

# Dynamics of Affordances and Implications for Design

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**Abstract.** Affordance is an important concept in HCI. There are various interpretations of affordances but it has been difficult to use this concept for design purposes. Often the treatment of affordances in the current HCI literature has been as a one-to-one relationship between a user and an artefact. According to our views, affordance is a dynamic, always emerging relationship between a human and his environment. We believe that the social and cultural contexts within which an artefact is situated affect the way in which the artefact is used. Using a Structuration Theory approach, we argue that affordances need also be treated at a much broader level, encompassing social and cultural aspects. We suggest that affordances should be seen at three levels: single user, organizational (or work group) and societal. Focusing on the organizational level affordances, we provide details of several important factors that affect the emergence of affordances.

## Categories and Subject Descriptors

H.5.3 [Information Interfaces and Presentations (HCI)]: Group and Organization Interfaces – *Collaborative computing, Computer-supported cooperative work, Organizational design, Theory and models.*

**Keywords:** Physicality Affordance, HCI, Artefact, Structuration Theory, Design, Meanings & Interpretations

## 1 Introduction

This paper explores a broader scope and treatment of affordances in order to develop better understanding of designed artefacts and technologies. In the field of HCI, Gibson's [12] notion of affordance has been used to understand usability problems, but engineering affordances has shown to be rather difficult. In several approaches to conceptualize affordance, its treatment has been merely as a one-to-one relationship between a user and an artefact or technology [22, 10]. However, when a technology is situated in a large organization, where it is used and is affected by more than one user, it becomes important that a broader view of affordance is considered that encompasses social and cultural aspects of work organizations.

Gibson's intention behind coining the notion of affordance was to refer to a phenomenon that indicates complementarity of animals and their environments. His original notion was very strictly tied within the ecological psychology, limiting it to the offerings or action possibilities in the environment in relation to the action capabilities of an actor. When the term was introduced to the HCI community by Norman [22] and subsequently by Gaver [10] and others, its intended use was to support usability and ease-of-use in digital and physical artefacts. These cognitivist accounts conceptualized affordance as perceived properties of the environment dependant on the experience, knowledge, or culture of the actors. Recently, the dimension of activity and practice was also introduced to the notion of affordance, utilizing activity theory [2] and phenomenological [31] perspectives. However, the current literature on affordance does not take into account the 'group dynamics' and its effects on the technology use. In this paper, we attempt to broaden the treatment of affordances by considering the one-to-many relationship focusing on the social and contextual aspects.

We introduce three levels to facilitate the treatment of affordances: single user, organizational (or work groups) and societal levels. The user level affordance is concerned with the one-to-one relationship between a user and an artefact. It focuses on how a user in a given situation uses and adapts to the technology and continuously form and re-form certain affordances. The organizational and societal affordances are concerned with the one-to-many relationship between an artefact or technology and users in a working organization and in the overall society, respectively. By understanding contextual issues in technology use, we focus on the organizational affordances and describe the factors that need to be considered for developing better understanding of organizational affordances. These factors go beyond the basic functionality, dialogue and representations of a technology and encompass organization culture, changes in organizations, users' identity and power differences and their emotional, symbolic and functional values related to the technology.

The term 'affordance' has been stretched in the HCI literature way beyond the very tight meaning introduced by Gibson. This paper continues this stretching of meaning and arguably does so far beyond its original meaning. However, the meanings we attach to the term are continuous with other recent work and without an alternative more generic term it seems the most appropriate word to use. In this paper we mean affordance as things that 'enable' and 'facilitate' certain possibilities in certain cultural and social contexts. In addition, at each level, like Gibson's original affordances; we are concerned with the ecological fit between a technology and an individual or group; how the relationship allows/affords some particular set of actions or activities.

Why stretch affordances? Technology is becoming more complex and at the same time becoming more equivocal and therefore allowing a space for multiple user-interpretations and multiple plausible actions. This is especially the case in groupware technologies and systems that allow multi-party interaction. From a designer's point of view it becomes really difficult to understand how users in large organizations adapt and appropriate these technologies as they offer unbounded (but not infinite) possibilities. We believe that adding the notion of group dynamics to affordance could facilitate designers to see a holistic picture of the technology use and

hence the improvements in technology design. There is obviously a huge amount of literature on ethnography and other research focusing on social and contextual issues [1, 4, 17, 19], but affordances have not been treated in this way before.

In the rest of the paper, we will first provide a brief background research and related work on understanding affordances, in section 2. In section 3, we will attempt to understand the dynamic relationship supported by affordances using Giddens' Structuration Theory approach. In section 4, we will introduce three rough levels of understanding affordances, namely, user level, organizational level and societal level. In section 5, focusing on the organizational level affordance we will provide details of four factors (or conditions) that play an important role in forming affordances as an emergent phenomenon. We also provide details of 2 case studies where our notion of organizational affordances is used to understand the technology situated in large organizations. In section 6, we provide details of several design considerations that we learnt from the two case studies. Finally, we discuss our approach and conclude that affordances are not just the 'mediator' or human action but also the 'product' of human actions.

