Towards a unified view of intuitive interaction: definitions, models and tools across the world

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Abstract

Two previously independent approaches to investigating intuitive interaction in Australia and Germany are described and compared. Both definitions are based on the literature and so agree very closely, grounded in the non-conscious use of prior knowledge for intuitive interaction. Models have been devised by both groups: a continuum of intuitive interaction and a continuum of prior knowledge. Although there are points of difference in the models it is found that these are minimal and that the models are complementary. Tools like design methodologies, design principles, questionnaires, and an online database have been devised by the two groups that can contribute to helping designers in making user interfaces more intuitive to use.

1. Introduction: two strands of research on intuitive use

"Intuitive use" has become a buzzword when talking about interactive technology and is used by producers and consumers alike. But until quite recently there has not been an agreed consensus of what the term really means and how we can design products and interfaces that are intuitive to use. This paper reviews two strands of so far independent research undertaken in Australia and Germany. It will be shown that although the methodological approaches are different, the results obtained are complementary. This common basis offers a bright outlook for future research in the field. The following sections will cover the definitions of intuitive use, models, tools and methodologies, followed by a comparison of the two approaches.

2. The Australian Approach: Alethea Blackler and colleagues

With a background in industrial design research, Alethea Blackler was keen to pin down the complex and confusing term "intuitive use" and find answers about how it could be applied to new interfaces. She began working on the topic in 2000, along with Vesna Popovic (a professor of industrial design with expertise in HCI and human centred design) and Doug Mahar (a cognitive psychologist). The team continues to work on this topic. A summary of their empirical work can be found in this issue (Blackler, Popovic, and Mahar, 2007).

2.1 Definition of intuitive use

This definition was reached through literature review into intuition and various fields relevant to intuitive interaction (eg. HCI, cognitive psychology, usability and interaction design).

> *Intuitive use of products involves utilising knowledge gained through other experience(s). Therefore, products that people use intuitively are those with features they have encountered before. Intuitive interaction is fast and generally non-conscious, so people may be unable to explain how they made decisions during intuitive interaction (Blackler, 2006; Blackler, Popovic, and Mahar, 2002; Blackler, Popovic, and Mahar, 2003a, b, 2004a, b, 2005).*

The definition was then used to form hypotheses for empirical testing, which confirmed its accuracy. The experiments are described in more depth by Blackler, Popovic and Mahar (2007) as well as elsewhere (Blackler, 2006; Blackler et al., 2002; Blackler et al., 2003a, b, 2004a; 2005; Blackler, Popovic, and Mahar, 2006).

Two initial experimental studies revealed that prior exposure to products employing similar features helped participants to complete set tasks more quickly and intuitively, and that familiar features were intuitively used more often than unfamiliar ones (Blackler et al., 2002; Blackler et al., 2003a, b). A third experiment was conducted to test four different interface designs on a universal remote control in order to establish whether a feature's appearance or its location was more important in making a design intuitive to use. The results showed that appearance (shape, size and labelling of buttons) most affects time on task and intuitive uses (Blackler et al., 2004a, 2005). Also, older people were significantly slower at completing the tasks and had significantly fewer intuitive uses (Blackler, 2006).

An important variable in this research was technology familiarity score. This was established through the technology familiarity questionnaire, which asked participants about how often they used certain products, and how much of the functionality of those products they used. More exposure to, and knowledge of, the products in the questionnaire produced a higher technology familiarity score. The TF score was used either to group participants or to balance the groups during subject matching.

2.2 Models of intuitive interaction

2.2.1 Principles for Designing Intuitive Interaction

Three principles for intuitive interaction were developed from the empirical work:

1. Make function, location and appearance familiar for features that are already known. Use familiar symbols and/or words, put them in a familiar position and make the function comparable with functions users have seen before.
2. Make it obvious how to use less well-known features by using familiar things to demonstrate their function, appearance and location.
3. Increase the consistency within the interface so that function, appearance and location of features are consistent between different parts of the design. Use redundancy in order to maximise the number of users who can intuitively use the interface and the ways in which they can choose to complete their tasks.

These principles are discussed in more depth by Blackler et al. (2007).

2.2.2 Continuum of Intuitive Interaction

A continuum of intuitive interaction was developed based on the principles explained above and related theories (Figure 1). The terms are ordered by complexity of design; it is suggested that as the newness or unfamiliarity of products increases, so too does the complexity of the designing required to make the interfaces intuitive to use. Very innovative products (or those based on very new technologies that have no established conventions) may require the application of features from other domains or metaphors, whereas familiar technologies or features can utilise familiar things from similar products, or even standard stereotypes and body reflectors. These terms are shown at the top of the continuum box. Other theories and terms (shown below) are seen as equivalent to the top terms. All of these ideas, and how they link to each other, are discussed in detail below.

