

Implementing the HCD Method into the Developing Process of a CPD System

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Abstract. This paper aims to investigate collaborative product development activities and highlights the importance of human perspectives for developing a collaborative product development (CPD) system. For CPD systems to be useful, it is necessary to effect usable and useful interaction. Therefore, the human-centred design (HCD) method had been implemented into the developing process of a CPD system. The modified HCD method specifies how the activities fit into the overall system development process. A proposed plan guides: (1) the design process activities described, (2) procedures for integrating these activities with other system development activities, (3) the individuals and the organisation(s) responsible for the design activities and the range of skills and viewpoints they provide and (4) effective procedures for establishing feedback and communication on design activities as they affect other design activities and methods for documenting these activities.

Keywords: collaborative product development, human-centred design, software engineering.

1 Introduction

Nowadays, the CPD systems are increasingly being seen as useful mechanisms for the sharing of design knowledge and the distributed design collaboration; particularly in the field of consumer goods production. Although many systems have been developed, few can be termed ‘successful’ (i.e. have a significant uptake by intended users, and used by them).

Industrial product development is an interdisciplinary activity requiring contributions from nearly all the functions of an organisation. Three functions are usually central to a product development project: marketing, design, and manufacturing. However, people in different functional departments have different disciplines. It is essential to assure the end system meets the target audiences’ requirements, experience and expertise. A CPD system may thus be executed by a wide range of different types of users. These may be inexperienced users, unskilled people, users with average abilities and expert operatives.

Documented reports of underperformance of ICT systems over several decades reveal that a major factor contributing to the disappointing outcome is the inadequate understanding of user requirements and thus failure to design new technologies to meet those requirements [1, 2]. Maguire [3] stated that the benefits of designing a useable system can be summed up as follows: increased productivity, reduced errors, reduced training and support, improved acceptance and enhanced reputation. Stamato [4] referred there are several factors that create the impetus for collaboration; however, technology is only one of the factors to affect collaborative product development. Instead, successful collaborative product development will have a balanced approach between users, organisations, and technology.

Human factors, also called Ergonomics, is a branch of applied science concerned both with the study of human behaviour in the context of technology and with the application of the knowledge gained from such study to real-world needs. For a collaborative product development system, it is centred on the characteristics and needs of team members in complex systems using advanced information and communication technology. Many poorly designed and unusable systems exist which users find difficult to learn and complicated to operate. These systems are likely to be underused, misused or fall into disuse with frustrated users maintaining their current working methods. The outcome is costly for an organisation using the system and wasteful for people learning the system. A global manufacturing organisation needs a CPD system that concerns all parameters during the product development life cycle. This requires the critical consideration of various tasks such as overall coordination, control, design rules, consistency, and data integrity to maximise the design efficiency and to minimise cost, time and resources waste. This can be achieved by the integration of different design areas through establishing a Web-based system, within an organisation in a consistent manner. Such integration should include a strategy for conflict resolution, to avoid disagreements within the different activities or areas. Research work in this area was conducted by several authors including Tseng et al. [5]. In addition, it is important early in the innovation cycle to identify and predict user needs and requirements. An effective application of theory requires a methodological framework which guides the process of the intervention, i.e., HOW, WHO, WHEN and WHERE. Hence, the HCD method has been implemented in achieving clear definition and prediction of needs, improved design and more effective involvement of end-users, as detailed in this paper.

This paper aims to investigate collaborative product development activities and highlights the importance of human perspectives for developing a CPD system. The HCD method systematically addresses phases of system design and development and considers the needs between users, organisation, and technology. The infrastructure of the HCD method is introduced, and then three development phases are presented accordingly for the development of the CPD system. The HCD method helps the system developer to identify and predict users' needs and requirements in the early design life cycle and guide the intervention, i.e., HOW, WHO, WHEN, and WHERE.

2 Challenges of a CPD System Design

For collaborative systems to be useful, it is necessary to effect usable and useful interaction. When designing these systems, several concerns at the theoretical and methodological content, and organisational and technical levels should be taken into consideration. Current problems faced to designing a CPD system have been addressed as follows:

- Insufficient knowledge, skill, and experience;
- Most CPD systems are designed by a third party such as a software engineer. They lack of sufficient knowledge, skill, and experience about the specific functions of the CPD system, the process for designing a CPD system, or the criteria for good design.
- Insufficient human-centred design guidelines;
- Most of the directions available to the CPD system are focused on outside the domain of software design in fields long involved in CPD research including human factors [6], human-computer interaction [7], cognitive science [8], graphic arts [9], and technical communications [10]. However, the guidelines from these disciplines apply more to software environments than CPD environments, where the user task is fundamentally different. CPD system, on the other hand, often promotes the user's acquisition of new knowledge, skills and attitudes needed for performance or for understanding. Users enter these environments to build their expertise. Their interactions with the environment may not produce visible results. The outcome of a CPD experience is often not reflected in the interface environment, but in the CPD user's mind. Guidelines for the design of a CPD user interface clearly must be based on set of assumptions different from those based on software users and tasks.
- Graphically Embellished Design.
- Many CPD interfaces are also poor examples of graphic design featuring ornate background fills, multiple bevelled information zones, and distracting animations that ultimately direct the user's attention to the elements that surround the core CPD information, rather than to the core information itself.

