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TOWARDS DEFINING CONTEXT

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ABSTRACT
Designing is an abstract activity. In designing, solutions must be derived in an environment where design requirements, methods and evaluation criteria are subject to frequent change. Consequently while designing, recognising *something* that makes *something* better or worse in relation to its context, is vital to achieve design solution [1]. The interrelationship shared by context and designing though acknowledged; understanding of the same has remained fuzzy yet. A theoretical interpretation of *designing* and *context* is a necessary precursor to develop such an understanding. While the literature in design domain is rich in discussions on designing the same is not the case with later. Although a great amount of deliberation on the notion of context exists in other domains of study, however, a comprehensive dialogue in relation to design is needed. This paper intends to address few aspects of this issue by providing a definition of context that is synthesised through a broad survey and argumentation.

Keywords: context, design context, context in designing, context of designing

1 WHY CONTEXT IS IMPORTANT?
Consider the conversation - 'Yesterday's practice was tiring'. Certainly we need more information to understand the meaning of the above sentence as 'practice' could be for a cricket match, or a theatre play, or something else. It is the context alone which is capable of determining relevant interpretation. Linguistics has for long accepted the crucial role of context in human communication. Studies of human-human dialogue show that explanations constitute about one-third of dialogues, most of them being offered spontaneously without questions. The role of explanations is to convey contextual information that is missing in the interpreter's context [2]. When Schon and Wiggins suggest that, 'designing is a reflective conversation with materials conducted in the medium of drawing and crucially dependent on seeing' [1], it remains important to unravel what is influencing such *reflective conversation* and *seeing*. Valkenburg and Dorst have described *reflection* as an activity aimed at exploration and formation of context [3]. In a recent conference held in Hohenkammer, during the

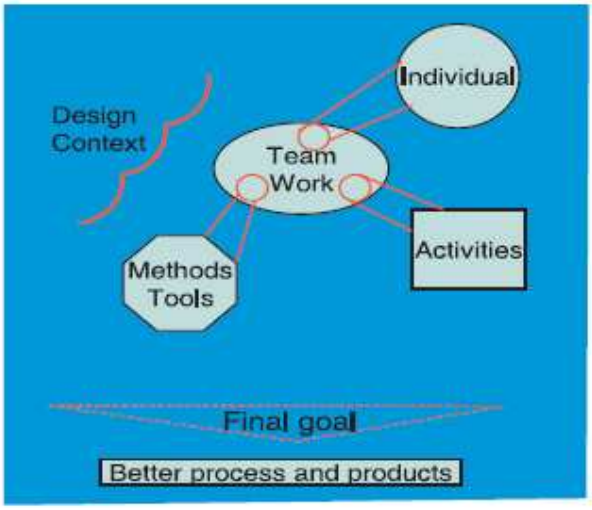

Figure 1 - A shared mental model of team designing

discussions on ‘team designing’, a shared mental model of interaction between individuals was formed that incorporates ‘design context’ at its centre (Figure 1) [4]. Purcell and Sodersten while describing the role of sketches in designing explain that, ‘...new spatial relationships and forms that emerge are tied to the particular characteristics of the design process at that point in time...they are situated in the context...’ [5]. On the other hand Friedrich observed in a protocol study that, ‘More than collecting a list of requirements, designers seek to come to a shared understanding of the device by invoking contexts...’ [6]. Dorst and Hendriks describe, ‘...design does not just take place in a context, but that the context pervades the design process’ [7]. These observations taken from description of design studies of individual designers and those working in a team clearly indicate the crucial role of context in designing. However, as concluded in the Hohenkammer conference, the analysis of design context is still inadequate. Thus a theoretical interpretation of the notion of context in relation to designing supported by empirical observations is of utmost need, in order to arrive at a concise understanding [8].

2 WHAT IS CONTEXT?

The necessary condition to understand the notion of context is its formal definition, which can act as a foundation for theoretical deliberation. The word *context* has been used in varied ways in the design literature conveying different interpretations. The following list, adapted from Charlton and Wallace [9], demonstrates the breadth of interpretation of the term ‘context’ held in the design literature.