## 2 A Short Background On affordances

We will briefly review some literature on affordance, including Gibson's original notion, and move onto the latest developments on conceptualizing affordances in a much broader sense.

Gibson defined affordance as, "the affordances of the environment are what it offers the animal, what it provides and furnishes, either for good or for ill" [12, p.127]. Having its origin in perceptual psychology, affordances were described as a shared relationship between humans and the world – "something that refers both to the environment and the animal in a way that no existing term does." According to Gibson, an important fact about affordances is that while they are in a sense objective, real and physical, unlike values and meanings, they are neither an objective property nor a subjective property. They are both a fact of the environment and a fact of embodied behavior that exists *only* in the relation between them. "An affordance is for a species of animal, a layout *relative* to the animal and commensurate with its body . . . What animals need to perceive is not layout as such but the affordances of the layout" (p.157). Gibson's intention behind affordance was to refer to the action possibilities offered by the environment to an individual, regardless of the individual's ability to perceive and realize this possibility.

Norman [22] introduced the concept of affordance to the HCI community as a design aspect that informs users how an object should be used. According to his definition, "the term *affordance* refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used. A chair affords ('is for') support and, therefore, affords sitting. A chair can also be carried". [p.9] This way Norman's conceptualization of affordance fundamentally differed from Gibson's definition reflecting on the fact that affordances depend on the way they are perceived by the users, tightly attaching affordances with users' knowledge, skills, experience and culture. To Norman,

affordances provide cues to utilize properties of objects. Norman [23] later distinguished between perceived and real affordances and suggested that it was the perceived affordances that determine the usability of an object. Note also the words 'is for' – in Norman's use of the term affordances can be designed into an artefact, an issue we return to in section 4.

Several attempts have also been made to further enhance and clarify the notion of affordance, most notably by Gaver [10], McGrenere & Ho [21] and Hartson [14]. Gaver followed the cognitivist view as initiated by Norman. His aim was to use the notion of affordances to understand the strength and weakness of technologies with respect to the possibilities these offer. By introducing perceptible, hidden and false affordance, Gaver [10] differentiated between affordances and information that suggests certain affordances. Gaver believed that to be able to understand the ease-of-use of a technology, affordances should be differentiated from the perceptual information about them. He introduced the concept of sequential affordances. Sequential affordances refer to 'exploration', meaning how certain affordances may reveal over time. To be specific, Gaver's sequential affordances refer to the situations where a user's action on affordances leads to certain new affordances.

In addition to their critical reviews on other seminal literatures on affordance, McGrenere & Ho [21] further explored the hierarchical nature of affordances. They state, "it is important to note that affordances exist (or are nested) in a hierarchy and that the levels of the hierarchy may or may not map to system functions" (p.185). They suggest that affordances are not binary; these should be seen in a two-dimensional space: the ease with which an affordance can be undertaken and the clarity of the information that describes the existing affordance.

By taking a closer view, Hartson [14] categorizes affordances into four complementary types: Cognitive, Physical, Sensory and Functional. Cognitive affordances correlate to Norman's perceived affordances and physical affordances relates to his real affordances. In addition, Hartson also addresses properties of stimuli that a user senses (i.e. sounds, texts, lights) by introducing sensory affordances as a design feature. Functional affordances are defined as, "a design feature that helps a user accomplishes work, i.e., the usefulness of a system function" (p.323).

Recently, several attempts have been made to re-clarify and expand Gibson's original notion of affordance, most notably the philosophical view initiated by Turner [31] and the Activity Theory approach to affordances by Bærentsen & Trettvik [2]. Taking a phenomenological account, Turner suggests that in addition to the 'simple' affordances (as Gibson's original version of affordance), designers should also take into account the 'complex' affordances that include issues such as history and practice. Bærentsen and Trettvik argue that the phenomenon of affordance only exists when a user is actively involved in interaction with a system. To them, user's active participation with the system is an important determinant of its affordances. Hence, affordance is an emergent property of the material world.

The approach of Turner and Bærentsen & Trettvik can be labelled: interaction-centered, as they emphasize the fact that affordances of a system emerge during users' actual interaction with it. Unlike the cognitivist views [22, 10], from the interaction-centered view affordances of an artefact are the possibilities for, both, thinking and doing, which are signified by its users during their actual interaction with the artefact. Users actively participate in the interaction with the artefact, continuously interpret

the situation, and construct or re-build meanings about the artefact. From the interaction-centered view, affordances are not the pre-determined properties of a technology but a relationship that is socially and culturally constructed between the users and the artefact in the lived world. This view also suggests that affordance is an interpretive (in addition to the behavioral) relationship between users and the technology that emerges during users' interaction with the technology in the lived environment.