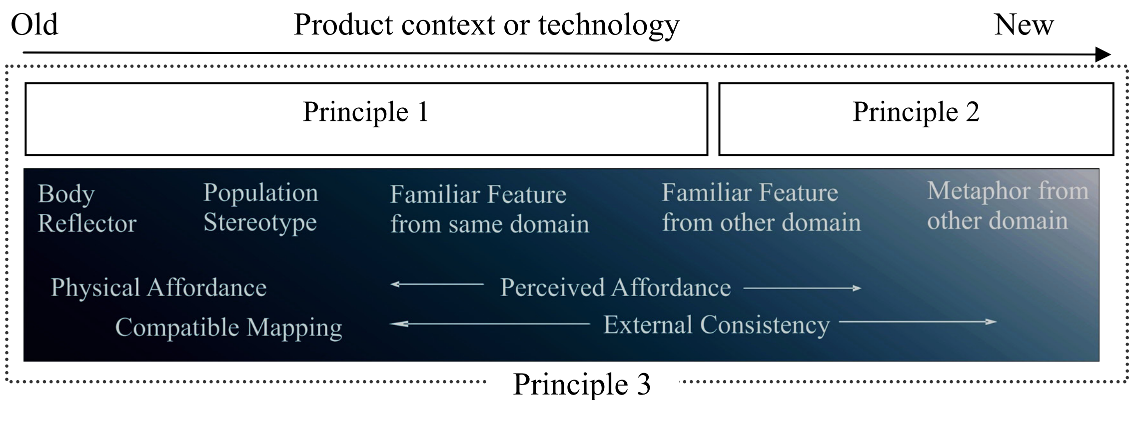

Figure 1: The intuitive interaction continuum as it relates to the principles

Figure 1 also demonstrates how the principles relate to the continuum of intuitive interaction. Principle 1 relates to the simpler end of the continuum, where body reflectors, population stereotypes or familiar things from the same domain are applied. Principles 2 relates to transferring things from other domains, including the use of metaphor. Principle 3, internal consistency and redundancy (represented by the dotted line), needs to be considered at all times and so it surrounds the other principles.

Looking at this continuum, it may seem to make sense to say that as one moves along to the right, more technology familiarity would be required to use the interface. However, if the principles and tool suggested here are used, it should be possible to design an interface at any of these levels which people with differing levels of technology familiarity could use intuitively. For example, a metaphor or familiar feature from another domain may be more familiar to some than a feature from the same domain – depending on their experience with the various domains. Therefore, moving along the continuum represents an increase in the complexity or recency of the product or technology but not the level of technology familiarity required to use it.

Body Reflectors

The continuum starts from the simplest form of intuitive interaction; body reflectors (Bush, 1989), which are based on embodied knowledge learned so early that it seems almost innate. A handle would be a simple example. Bush (1989) describes body reflectors as products or parts that resemble or mirror the body because they come into close contact with it, and claims that it is not necessary to be familiar with a body reflector in order to ascertain its relation to a person. Any person would be able to make the association whether familiar with similar things or not. This idea has also been discussed by Norman (2004b) in relation to physical, or real, affordances.

Population Stereotypes

At a more complex level, intuitive interaction employs population stereotypes which are engrained from an early age. Population stereotypes, for example clockwise to increase, derive largely from experience of cultural conventions. When population stereotypes are conformed to, reaction or decision time is shorter, the first movement made is more likely to be correct, use of the control is faster and more precise and people learn to use the control more rapidly (Asfour, Omachonu, Diaz and Abdel-Moty, 1991).

Familiar Features from same or other domain

At the next level again intuitive interaction can work through similar features from the same domain (eg. shutter buttons on cameras, file menus on software) or differing domains (eg. the ubiquitous power symbol, the increasingly popular 4 way navigation device). There is general consensus about the importance of designing artefacts that relate to users' prior knowledge and familiarity. The experiments conducted by the Australian team were based on the differentiation of familiar and unfamiliar features, applied from both similar and differing domains. All these experiments showed that familiarity with a feature will allow a person to use it more quickly and intuitively (Blackler et al., 2002; Blackler et al., 2003a, b, 2004a, 2005).

Metaphor

At its most complex, intuitive interaction requires the application of metaphor, used to explain a completely new concept or function. Metaphors are grounded in experience (Lakoff and Johnson, 1981, p202) and allow retrieval of useful analogies from memory and mapping of the elements of a known situation, the source, and a new situation, the target (Holyoak, 1991; Lakoff, 1987). Intuition is enabled by this sort of transfer (Rasmussen, 1986, p123). The most obvious successful example is the desktop metaphor.

Affordances

Affordances have been much popularised and have been used to describe both physical and virtual interface objects (Preece, Rogers, and Sharp, 2002). Norman (2004a) admits that by popularising the use of the term affordance in the design community he deviated from Gibson's (1977) original definition. Norman (2004b) tried to clarify the situation by distinguishing perceived and real, or physical, affordances. Physical objects have real affordances, like grasping, that are perceptually obvious and do not have to be learned. Their physical properties constrain what can be done with them. However, a virtual object like an icon button invites pushing or clicking because a user has learned that that is what it does. Screen-based features do not have real affordances; they have perceived affordances, which are essentially learned conventions (Norman, 2004b). This is a useful distinction – between "real" physical affordances that do not require learning beyond experience of being in the human body, and "perceived" affordances which are based on prior experience with similar things. Perceived affordance has therefore been placed on the continuum as being equivalent to familiar features, while physical affordance is seen as equivalent to body reflector.