Research is needed to study, analyse and reflect on the use of technology. Interdisciplinary research should:-

- understand the factors that make the technology useful. What are the characteristics of collaborative systems that can be linked to measurable improvements in the user's and team's performance?;
- understand the end-user of persistent collaborative systems in relation to existing information technology for product development. The core functions of the existing CPD systems may interact with the proposed system;
- implement the HCD method that conducts the process of development of CPD system in human perspectives;
- understand user's essential properties which affect his/her interaction with computers;
- understand users' tasks and requirements and analyse what people do with computer systems and their interfaces;
- specify how the interface should function, how it should respond to the user and its appearance;

- design interfaces so that users' needs are fulfilled and the system matches users' characteristics;
- evaluate the properties of the developed system and their effect on people to ensure good quality.

Therefore, the human-centred design (HCD) method had been implemented into the developing process of a CPD system. This paper has attempted to illustrate the impact that HCD method has had on the development and take-up of CPD systems for consumer goods production, and can have in other sector too. It has shown that each issue considered to be relevant to the success/failure of the CPD system in consumer goods production can be addressed by the appropriate inclusion of users in the design and development process. It has also provided evidence that the use of HCD method, however simple, is a common feature of successful examples of these systems. While this is not conclusive, it seems to be useful evidence to support the effectiveness of the HCD method in this sector.

3 Human-Centred Design Method

The HCD (human-centred design) method (**Fig. 1.**) is a cycle of three flexible implementation phases:-

- planning and suggestions;
- implementation and improvement;
- check and evaluation.



Fig. 1. The Human-Centred Design Method

HCD method specifies how the activities fit into the overall system development process. A proposed plan guides: (1) the design process activities described, (2) procedures for integrating these activities with other system development activities, (3) the individuals and the organisation(s) responsible for the design activities and the range of skills and viewpoints they provide and (4) effective procedures for establishing feedback and communication on design activities as they affect other design activities and methods for documenting these activities.

Organisations may enter and move through the phases at different speeds and give different phases different emphasis depending on their individual circumstances, the availability of resources and the level of maturity of their ICT policies, strategies and programmes for collaborative product development.

The HCD method for developing a CPD system is used in five stages of the system development life cycle, as shown in authors' another paper [11]:

- to establish a management system for developing the CPD system as guidance to deepen and broaden existing management practices;
- to integrate existing organisational systems for collaborative product development.

To ensure compatibility with existing practice, the HCD method is modelled on a systematic framework [11] incorporated in the process of the system development. Organisations can either improve their CPD system performance or develop a new CPD system by using the HCD method as guidance to:-

- plan the human-centred design process for guiding the organisation to develop a CPD system based on human requirements during collaborative product development;
- understand and specify the context of use and the user and organisational requirements;
- assess the organisational systems for collaborative product development based on usability evaluation;
- set the priority for improving CPD system functions and applications.

Fig. 1. and **Table 1.** cover the outline of the three key phases of the HCD method for developing a CPD system. Each phase is divided into sub-phases; for instance, the planning and suggestion (PS) phase is divided into sub-phases PS1 to PS3. All the phase and its sub-phases are described in detailed tables. The tables contain:-

- key questions to focus on;
- a cross-check of how intended activities link to the organisation's chosen principles;
- who needs to be involved;
- what the key activities are;
- when they need to be implemented;
- a list of helpful resources;
- expected outcomes and outputs;
- key implementation issues of which the organisation may need to be aware.

Organisations may choose to establish a dedicated team to implement the development of the CPD system. The tables refer to such a team as the system development team. Similarly, an organisation may appoint a key individual to support the implementation process; this is referred to as the project manager.