### **3 Afford-dance: a dynamic relationship**

One of the major shortcomings in the current literature on affordance is that none of these has taken into account the group dynamics and its effect on affordances. As we mentioned in the beginning of the paper, the current literature on affordance is limited to the one-to-one relationship between a system (technology or artefact) and a human. When a system is situated in a larger organizational and cultural context and is being used by more than one users establishing one-to-many (one technology, many users) relationship, requires more complex understanding of what the system in the given environment offers to its users.

#### **3.1 A Structuration Theory Approach to Affordance**

If we interpret Gibson's original view with respect to technology design, the ways of using a complex technology, for example, is directly perceivable from the technology itself. His original notion of affordance was criticized for supporting only the artefact level considerations (e.g. representations, dialogue, functionality, etc.), leaving aside the actual use of the technology. Additionally, there was a minimal relevance to users' social contexts. In order to understand technology use and to improve design practices, we believe that a holistic view of affordance is required.

Take the Fax machines for example. When the first Fax machine was invented, its main functionality was to allow its users to send and receive Faxes. Overtime, however, users' understandings of the Fax machine evolved as they learnt to use it for photocopying. Photocopying can be considered as a side effect, rather than a major functionality but through users' involvement and long-term acquaintance, the Fax machine '*afforded*' photocopying. Of course, humans adapt their environments for themselves and for others; in particular often using these appropriated affordances as design inspiration. As a result we now see a machine comprising of fax, photocopying and scanning facilities.

During technology use, users adapt and re-structure their (shared) working practices, hence users' understandings of what the technology does and symbolizes, may also emerge over time. We believe that affordances should not be seen as static entities of a technology. In this section we will discuss the practice level affordances that focus on the emergent nature of affordances. We will especially focus on the technologies that are used in big organizations, where more than one actor affects the use of the technology and vice versa. We will draw on Giddens' [13] Structuration Theory to develop our understanding of affordances.

Structuration Theory focuses on human-human interactions and shows that through communications, using power and giving sanctions, we apply social structures in practice. It is one of the most employed frameworks for investigating the use of technology by groups or organizations. There are two views in which Structuration Theory can be applied to understand the use of technology in practice: ‘appropriation’ and ‘enactment’.

The *appropriation*<sup>1</sup> view is used by approaches that focus on structural properties of a technology (e.g. [6]). They observe how users, during their interaction with the technology, adapt their social structures to the technology. Orlikowski [24] proposes the *enactment* view and states that social structures are instantiated only through actions and practice. And they cannot be seen embedded into the technology. So, properties of a technology may not be useful to determine social structures, as they are external to the human actions. Orlikowski suggests that users do not just use the technology as it is given. Users may ignore certain properties of the technology [25] while they interact with it, or invent new properties beyond designers’ expectations (e.g. the Fax machine example). Users may modify the way a technology should be used after it is designed. The repeated and on-going interaction of users with a technology determines the production of structures of technology use, the so-called *technology-in-practice*.

From the enactment view of the Structuration Theory, we can say that a specific format of technology use (technology-in-practice) determines what the technology affords. Affordances of a technology emerge through this continuous process of technology affecting human actions and actions affecting the technology use. In this way affordances refer to the *behavioral* and *interpretive* forms of people’s situated use of the technology. This means that affordances do not just have behavioral forms, e.g. "how to physically grab something" but also interpretive forms as to "what that thing means."

### **3.2 Need for a Broader View**

Our motivations to further stretch the notion of affordances to include the social aspects is merely focused on establishing better understanding of designed artefacts and reflect on design practices. We believe that a broader notion that includes group dynamics could benefit the HCI design processes in two ways: to overcome the historical limitations and to establish the socio-cultural support.

#### **3.2.1 Overcoming Historical Limitations**

Historically, in HCI, systems are built to convey designers’ meanings and interpretations to the users [28]. The designers determine what possibilities or opportunities should be offered to the users. From a design perspective, this suggests that designers can premeditatedly decide what affordances (possibilities for different activities) of a system should be offered to users [22, 10]. During the technology use, however, users do not just passively receive information. They actively participate in the interaction and also add to this interaction, sometimes beyond what is offered by the designers. There has been some work looking to create less fixed interfaces, for example de Souza’s [29] treatment of interaction as an unfolding, but designed,