Compatible Mappings (or compatibility)

Stimulus-response compatibility relates to the relationships of controls and the object they are controlling (mostly displays). It is important because a system with a greater degree of compatibility will result in faster learning and response times, fewer errors and a lower mental workload (Wickens, 1987; Wu, 1997). Compatibility is discussed further in Section 3.3.1

Ravden and Johnson (1989) relate compatibility to similarity of the interface with other familiar systems and with users' expectations and mental models of the system. This highlights the fact that mappings rely on past experience. Therefore, compatible mappings have been equated with population stereotypes on the continuum. Population stereotypes and compatible mapping are completely ingrained cultural norms that are widely but fairly unconsciously known by the majority of a particular population.

Consistency

Internal consistency is consistency within the system. External consistency is the consistency of the system with things outside the system; for example, metaphors, user knowledge, the work domain and other systems (Kellogg, 1987). External consistency is assumed to enhance the possibility that the user can transfer skills from one system to another, which makes new systems easier to use (Nielsen, 1989; Preece et al., 2002). It improves users' productivity because they can predict what a system will do in a given situation and can rely on a few rules to govern their use of the system (Nielsen, 1989). Principles 1 and 2 involve applying external consistency, which on the continuum is seen as equivalent to applying familiar features and metaphors. Principle 3 involves internal consistency.

2.3 What's in it for practitioners?

As well as the principles and continuum, the Australian team has produced a conceptual tool which is intended to help designers to apply intuitive use to interfaces.

2.3.1 Conceptual Tool for Applying Intuitive Interaction

The continuum (in a vertical orientation) is juxtaposed with an iterative spiral, which represents a design process with a variety of entry and exit points (Figure 2). As indicated at the top of the diagram, before starting design, the designers need to establish who the users are and what they are already familiar with so that they know what stereotypes, features or metaphors would be suitable to apply.

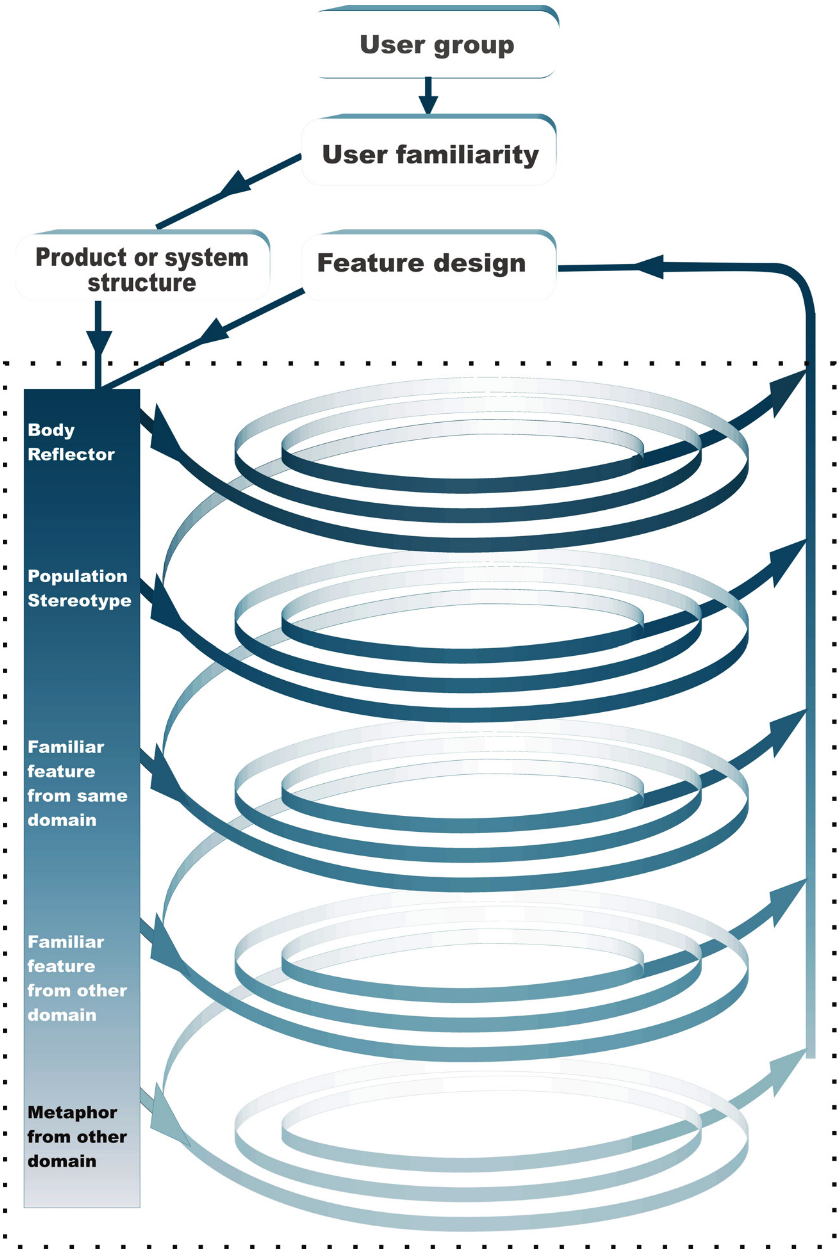

Figure 2: Conceptual tool for applying intuitive interaction during the design process

The conceptual tool has been designed so that one can enter the spiral at a suitable point and leave it when necessary. As designers work down the spiral, they can establish the earliest point at which a familiar thing can be applied to each feature. For a simple interface, this may be a body reflector for a handle or a population stereotype for direction of a scale. For more complex interfaces, it would involve applying familiar features from similar or extra-domain products. For very new technology which has none of its own conventions, a metaphor which relates to something that is familiar to the users would need to be applied. The spiral should be exited at the point at which a suitable level is found, and the process repeated until the entire form or structure of the product and the design of all the features has been completed. Testing, user consultation and re-designing are part of the design process, which is why the spiral is iterative.