Table 1. The Three Key Phases of the HCD Method for Developing the Proposed System

Management Phase	Purpose
<p>Planning and Suggestion</p> <p><i>Plan and suggest what ICT strategies/applications for collaborative product development need to be in their core processes and decision-making</i></p>	<ul style="list-style-type: none"> • Ascertaining the organisation's and end-users' needs for a CPD system for collaborative product development • Identifying and prioritising the organisation's key ICT issues and needs for collaborative product development • Analysing and managing strategies and processes to ensure the proposed system is integrating into current performance • Developing strategic plans to deliver the proposed system
<p>Implementing and Improvement</p> <p><i>Decide what needs to be done to implement/improve ICT strategies/applications for collaborative product development</i></p>	<ul style="list-style-type: none"> • Implementing the developed plan to design the proposed system • Implementing approval approach/methodology/system • Reviewing and improving existing ICT performance for collaborative product development
<p>Check and Evaluation</p> <p><i>Check that the proposed system meets user requirements and analysis results</i></p>	<ul style="list-style-type: none"> • Identifying, evaluating, categorising and managing the actions, impacts and outcomes of executing the proposed system • Establishing or reinforcing mechanisms for handling and responding to end users' feedback on reports • Monitoring the process of executing the proposed system • Communicating with current users' findings and recommendations to evaluate whole product life cycle • Taking preventive, corrective and innovative actions as appropriate • Consulting with end users on performance and future challenges

The outcomes and outputs column lists the likely output and outcomes of the recommended activities. It is not necessary to produce all the documents listed in the tables. Some organisations will favour producing all or most of the written output, to aid monitoring and assessment; others will prefer a less formal approach, or will be able to modify existing documents rather than create new ones.

3.1 Planning and Suggestion Phase

Table 2. reveals the planning and suggestion phase of what ICT strategies/applications for collaborative product development are to be in their core processes and decision-making. Sub-phases are requirement list, analysis and management, and strategic planning.

Table 2. Planning and Suggestion Phase

Phase		Activity
PS1	Requirement list	<ul style="list-style-type: none"> Ascertaining the organisation's and end-users' needs for a CPD system for collaborative product development Identifying and prioritising the organisation's key ICT issues and needs for collaborative product development
PS2	Analysis and management	<ul style="list-style-type: none"> Analysing and managing strategies and processes to ensure the proposed system integrates into current performance
PS3	Strategic planning	<ul style="list-style-type: none"> Developing strategic plans to deliver the proposed system

3.2 Implementing and Improvement Phase

Table 3 reveals the implementing and improvement phase which decides what needs to be done to implement or improve ICT strategies and applications for collaborative product development. Sub-phases are implementing and managing programmes and improvement.

Table 3. Implementing and Improvement Phase

Phase		Activity
II1	Implementing and managing programmes	<ul style="list-style-type: none"> Implementing the developed plan to design the proposed system Implementing approval approach/methodology/system
II2	Improvement	<ul style="list-style-type: none"> Reviewing and improving the proposed system for collaborative product development

3.3 Check and Evaluation Phase

Table 4 reveals the check and evaluation phase to check that the proposed system meets user requirements and analysis results. Sub-phases are action, impacts and outcomes and monitoring, measurement, auditing and feedback.

Table 4. Check and Evaluation Phase

Phase		Activity
CE1	Action, impacts and outcomes	<ul style="list-style-type: none"> Identifying, evaluating, categorising and managing the actions, impacts and outcomes of executing the proposed system Establishing or reinforcing mechanisms for handling and responding to end users' feedback on reports
CE2	Monitoring, measurement, auditing and feedback	<ul style="list-style-type: none"> Monitoring the process of executing the proposed system Communicating with current users' findings and recommendations to evaluate whole product life cycle Taking preventive, corrective and innovative actions as appropriate Consulting with end users on performance and future challenges

4 Implementing the HCD Method for Developing a CPD System

Some organisations may have well-developed ICT approaches or applications for CPD, but may need to clarify or revise their ICT strategic vision. For instance, some organisations may have a good understanding of, and a willingness to develop CPD system, but they are facing barriers during the implementation of some of the technologies. For these organisations, the check and evaluation phase would be a good benchmark to measure what functions are needed for collaborative product development.

For other organisations without well-integrated ICT approaches or applications for CPD, the planning or suggestions may be to help those organisations in their core processes and decision-making. The planning and suggestion phases would be a good place to start in these circumstances.

Other organisations may have urgent needs to implement ICT approaches or applications for CPD. The implementing and improvement phases would be a good way to implement or improve ICT strategies or applications for collaborative product development in those organisations.

5 Conclusions

This paper detailed the HCD method for the development of the CPD system. In order to design a system for collaborative product development, the HCD method was introduced, and then the three design phases were presented accordingly. The HCD method, which is described in details in this paper, by modelling the HCD method for designing the CPD system. The main point, described in this paper, contained the following features:

- The HCD method systematically divides the system development life cycle into three phases that cover not only the development procedures but also balances the needs between users, organisation and technology;

- Fundamentally, the HCD method considered the three central requirements, which are functional requirement, design requirement and technical requirement;
- The human-centred design method is implemented into the developing process a CPD system and management programme is listed for guiding the system developer to design the CPD system.

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