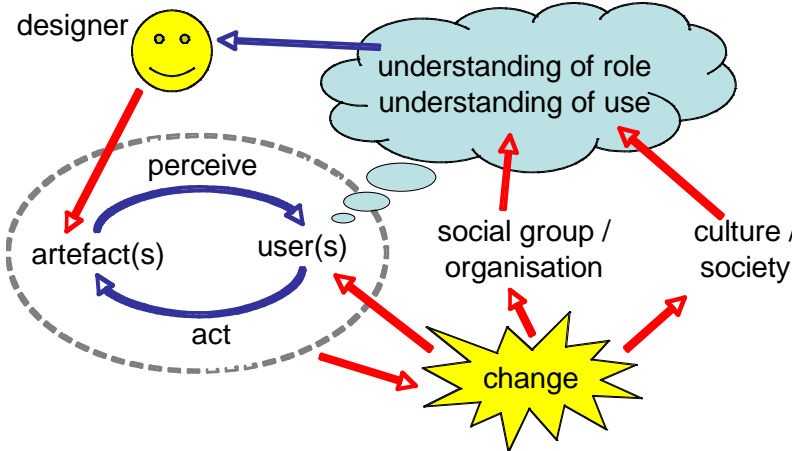
semiotic engagement between user and designer's surrogate or Dourish's [8] proposal for embodied interaction that is designed to be more open to interpretation and (in the HCI sense) appropriation. In addition Participatory Design practices do offer an opportunity for users to have their say in the design process. Nevertheless, seeing affordances as a dynamic relationship between users and artefacts would allow designers to overcome the above mentioned historical limitation.

**3.2.2 Establishing Socio-Cultural Support**

From a socio-cultural point of view a broader view of affordance is necessary too, especially in big organizations where more than one actor plays a collective role to define meanings of a technology. Additionally, technologies are becoming more complex in terms of functionality and interaction; hence ways to use these are also changing. It is important for the designers to know what impact their technology has on users and vice versa. As we saw in the previous section, the current notions on affordances do not adequately reason about the emergent nature of affordances.

**4 Levels of Affordances**

As discussed in the previous section, once we move from a very bare view of the physical affordances of natural objects, we inevitably have to take into account a network of social and ecological effects including many that change the nature of the available artefacts and affordances of them.



**Figure 1.** The afford-dance – dynamics and evolution of affordance

Figure 1 captures some of these interactions. The cycle (1) shows the simple pattern of artefacts having affordances perceived by a user (or in collaborative situations group of users) who then act on them. However, performing an action changes the situation (2), both physically, but also cognitively and culturally: for example a user

may become aware of more possibilities (existing affordances) as a result of using an artefact.

In particular, the perception and acting out of affordances may lead to reflection (3) on the artefacts, their uses (potential actions) and people's roles (constraints upon actions). Once users are aware of this their perceived affordances change also.

Furthermore, knowledge of the potentialities of artefacts and materials may lead (4) to modifications of artefacts, design of new artefacts (e.g. tools), which then change the environment both by their own existence and because of the changed affordance of pre-existing objects (e.g. a round stone affords building once you have tools to dress it). This cycle of change leading to modifications of artefacts is central to some of the notions of Ilyenkov [18] as applied to affordance in by Turner [31]. In particular Ilyenkov sees the creation of physical artefacts and tools as embodying practices of a community, claiming that the artefacts that we have and their affordances embody cultural norms and values. (E.g. George Orwell's novel 1984 describes a fictional language called Newspeak, which constrains the English language to only the acceptable topics – thus representing the social culture of the totalitarian regimes.)

From this discussion, and explicit in Figure 1 are the three rough levels of affordance we have mentioned earlier:

- (i) single user,
- (ii) organization (work-group or community of practice) and
- (iii) culture / society.

We say that this is a rough categorization as once we get beyond a single user in isolation (which never happens), there is a continuum of effects. Given this caveat, at each of these levels we can see effects of learning and change. At level 1, users build their knowledge of what is possible through action and reflection, but in addition may become more skilled and thus increase the theoretical (Gibsonian) affordance: for example, a unicycle does not afford movement (except downwards) unless you have sufficient skill. At level 2, ethnographies have repeatedly shown us the importance of overhearing or overseeing other people's activities [15] and the way we shape our actions for other people's overseeing. So as we act we influence others, and they learn about possibilities for action. In addition we may explicitly talk about action possibilities and train others in skills. Finally at level 3 cultural understandings (e.g. the light switch) influence perceived affordances and norms and roles may alter what people feel is possible or alternatively engender rebellion.

Furthermore, as noted, the actions or activities afforded by an object (or objects) may be about what actions can be performed in concert with others and this may vary from ad hoc collaboration (a stretcher affords carrying by two people) that is closest to level 1, to higher level effects. At level 2 we might say that a mobile phone affords communication, but only if a group of people all possess one, or at level 3 that stones afford building into pyramids, but only by a society of a particular level of sophistication and political type.

The principle difference between levels 2 and 3 is in extent: level 3 effects are long term and typically cover all one's interactions and experience, whereas at level 2 interactions may change more rapidly. Normally, level 2 has a tangible 'boundary', e.g. an organization, office-group. Even when new members come in or old members

leave and working practices change, the affordances remain specific to that organization or working group. On the other hand, at level 3, knowledge about artefacts is gathered from birth or learnt over time. However, as we have said the true picture is more complex, for example, a mediaeval guild had long term effect on the development of various crafts and their toolsets.