Each loop of the spiral has three layers. These layers represent the factors function, appearance and location (Figure 3). They are arranged so that function is tackled first, then appearance and finally location, as that is the order of priority that has been established through research (Blackler et al., 2005). Designers need to go through the spiral to determine function, appearance and location of both product/system structure and feature design. It is likely that system structure or form would need to be addressed before detail of individual features, but not essential.

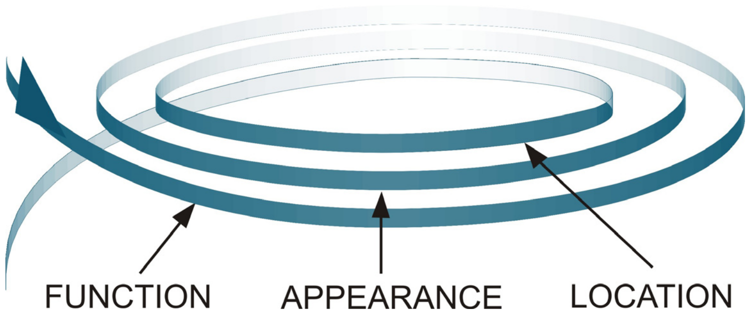

Figure 3: Detail of the three loops within each spiral.

Principle 3 (consistency and redundancy) is represented as a dotted line surrounding the spiral (Figure 2), as also shown in Figure 1. Consistency and redundancy should be considered at all times during the design process in order for design for intuitive interaction to be effective. Applying a similar type of familiarity to the function, location and appearance of each feature is part of remaining consistent. This could mean, for example, that if the function of the feature requires a metaphor, that metaphor is also applied to the appearance and location of that feature, so that the metaphor remains consistent.

According to all the conclusions reached though the Australian research, working through this process should mean that an appropriate level of familiarity based on things that target users already know will have been applied consistently throughout the design, and the resulting product is intuitive to use. This assumption is currently being tested through trials of the tool, feedback from designers and empirical testing of products designed using the tool, based on the same methodology as the previous experiments. One of the current challenges is helping designers to find out more about who the users are and what they are already familiar with (Blackler et al., 2006).

3. The German Approach (the IUUI Research Group)

The IUUI (Intuitive Use of User Interfaces) research group was established at the postgraduate research school "prometei" at the Technische Universität Berlin. IUUI is a reaction to the increasing use of the concepts 'intuitive' and 'intuitive use' as attributes of user interfaces and as assessment criteria for technical systems or for user interface requirements. The group started in late 2005 with the aim of creating a tenable definition of the term 'intuitive use' and providing tools and guidelines for designing interactive products that are intuitive to use. Group members have backgrounds in psychology, computer science, engineering, linguistics, and industrial design.

3.1 Definition of intuitive use

The IUUI definition of intuitive use is based on a literature review of usability design criteria (Scholz, 2006) and a series of interviews and workshops with users, usability specialists, and user interface design practitioners. For an overview of the results of these workshops see Mohs, Hurtienne, Kindsmüller, Israel, Meyer & die IUUI Research Group (2006b).

> *A technical system is intuitively usable if the users' unconscious application of prior knowledge leads to effective interaction. (Mohs, Hurtienne, Israel, Naumann, Kindsmüller, Meyer & Pohlmeyer, 2006a, page 130).*

The central concepts of *prior knowledge* and *unconscious application* in the above definition are further explicated in the following sections.

3.2 Models of intuitive interaction

3.2.1 Continuum of knowledge

Prior knowledge may stem from different sources. These sources can be classified along a continuum from *innate* knowledge, knowledge from embodied interaction with the physical world (*sensorimotor*), and *culture* to professional areas of *expertise*. On each of the last three levels there might be specialist knowledge about using respective *tools* and technologies (Figure 4).

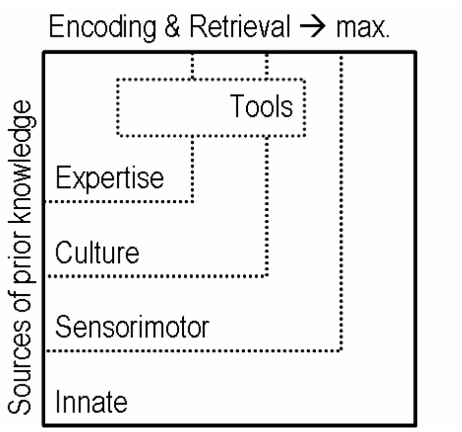

Figure 4: Continuum of knowledge in intuitive interaction

The first, and lowest, level of the continuum consists of *innate* knowledge - 'acquired' through the activation of genes or during the prenatal stage of development. Generally this is what reflexes or instinctive behaviour draw upon. Those who equate intuitive interaction only with innate knowledge may see this as the only valid level of knowledge when talking about intuitive interaction, because it assures universal applicability and unconscious processing, but these authors believe that intuitive interaction goes much further than innate knowledge.

