usability inspection method for model-driven Web development., The Journal of Systems and Software, 2013, Vol. 86, pp. 161– 186. http://www.sciencedirect.com/science/article/pii/S016412121200218X

Iváñez Gimeno, J. M., Design management in the company., McGraw-Hill of Management, 2000.

Joslin, C., Pandzic, I. S., Thalmann-Magnenat, N., Trends in networked collaborative virtual environments., Computer Communications Elsevier, Vol. 26, No. 5, 2003, pp. 430-437.

Marion, T. J., On the use of global cost modelling early in new product development., Engineering Management Conference, IEMC Europe, 2008, pp.1-7, DOI: 10.1109/IEMCE.2008.4617975

Nielsen, J., Heuristic Evaluation., In: Nielsen, J., Mack, R. L. (Eds.), Usability. Inspection Methods., John Wiley & Sons, 1994, pp. 25–62.

Lau, H. Y. K., Mak, K. L., A virtual design platform for interactive product design and visualization., Journal of Materials Processing Technology, 2003, Vol. 139, pp. 402-407

Ouertani, M. Z., Gzara, L., Tracking product specification dependencies in collaborative design for conflict management., Computer-Aided Design, Vol. 40, 2008, pp. 828–837.

Pérez González, D., Measuring ICT investment and its benefits. The case of SMEs in the sector of information technology and communications., Economic Bulletin ICE, No. 2902, 2007.

Pibernat-Domènech, O., Chaves, N., The design management. IMPI, the Mexican Institute of Industrial Property., Madrid, 1989, pp. 13-16.

Putnik, G. D., Goncalves, P., Sluga, A., Cunha, M. M., Virtual environments for dynamically reconfigurable Concurrent/Collaborative Engineering ''virtual'' teams., CIRP, Annals-Manufacturing Technology, 2008, Vol. 57, pp. 171–174.

Ren, Z., Yang, F., Bouchlaghem, N. M., Anumba, C. J., Multi-disciplinary collaborative building design-A comparative study between multi-agent systems and multi-disciplinary optimisation approaches., Automation in Construction, Vol. 20, No. 5, 2010, pp. 537-549. DOI: 10.1016/j.autcon.2010.11.020.

Rodgers, P. A. & Clarkson, P. J., An investigation and review of the knowledge needs of designers in SMEs., The Design Journal, 1998 Vol. 1, pp. 16-29.

Royo, T. M., Albiñana, B. J., Cuna, J. C., Montanana, I. T., New collaboration tools applied to design teaching., In: Promotion and Innovation with New Technologies in Engineering Education (FINTDI), 2011, pp. 1-7. DOI:10.1109/FINTDI.2011.5945966

Skelton, T. M., Thamhain, H. J., User-centered design as a risk management tool in new technology product development., In: Engineering Management Conference, Proceedings IEEE International, 2005, Vol. 2, pp. 690-694. DOI: 10.1109/IEMC.2005.1559237.

Uchihira, N., Kyoya, Y., Kim, S. K., Maeda, K., Ozawa, M., Ishii, K., Analysis and Design Methodology for Recognizing Opportunities and Difficulties for Product-based Services., In: Management of Engineering and Technology, Portland International Center, 2007, pp. 2755-2762. DOI: 10.1109/PICMET.2007.4349613.URL.

Wang, Q., Design and evaluation of a collaborative learning environment., Computers & Education, Vol. 53, 2009, pp. 1138–1146.

Winblad, A. L., Edwards, S., King, D. R., Object-oriented software., Addison-Wesley Iberoamericana S. A., 1993, pp. 118-119.

Xu, W., Liu, T., A web-enable PDM system in collaborative design environment., Robotics and Computer Integrated Manufacturing, Vol. 19, 2003, pp. 315-328

Yuanyuan, Y., Shengfeng, Q., Holland, R., Development of a project level performance measurement model for improving collaborative design team work., In: Computer Supported Cooperative Work in Design, CSCWD 2008. 12th International Conference, 2008, pp. 135-140. DOI:10.1109/CSCWD.2008.4536970.

Younghwa, L., Kozar, K. A., Understanding of website usability: Specifying and measuring constructs and their relationships., Decision Support Systems, Vol. 52, No. 2, 2012, pp. 450–463. http://www.sciencedirect.com/science/article/pii/S0167923611001679

Zhan, H. F., Lee, W. B., Cheung, C. F., Kwok, S. K., Gu, X. J., A web-based collaborative product design platform for dispersed network manufacturing., Journal of Materials Processing Technology, Vol. 138, 2003, pp. 600–604.