## 5 Organizational Affordances

Organization cultures and sub-cultures play an important part in forming and re-forming affordances. We use the term Organizational Affordances to refer to the affordance of a technology used in a large organization by more than one user.

### 5.1 Factors Affecting Organizational Affordances

Using a Structuration Theory approach, we have explored the use of technologies in two different settings: 1) in a large governmental organization (a system that supports budgetary processes); and 2) in an international bank (bank's Intranet system). In this paper, we propose four conditions as the main factors that may affect the emergence of affordances of a technology: technological, cultural, power and interpretive conditions.

- *Technological conditions:* These refer to the functionality, design features and infrastructure of a technology. In a dynamic technology (such as an Intranet) the technological conditions may also include changes in the technology and the frequency of those changes. Technological conditions influence the emergence of affordances, by providing the technical facilities of work and social interaction.
- *Cultural conditions:* These refer to beliefs and values held by a group of people concerned with a technology. In a big organization different subcultures may appear (e.g. team/departmental/professional) [30]. Depending on the values and beliefs of people, technology may be perceived affording different possibilities.
- *Power conditions:* Usually the concept of power is used to refer to formal power – the relation of dominance among different classes of actors based on their hierarchical positions. It is important to note here that power does not have to be just top-down. We consider that power can also be constructed in a bottom-up way [9]. This means that even a group with no formal power can exercise power by bringing changes in the organizations. With regards to the use of technology, power can exercise different social influences on the emergence of affordances like: changing access to applications of technology as regulated by laws; changing the way technology has to be used; changing the way technology use is controlled; etc.
- *Interpretive conditions:* The interpretive conditions refer to members' knowledge of, and attitude towards, the technology.

In fact, these conditions represent the ‘context’ in which a technology is used. The conditions are reinforced or sometimes changed (even the technological ones) by the very use of technology in a particular way. Due to the fact that these conditions influence the emergence of ways in which technology is used in a particular setting, they can also be interpreted as factors that influence the emergence of affordances of a certain technology.

It is important to understand that all the conditions mentioned above have a combined influence on the emergence of affordances. There is no situation in which one condition influences the emergence of affordances in an independent way. These conditions constitute the context; and the emergence of a certain affordance can reinforce the conditions or, in some cases, change them. The two cases, described below, will provide a deeper understanding and refinement of these conditions.

### **Case 1: The Budgetary System**

We have investigated the use of a technology that supports budgetary processes within a large governmental organization [5]. The budgetary system of in a public sector represents a static technology as it doesn’t change much over time, i.e. both the functionality and design aspects are relatively stable. The process of budgeting is of great importance for a government of a country and several aspects of this process are subject of discussion in the Parliament when laws are voted upon. The whole process is supported by a certain system used by people who are proposing a certain budget (the “controlled group”) and people who are controlling this budget to make sure that the numbers and policies behind the budget are correct (the “controllers group”). Both groups input data into the system. The data is used by the controllers to make reports about the status of the budgeting processes. Based on the data, negotiations about the budget take place, decisions are made and changes in the budget are approved or not.

The culture of the organization can be described as an elite culture (pride, status, power, ‘no-mistakes’, etc.). Within the organization there are people who work with the system as part of their daily activities, which are evaluated by their managers. In this situation, it is shown how the convergence of cultural, power and technological conditions can lead to the emergence of an unwanted affordance. A certain design characteristic (the system is designed in such a way that any mistake in the budget cannot be undone unless an equivalent amount is detracted from the whole; in this way any mistake is documented and can be controlled – technological condition) combined with an elite culture where there is no room for mistakes (culture condition) and with a situation in which managers are interested in controlling all mistakes made with the system (power conditions) leads to the emergence of an interpretation of the system by the people working with it as a “history pool for employees’ mistakes”. From that moment on, this interpretation is also part of the interpretive conditions of the people working with the system. The perception of people working with the system is that the system becomes a transparent window affording exposure of their vulnerability in front of power structures (the managers). This in turn leads to feeling of stress when using the system [32] and a tendency of avoiding working with it.

### **Case 2: The Bank Intranet**

The second case comes from an international bank study [5], in which the use of Intranet within different branches of an international bank is observed. This case represents the use of a dynamic technology from the private sector. The focus was one a specific division that was concerned with private and commercial customers, with the goal of selling financial products and services to the customers. The division used advice offices, bank shops, ATM's, call centers and the Internet to offer products and services related to the assortment of banking, stock investment and insurance. The goal here was to understand the use of a dynamic technology.