The next level is *sensorimotor*. It consists of general knowledge, which is acquired very early in childhood and is from then on used continuously through interaction with the world. For example, children learn to differentiate faces; they learn about gravity; they build up concepts for speed and animation. Scientific notions like affordances (Gibson, 1979) and the later discussed image schemas (Johnson, 1987) reside at this level of knowledge.

The next level is about knowledge specific to the *culture* an individual lives in. What is known within the western group of cultures is not necessarily equivalent to the knowledge of people in eastern cultures (e.g. the preferred colour at funerals).

The most specific level of knowledge is *expertise*, that is specialist knowledge acquired in one's profession, for example as a doctor, mechanic, or accounting clerk; and in hobbies (e.g. riding, surfing, online-gaming).

Across the sensorimotor, culture and expertise levels of knowledge we also distinguish knowledge about *tools.* Tool knowledge seems to be an important reference when designing user interfaces. At the sensorimotor level there are primitive tools like sticks for extending one's reach and stones used as weights. At the culture level we find tools commonly used by people, like ball point pens for writing, pocket lamps for lighting, or cell phones for communication. At the last stage there is the knowledge acquired from using *tools* in one's area of expertise, for example image editing tools, enterprise resource planning (ERP) systems, or CNC machines. Even within the same domain of expertise (e.g. graphic design) there may be differing knowledge on the tool level of the continuum, depending on the kind of tools used (e.g. Corel Paint Shop vs. Adobe Photoshop).

The continuum of knowledge has an inherent dimensionality. The frequency of encoding and retrieval of knowledge increases from the top to the bottom of the continuum. Then, the further one rises towards the top level of the continuum, the higher the degree of specialisation of knowledge and the smaller the potential number of users possessing this knowledge. But still, on each level of the knowledge continuum one may assign 'intuitive use' according to the IUUI definition – as long as it is *unconsciously* applied by users.

3.2.2 Unconscious application of prior knowledge

The application of knowledge may be unconscious from the beginning (as with reflexes) or may have become unconscious due to frequent exposure and reaction to stimuli in the environment: the more frequent the encoding and retrieval was in the past, the more likely it is that memorised knowledge is applied without awareness by the user (Reason and Mycielska, 1982). Knowledge at the expertise level is acquired relatively late in life and is (over the life span) not as frequently used as knowledge from the culture or sensorimotor level. As learning theory suggests, knowledge from the lower levels of the continuum is therefore more likely to be applied unconsciously than knowledge from the upper levels (Rasmussen, 1986). If the unconscious application of knowledge is a precondition for intuitive use, it will be more common to see intuitive interaction involving knowledge at the lower levels of the continuum.

Limiting 'intuitive interaction' to the lower levels of the knowledge continuum does have further advantages:

- The further down we move on the continuum the larger and more heterogeneous the user groups we can reach are. While almost everyone will have a concept of 'verticality' (sensorimotor level), not everyone understands the Corel Paint Shop software package (tool/expertise level).
- Instead of being required to analyse the prior knowledge of the specific target user group, designers might simply refer to rules generated from findings about the general structure of human knowledge (i.e. general human knowledge on the sensorimotor level).
- Extremely frequent encoding and retrieval events lead to a higher robustness of information processing. In situations of high mental workload and stress a fall-back on lower stages of the knowledge continuum will occur. This will be especially important to the design of systems with a high impact on security (control of aircraft or of nuclear power plants).
- Unconscious processing of user interface elements in general means less workload on the cognitive processing capacity. Thus more cognitive resources will be available for solving the working task at hand instead of wasting time and mental effort on figuring out how a piece of technology works.

Although the lower levels of the knowledge continuum are emphasised by this approach, the definition of the IUUI group still allows for intuitive use based on higher level knowledge that is well learned and can be applied automatically. Knowledge from the higher levels thus certainly helps expert users – but maybe at the cost of robustness.

3.3 What's in it for practitioners?

The IUUI group has developed some tools to help designers to build intuitive interaction (Mohs, Hurtienne, Scholz & Rötting, 2006c; Hurtienne & Blessing, in press).

3.3.1 Check-list for intuitive interaction design

Of the many principles for intuitive interaction collected in workshops and interviews with usability experts and users, seven principles survived the review process. They fit the IUUI definition of intuitive use and include suitability for the task, compatibility, consistency, gestalt laws, feedback, self descriptiveness, and affordances. These principles were collected in a checklist that provides design rules and can be used for inspiration and early reviews in the user interface design process (Mohs et. al, 2006c). Currently the checklist is being evaluated with user interface designers. The seven principles that form the basis of the checklist are detailed below.

Suitability for the task

Technology is for accomplishing users' tasks. Suitability for the task includes the following aspects: functionality and interaction are based on task characteristics (rather than on the technology chosen to perform the task); the user interface should only present information related to the successful completion of the tasks; the format of input and output should be appropriate to the tasks; and only necessary interaction steps should be included (ISO 9241-110). Of course, this principle is based on thorough knowledge of the task that the designer must acquire beforehand.