At the time of the study there was a transition from a DOS-based system (the "old system") to a Windows based system (the "new system"). This transition required a process in which applications were gradually transferred from one platform to another. As the rules and procedures of the bank changed, new applications were developed (and implemented only on the new Windows-based medium) and the old applications that did not correspond anymore with the new regulations were no longer allowed to be used. Over time, these applications were iteratively blocked in the old system. However, at a certain time certain applications were still available in the old system. The managers of the bank branches had a mediating role to decide whether to allow (or not) the old applications to run on the system. However, some of the employees used them anyway. For example, one subculture found within bank branches was "service oriented" (cultural condition) with a strong belief that clients should be served in the best possible way, opposed to the new management philosophy that required to sell as much as possible to clients. In certain technological conditions (some applications are still available in the old system), power conditions (managers allowing the old application to be kept into the system) and interpretive conditions (employees had the knowledge and skills to operate the older applications), employees used the technology to provide services that were no longer allowed by the management. For the service oriented subculture the old system afforded the possibility of fulfilling their values, even if these contradicted management regulations. In this particular case, the kind of historical analysis that is supported by the four factors helped us develop better understandings of the technology use.

## **6 Design Considerations**

### **6.1 Establishing Reflexivity through Design**

Design introduces a level of reflexivity through physical and digital artefacts and not just what is said about them.

In pre-industrial society it was common to make your own tools (although even in Neolithic society there was mass production of flint articles, and later pottery and others). In traditional carpentry this was one of the jobs during an apprenticeship and the tools were made almost entirely of wood with only the cutting surfaces, or essential parts, like ferules to stop splitting, were made in metal. Well into the early years of the 20th century, bodgers (itinerant wood turners who made chair legs)

would make their own lathes in a clearing in the forest where they cut the wood for their craft. Design thus evolved through use (technology in practice) and through a shared learning. In merchant society specialised artisan guilds developed, formalising tools and roles, sometimes through secret knowledge, sometimes through charters and legal restrictions. Tools are still often made by individuals, or inherited, but made to more standard forms. Even far from the organized guilds in towns and cities, country blacksmiths and carpenters use fairly standard sets of tools, through shared cultures in very dispersed communities of practice. In industrial society tool making becomes a separate activity, tools are mass-produced, often alienating tool users and tools. Interestingly even in the industrial world the use of particular tools is a mark of being 'in the club'. Often engineers, carpenters, brick layers, would have their own tools rather than use those supplied by an employer – in some ways offering autonomy, but also creating barriers to entry through long apprenticeships.

What we mean here is that artefacts speak about the culture within which they are designed and used. And the design of these artefacts evolves as the users, working-groups and culture evolve, over time. The three levels of affordances (user, organizational and societal) could be helpful to establish better reflexivity over the designed artefacts. Designers can modify certain aspects of their artefacts or design new artefacts to make it suitable for the users, the organization and the overall culture. In some cases, the existence and prolonged use of certain artefacts could change users' behavior, the organization or the culture itself. The use of Apple's iPod is a prime example of an artefact affecting the culture and the society.

## **6.2 Control and Revolution – making things to influence people**

Technology, tools, artefacts embody and enforce particular (not necessarily dominant) social, cultural and work-practice norms. These may be:

- explicit – the designer deliberately understands the social or work practice implications and builds the artefact in that knowledge
- implicit – there is no explicit knowledge, the designer just works within unspoken assumptions

In the case of explicit design, the designer may create an artefact that deliberately reinforces the norms, complies with the norms, or rejects/rebels against those norms (undermining them, perhaps explicitly or implicitly suggesting alternatives). The reasons for any of these may lie with the designer, in which case the values embedded are quite likely to reflect those of the designer or because she/he has been told/paid to do it in which case they may not be the designer's personal values. In some recent research in HCI one may see some examples of explicit design utilizing exaggeration [7], ambiguity [11], and defamiliarization [3] as strategies for designing artefacts.

In the case of implicit design the embodied norm are almost certainly those of the designer, although the designer's own norms will be influenced by surrounding culture. Alternatively the artefact may simply poorly embody culture. Where the design occurs through adaptation by end users, it is most likely to be implicit. However, such designs react to emergent work practices and are thus likely to reflect the end-users' values and aspirations.

User of an artefact can choose to comply with these embodied norms, adapt them to their own purpose, or reject them (and possibly the artefact) entirely. Just like with the designer who embodies these social and cultural assumptions, the users' acceptance or rejection can be explicit or implicit. The enactment whether adaptive or revolutionary, of course itself becomes part of the reflexive design process and may become embodied in later designs – interestingly participatory design (ostensibly) seeks to effectively do some of this 'up front' during a single cycle of design and use rather over evolutionary design timescales.

Note in the Bank Intranet case (section 5.1.2), the design of the Windows based system was not only about adapting new technology, but also to impose a more sales-oriented culture on the employees. However, we saw how some employees subverted this by using the old DOS-based system.

### **6.3 Role of Artefacts in Multi-Party Interaction**

What an artefact affords can be seen and interpreted differently in different situations. Virtually all the ethnographic studies (e.g. [15, 16]) have reported the value of physical and digital artefacts as a major contributor for supporting mediation. Two thorough studies focusing on the role of artefacts in coordinated work [26, 27] have reported that because of its physical and material properties (content, appearance and disposition) an artefact can serve as a carrier of knowledge and information for coordinative work practices. Both the cases reported in section 5.1 showed that artefacts (digital technology) carry certain functional as well as symbolic meanings. The issue of symbolic meaning is of a great importance here. In both the cases, the system represented the power differences within the organizations. In the first case (Budgetary System), the power difference that was mediated through the system created stressful situation amongst a sub-culture of employees. However, in the second case (Bank Intranet), the system did not symbolize for a large power difference as both the new and old application were made available in the same system. We observed in both the cases that artefacts allowed users to skillfully utilize their affordances to articulate cooperative efforts. In the first case, it made (or even forced) the employees to be more careful and cautious when they work with the system. In the second case, it provided a sort of flexibility to allow employees to 'get around' the hurdle of having to use the new application by allowing them to use the older application that they were used to.

It is outside the scope of this paper to provide a detailed analysis of the role these artefacts played in both the work environments. Nevertheless, we support the notion of understanding the artefacts as designed, as well as understanding the use of those artefacts in the real-world scenario, as coined in [26].

### **6.4 Supporting Experience & Value**

McCarthy and Wright [20] describe user-experience as the outcome of users' interaction with-or-through the artefacts. Normally, affordance is seen as an 'enabler' or 'mediator' of certain human actions. The kind of notion of affordance that is

presented here describes affordance also as a ‘product’ or ‘result’ of human actions. This fact refers to the dynamic and evolving nature of affordances. It allows designers to understand not only what is given to the users but also the experience and values that are supported by their designed artefacts. As it was apparent from both the cases, the use of artefacts in different organizations (public vs. private, national vs. international), afforded different experience and values amongst the users. We noted in the Budgetary System case (section 5.1.1) that when the system was perceived as a “history pool of employee mistakes” within a sub-culture that was *elite*, it invoked certain emotional issues amongst the employees. From the organization’s point of view this was nothing but a mechanism to prevent fraud, however, it compromised social worth of employees. This resulted in stress and fear and employees started working in a more cautious way. As we described in our case-studies, by understanding the four conditions (technological, cultural, power and interpretive) that contribute towards the emergence of affordances of artefacts used within an organization, designers can get a thorough understanding of the use of these artefacts within a large organization.

## **6.5 Design Implications for Affordance**

Affordance can be described as a constantly changing and moving set of relationships around the artefacts. Additionally, the ‘dynamic’ or the ‘emergent’ nature of affordance can be seen at all the 3 levels (user level, organizational level and societal level) of affordances, as described in section 4. During their interaction with artefacts users learn and adapt through the use of the artefact and/or through colleagues, other people and from the working situation itself.

In addition to understanding the relationship between the 3 levels of affordances, it is also important to see how these 3 levels of affordances could affect the design aspects. Let’s take the classic example of door handles. At the user level affordances: designers may think about the size, grips and other ergonomically related aspects of the door handle. They may also consider some look-and-feel aspects for designing. At the organizational level (also the societal level): if the door is in an office situation, the designer may consider putting a sign about the presence or absence of the person inside. And in a public toilet, the door would show whether the toilet is vacant or occupied. Hence, at this level it’s not just about grabbing the door handle but also considering the contextual settings. Clearly, one cannot think of a situation that is outside the social or societal level. So, in the real world applications all 3 levels of affordances need to be taken into account.

## **7 Discussion**

### **7.1 Affordance as a Mediator and a Product of Human Actions**

Our notion of affordance, influenced by the Structuration Theory, suggests that affordances are the *mediator* as well as the *product* of human actions. Affordance is a

mediator in the sense that it offers, and at the same time constrains, action possibilities and opportunities to use the properties of a technology that are inscribed by designers. On the other hand, it is a social product of human actions, as through practices users develop new understanding of what the technology is and how to use it. The four conditions (technological, cultural, power, and interpretive), in combination, affect the emergence of affordances. We suggest HCI practitioners to take into account these conditions while designing systems for large organizations.

### **7.2 Affordance as Enabler or Encourager of Social Activity**

In some cases the technology does not always just allow or make things possible, but also encourages certain activities. For example, early work in media spaces focused on the way the systems enabled social awareness and social contact across space. These and indeed simple video conferencing, Voice over IP and instant messaging can be seen as at a person-to-person level affording remote contact, but at an organizational level affording distributed working. At a wider level again, this means that an organization (considered as an entity) may be able to take part on global markets and so perform corporate actions that would be impossible without the technology.