Compatibility

Compatibility, as a multifaceted concept, comprises at least three levels: the user interface level, the level of the technical system, and the user-task level. At the UI level classical stimulus-response compatibility refers to corresponding arrangements or movements of displays and their respective controls. At the technical system level compatibility refers to location and movement of displays and controls on the one side and the location and movement of parts of the technical system (chemical plant, car, or aircraft) on the other side. At the user-task level there is the proximity compatibility principle by Wickens & Carswell (1995). The principle specifies that when a task requires the integration of multiple sources of information, performance will be best when that information is displayed in close proximity. And finally, there is what can be termed mental-model compatibility, that occurs when user interface properties are congruent with user expectations acquired from the use of the current or other systems or with general knowledge like population stereotypes (see above) or image schemas (see below). Note that mental model compatibility goes beyond mere arrangement and movement correspondences. It can also explain spatial mappings to abstract concepts (like time, quality, or quantity). An important consideration in this context is that mental models do also exhibit dynamic properties that should be matched by the user interface.

Consistency

The IUUI principle of consistency follows the description given in Section 2.2.2.

Gestalt laws

Gestalt laws refer to the application of basic principles of perception as they have been described (e.g. Koffka, 1936). Applied to user interface design they contribute to the overall clarity of the interface. One of them is the Law of Similarity. Transferred to user interface design it means making objects belonging to one task look similar because the mind groups similar elements to an entity. The similarity depends on relationships constructed about form, colour, size and brightness of the elements.

Feedback
After any operation users must get immediate, self-evident, and appropriate feedback from the control itself or via display. Users should have no uncertainties about the result of their action because this may interrupt the intuitive flow of operation.

Self descriptiveness
Technology is self-descriptive to the extent that at any time it is obvious to the users which interaction step they are in, where they are within the sequence of interactions, which actions can be taken and how they can be performed (ISO 9241-110). This means that the meaning and function of user interface elements is immediately clear. Any explanation a user gets only after additional interaction steps is not intuitive.

Affordances
The IUUI principle of affordances follows the description given in Section 2.2.2.

3.3.2 Evalint - User questionnaire for intuitive interaction evaluation

Another product of the IUUI research group that can be useful for designers is Evalint (*Eval*uate *int*uitive use), a questionnaire for evaluating intuitive interaction with prospective users of the product (Mohs et. al, 2006c). The questionnaire consists of four scales: perceived effortlessness of use, perceived error rate, perceived achievement of goals, and perceived effort of learning, all likely consequences of intuitive interaction.

Perceived effortlessness
A fundamental characteristic of intuitive use is information processing without conscious awareness. From the user's perspective this is experienced as effortless and untroubled interaction. Note that this criterion relates to *mental* efficiency: the mental resources expended in relation to the accuracy and completeness with which the users achieve their goals (after ISO 9241-11).

Perceived error rate and perceived achievement of goals
According to the IUUI definition intuitive interaction is required to be effective. ISO 9241-11 defines effectiveness as the accuracy and completeness with which users achieve specified goals. Perceived error rates and completeness of goal achievement are operationalisations of this requirement.

Perceived effort of learning
If users realise any effort of learning when using technology this interaction cannot be intuitive by definition. Consciously acquiring interaction knowledge is not a part of intuitive interaction. The phrase "trial and success" captures the idea.

3.3.3 ISCAT - Image schema catalogue

Image schemas are abstract representations of recurring dynamic patterns of bodily interactions that structure the way we understand the world (Johnson, 1987) and thus are important building blocks for thinking. They can be classified into the sensorimotor level of the knowledge continuum (Figure 4). The CONTAINER schema, for example, forms the basis of the daily experience with cars, housings, boxes, tea pots, cups, etc. A CONTAINER is characterized by an inside, an outside, and a boundary between them. Depending on the author, about 30 to 40 such image schemas are distinguished (Johnson, 1987; Hampe, 2005). See Table 1 for a list of image schemas that are grouped into seven basic categories. The universal character of image schemas, their - in the course of life - extremely frequent encoding in and retrieval from memory and their unconscious processing make them interesting as patterns for designing user interfaces. An UP-DOWN schema (along with a LEFT-RIGHT schema), for example, may be represented by a mini joystick on a mobile phone. When the joystick is moved downwards, the menu item below the current selection gets selected. An upward move with the joystick moves the selection upwards. The UP-DOWN schema can be used equally well for representing abstract concepts like intensity of speaker volume or attractiveness ratings. This use of image schemas for representing abstract concepts is one of the major promises for user interface design because, in their minds, users unconsciously tie the location, movement and appearance of UI elements to their functionality. So, for instance, the image schemas UP-DOWN, LEFT-RIGHT, and SCALE were experimentally validated for representing quality and quantity in user interfaces (Hurtienne & Blessing, in press) and NEAR-FAR for representing similarity or considered action possibilities (ongoing).

Table 1: List of Image Schemas

Group	Image Schemas
BASIC SCHEMAS	SUBSTANCE, OBJECT
SPACE	UP-DOWN, LEFT-RIGHT, NEAR-FAR, FRONT-BACK, CENTER-PERIPHERY, CONTACT, PATH, SCALE
CONTAINMENT	CONTAINER, IN-OUT, CONTENT, FULL-EMPTY, SURFACE
MULTIPLICITY	MERGING, COLLECTION, SPLITTING, PART-WHOLE, COUNT-MASS, LINK, MATCHING
PROCESS	ITERATION, CYCLE
FORCE	DIVERSION, COUNTERFORCE, RESTRAINT REMOVAL, RESISTANCE, ATTRACTION, COMPULSION, BLOCKAGE, BALANCE, MOMENTUM, ENABLEMENT
ATTRIBUTE	HEAVY-LIGHT, DARK-BRIGHT, BIG-SMALL, WARM-COLD, STRONG-WEAK, SMOOTH-ROUGH, STRAIGHT

ISCAT is a database of image schema examples in user interfaces. It is based on analyses of user interfaces as different as airplane cockpits, cash and ticket machines, and software (e.g. ERP software, Microsoft Windows widgets). ISCAT contains searchable information about (1) how image schemas are represented by the various user interface elements (e.g. vertical sliders are instances of the UP-DOWN and SCALE image schemas) and (2) how these image schemas are used to intuitively convey meaning and which abstract concepts are structured by them. For example, sliders (= UP-DOWN or LEFT-RIGHT + SCALE) can be used for representing quantitative variables; and blinking warning lights (= ATTRACTION) can be used for directing the attention of the user towards important information. The database lists examples of image schema applications that either support or obstruct usability. In its current form the database serves two purposes. (1) It is used by user interface designers for looking up examples of good and bad uses of image schemas in user interface design. They can see how to represent image schemas at the user interface, what meaning their usage is conveying to the user, and they are inspired by additional linguistic examples of the use of image schemas for conceptualising abstract concepts. (2) The database serves as a research tool, open to the usability community for searching image schema instances and for input of further examples[1]. The aim is to concentrate the collection of image schema examples into rules of how sensorimotor knowledge can be applied to designing for intuitive interaction (Hurtienne & Blessing, in press).

4. Similarities and Differences

There are many similarities between the work of these two groups, as well as some differences. These are discussed below and possible future directions and contributions explored.

Backgrounds of the teams and origins of the definitions vary a bit but not much – both are interdisciplinary teams and both approaches are grounded in the literature and in experimentation. Importantly, what is common across the definitions is the *unconscious use of prior knowledge* (although it is phrased differently in each), which has become foundational for both groups.

Within the definitions, IUUI has the additional *effective* requirement and Blackler and colleagues the *fast* requirement. However, Blackler at al (2004b) did include effectiveness (correctness) as one of the criteria used to determine intuitive uses when analysing experimental data. In fact, in many cases intuitive interaction would likely be both fast and effective. Both teams agree that fastness results from enhancement of information processing speed and does not refer to action fastness: whether intuitive interaction leads to more or less clicks or faster physical movement, for instance, is not relevant. Intuitive use reduces cognitive processing time and hence the IUUI emphasis on 'effortlessness' as a subjective criterion (see also Mohs et al., 2006c).

Both teams agree that intuitive use is most beneficial for first, early and intermittent uses of interfaces. Considering the proliferation of interfaces in all areas of modern life, this covers a large proportion of uses. Experts may develop seemingly counter-intuitive ways of interacting with specialist systems that are highly efficient, but inexplicable to novices. However, the more intuitive even these systems can be, the more robust operations are likely to be under conditions of stress or during emergencies. For some systems (eg. power stations), this may be particularly important.

[1] Please contact the second author at http://iscat.zmms.tu-berlin.de:8080/iscat/ to get access to the ISCAT database.