A recent example, the Panorama system [33] designed for staff members in an academic work environment allows the members to share non-work related but highly sentimental news (e.g. announcing the birth of a new born child), personal achievements (e.g. best paper award), personal interests (e.g. favorite books, favorite conferences) to support social awareness. Panorama offers several mechanisms by which staff members can express their creativity and playfulness to the other members in the department. Here Panorama affords social awareness by encouraging the members to contribute.

From a Gibsonian perspective (however stretched) it is unclear whether social awareness itself is an action or activity, or is more a matter of perception. So one could debate whether at the person-to-person level the social awareness can be afforded by anything (if so then all a TV 'affords' is switching on an indolence). However, undoubtedly at an organizational level the social awareness encourages senses of community and hence eases, and so affords, other social activities

### **7.3 Affordance of Organizational Structure**

Pushing definitions even further technologies do not just enable or encourage particular social actions, but also make possible, facilitate or promote social and organizational structures.

For example, early experience of email use in hierarchical organizations often caused problems because it allowed invisible communications both across the structure (someone in marketing emails someone in finance) and skipping levels (subordinate emails the CEO!). Middle management was often disempowered and resistant. Over time electronic communication has acted as an enabler of flatter organization structures.

In contrast, in the Budgetary System case study, we saw the opposite. The system clearly afforded an organizational activity of auditing, but also the effect of reinforcing a strong power structure. Similarly in the Bank Intranet the Windows system afforded an organizational activity (sales of financial products), but also was clearly intended to encourage a sales culture.

Note that like affordances of artifacts there is no technological determinism here, it would be possible for an organization to prescribe emails except within a department, or for the internal culture to be so strong this does not happen. That is like physical affordances: certain things are in principle possible but the affordance may not be perceived, recognized or acted upon. The one important difference is that whereas at level 1 actions and effects of afforded actions are usually assumed to be intentional (although secondary effects may not be), in contrast at levels 2 and 3 (organizational and societal) the effects are often emergent based on lower level decisions. We saw that in both case studies where in the Budgetary System employees avoided using the system (presumably using paper for intermediate results until sure) whereas in the Bank Intranet the aim to encourage a sales culture was subverted by an alternative local sub-culture.

#### **7.4 Critique**

Have we taken the notion of affordance too far? If so then clearly some other term is required that encompasses both the level 1 affordances common in the literature and also broader level 2 and 3 effects. Whatever we call it, there is a continuity of phenomena where there is an ecological fit between (i) natural objects and artefacts of all kinds from engineered tools, to software and even conceptual works, (ii) humans as individuals, small groups, organizations or whole societies, that potentially enables (iii) action, activity, maybe perception or even internal change (after all what is action but intentional change).

Taking this broader view entails a cross-disciplinary approach as is evident from the evolution of the term affordance from essentially perceptual foundations, though more cognitive psychology and more recently including roots such as late-Soviet philosophy. To this we have in addition brought a more organizational and human-interactional perspective, in particular the Structuration Theory and also used case studies, although they can only illustrate a part of the bigger picture. The danger of this cross-disciplinarily is that it may be more confusing than enlightening and we hope we have avoided that in our treatment.

Certainly we are aware that it feels rather like a patchwork, where pieces from one field seem to parallel or recapitulate those from another. This is certainly problematic in trying to draw a narrative thread in a paper, but also emphasizes the continuity and interconnectedness of the multiple perspectives. This certainly reinforces our belief that there is a single broad phenomenon worthy of study.

## 8 Conclusion

In this paper we showed that the notion of affordance needs to be treated considering the group dynamics, in addition to the one-to-one level considering only the single user. When it comes to design, the user level affordances of a technology refer to the functionality, dialogue and representation of the technology. This requires understanding of the one-to-one relationship between a user and a system. However, dealing with the organizational and societal level affordances requires going beyond this one-to-one relationship and understanding the cultural and social effects on the human-technology interaction.

The two cases suggest that even when a system is technologically functional, usable and efficient, there are contextual aspects that may affect the use of the system. Our notion of affordances allows designers to consider the broader impact their designed products could have in a socio-cultural context. This supports the HCI design processes in two ways: 1) it views users as active creators, and 2) it allows designers to focus beyond the one-to-one relationship between users and artefacts or technologies.

Whether we use the term ‘affordance’ or something else, the growing body of work in this broader perspective, including our own, makes it clear that there are benefits in seeing the parallels between the different levels and kinds of ‘affordance’ and suggests that this is a valuable perspective for design.

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**Notes:**

1. The use of the word 'appropriation' in the Structuration Theory is not the same as more often used in HCI and HCI ethnographies to mean where users take technology and use it in their own way. In fact the HCI use of 'appropriation' is closer to Orlikowski's 'enactment'.