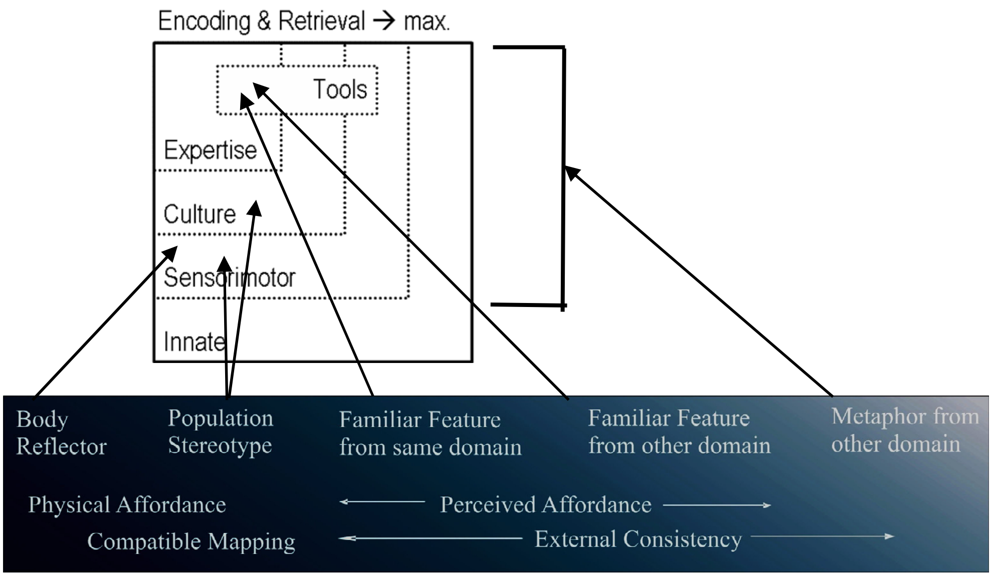

Figure 5: Interaction of the two continua

The models produced are in the form of continua and although they look different at first glance, there are definite overlaps. Figure 5 shows how the two continua interact. The body reflector (or physical affordance) is sensorimotor. Population stereotypes (and compatible mappings) are linked to the sensorimotor stage (like the connection MORE IS UP) or to particular cultures (like the different light switch conventions in the US and Germany / Australia). Knowledge of familiar features (equated to perceived affordances and external consistency) comes from expertise with other products and systems (tools). However, metaphor can apply across the IUUI continuum from sensorimotor to expertise.

Blackler and colleagues have not included innate knowledge on their continuum, whereas IUUI have. Among the innate examples IUUI use are reflexes, e.g. the startle response: an involuntary reaction to a sudden unexpected stimulus (especially a loud noise) which involves flexion of most skeletal muscles and a variety of visceral reactions. If a dot on a screen rapidly expands the operator will involuntarily wince. The orienting response (or reflex) is the reflex that causes an organism to respond immediately to a change in its environment. The term was coined by Ivan Pavlov, who also referred to it as the "What is it?" reflex. The orienting response is a reaction to novelty. For example, if the computer suddenly plays a melody it will not necessarily elicit a startle response but still successfully interrupt flow of attention and people will orient themselves so as to find out what this means. It is easy to see how incorporating this kind of reflex reaction into user interfaces can increase their effectiveness and make them more intuitive to use. Having worked with the IUUI group, Blackler would now argue that, although innate reflexes not based on learned knowledge cannot be intuition, they can contribute to intuitive interaction.

Another point of agreement is the idea that the simpler levels on both continua will apply to more people and applying them where possible rather than the familiar features or expertise levels will make an interface more universally usable. This is why they are placed at the top of the spiral in the tool devised by Blackler et al. Metaphor, however, has the potential to operate on all these levels, as it allows experiences many people have had in everyday life to be applied to quite complex features and functions. This can allow the maximum number of people, regardless of their technology familiarity, to use complex interfaces intuitively.

One of the main points of difference is that IUUI tries to relate the intuitive use approach to international usability standards, especially ISO 9241-110 which inspired some of the checklist criteria, and ISO 9241-11 which gives the framework for evaluation: effectiveness, efficiency and satisfaction. These standards are very important in the German usability community. Intuitive interaction fulfils the requirements of effectiveness and refers to the cognitive (not motor or general temporal) efficiency of interaction. Satisfaction is enhanced a consequence of intuitive interaction and can be measured using the Evalint questionnaire.

Overall, the approaches, results and tools are similar. The main findings of each group correspond and the theories based on them are complementary, as demonstrated above. The various tools devised by the groups are useful for designers, who now have a wide selection to choose from.

5. Where do we go from here?

Blackler and colleagues are beginning to investigate intuitive interaction for older people and are also developing their tools further. The spiral tool has been tested with designers. The first test showed that the tool enabled the designer to understand and include in the design key aspects of products users would already be familiar with. However, it was suggested that more guidance on the user group and user familiarity stages was required (Blackler et al., 2006). A refined version of the tool was then tested by seven groups of postgraduate designers. A microwave interface, redesigned by one of these groups using this tool, is now being tested against the original microwave design. This will help to ascertain whether or not the new design leads to more intuitive interaction (and therefore if the tool is effective), as well as being the first step in looking specifically at intuitive interaction for older people. Once refined, the spiral tool will be developed into a comprehensive, flexible, interactive tool for use by designers. At this stage, possible compatibility with other design process models (eg waterfall model) will be examined.

The next steps for IUUI will be to work on the issue of how intuitive use can be more easily measured (the experiments used by Blackler et al. are very time consuming), release more tools and improve the others. The group is validating and standardising the checklist and the Evalint questionnaire. First steps have been undertaken on devising and validating a new method for the online measurement of mental efficiency (Mohs et al, 2006b). Currently techniques are under development for the elicitation of intuitive task sequences from the user's point of view. Israel is working on physically represented tangible user interfaces and their use for manipulating digital data. Their effectiveness has been shown in previous experiments (Krause, Israel, Neumann & Feldmann-Wüstefeld, 2007). A fruitful combination of image schema theory and the design of tangible user interfaces has recently been shown by Hurtienne & Israel (2007). More work will be done to extend the image schema database and to condense the many examples collected in ISCAT into some general information about the application of image schemas in UI. Finally, some exploratory studies are planned that look at all the other unconscious effects that are out there, for example in marketing, in psychology, or in art that can be used for the design of intuitive interaction with technology.

Representatives of the two groups met at a workshop on intuitive use in Berlin in November 2006. Although the two groups have no formal plans to collaborate further at the moment, they are keeping each other in touch and up to date with developments, and hope to find opportunities in the future, e.g. to develop an integrated model of intuitive interaction. Watch this space!

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