- ‘The issue(s), goal(s) or requirement(s) being addressed by the current part of the product development process: e.g. safety; usability; assembly’.
- ‘The function(s) currently being considered for an aspect of the product: e.g. transmitting a torque; acting as a pressure vessel’.
- ‘The current phase of the product lifecycle: e.g. design; manufacturing; marketing; disposal’.
- ‘The activity within the current lifecycle phase: e.g. concept generation during design; operating an emergency stop during use’.
- ‘The physical surroundings with which a part of the product can interact, including either internal or external aspects of the product's environment: e.g. the components in a hydraulic system; the temperature of the operating environment; the manufacturing environment; aspects of the surrounding landscape reflected in an architectural design’.
- ‘The abstract surroundings with which a part of the product can interact, including higher conceptual levels within which the part is nested: e.g. the business process supported by a document management system; the document structure, sub-headings and titles enclosing this sentence; the *mood* for fashion this season’.
- ‘The application sector for the product: e.g. aerospace; medical’.
- ‘The current reasoning domain: e.g. electrical; mechanical’.
- ‘The current reasoning framework and activity: e.g. planning; CBR; training a neural network’.
- ‘The stakeholders for a particular activity within the product lifecycle, together with their capabilities, limitations, skills and training: e.g. users; production line workers’.
- ‘The environment in which stakeholders perform their activities, including both physical and temporal surroundings: e.g. a clean room; colleagues; other things which happen to be on the desk; the *Friday afternoon* effect; the previous task’.
- ‘The abstract (organisational) environment in which stakeholders perform their activities: e.g. the design process or method being followed; the legislative or regulatory framework’.
- ‘The commercial, political or economic environment of the product: e.g. a boom in construction; an ageing population’.
- ‘The social or cultural environment of the product: e.g. the references it makes to previous products’.
- ‘The preferences, presuppositions or (possibly partial) beliefs held by an agent’.

Charlton and Wallace themselves defined context as, ‘context is only the relevant information’ [9]. On the other hand Hekkert and van Dijk define context as, ‘a set of factors selected and combined by the designer’ [10]. It is easily noted here that, these two definitions share a disparity in their conveyed meaning. Even a superficial exercise to compare and choose one generally applicable definition

among the listed above turns out to be a futile one. For example, first nine definitions in the list closely corroborate to the definition proposed by Charlton and Wallace. Similarly, the last definition from the list more or less reflects the idea behind Hekkert and van Dijk's definition. Further the definition by Charlton and Wallace as well as that by Hekkert and van Dijk, rather partially characterise the definitions numbered ten to fourteen in the list. An important fact here is also that, almost all of these definitions are based on the intuition of authors and not on rigorous synthesis process. Therefore it is pertinent to have a concrete as well as generally applicable definition of context, derived through transparent argumentation as opposed to intuition. In absence of any well argued definition of context in the design literature, we first present here an informal definition. The approach adopted here is to discuss various worldviews held by different domains of study about the notion of context, and simultaneously extract the salient points in order to devise a concise definition of context. It is believed that such a definition will form the basis to understand the interplay between context and designing [8].

3 FRAMING CONTEXT

Before moving further it is important here now to provide an informal characterisation of context. Dewey has described role of context in human communication as: 'We grasp the meaning of what is said in our language not because appreciation of context is unnecessary but because context is inescapably present' [11]. Etymology of the word context can be traced back to Latin *contextus* - connection of words, coherence, from *contexere*- to weave together. Two dictionary definitions of context are:

- the situation within which something exists or happens, and that can help explain it (Cambridge)
- the interrelated conditions in which something exists or occurs (Merriam-Webster).

Thus, to begin with, context can be defined as - the frame defining the occurrence of *something* in the coherent backdrop of *something*. For long, studies in the domains of linguistics and natural language processing, philosophy, psychology, were engaged in exploration and understanding of context. The renewed interest in studies relating to context, during the last few decades, is however solely due to the emergence of computation. Artificial intelligence (AI) in particular and coupled by its sub-domains including knowledge-based systems, ubiquitous and pervasive computing have brought the issues of context-awareness in computing to the forefront. The need arose due to the fact that, human - computer interaction is an ill-posed problem due to the requirement that context be explicitly stated to the computer. On the other hand in human - human communication, context is taken for granted to the extent that we do not need to explicitly chalk out every underlying assumption and fact. The inescapable embrace of context by AI is evident from Lenat's admission - 'During the 1984 - 1989 time period, as the *Cyc* common sense knowledge base grew ever larger, it became increasingly difficult to shoehorn every fact and rule into the same flat *world*. Finally, in 1989, as *Cyc* exceeded 100,000 *rules* in size, we found it necessary to introduce an explicit context mechanism' [12]. The next sections discuss in detail the pertinent literature in the related areas of artificial intelligence, knowledge theory, philosophy and cognitive psychology.

4 CONTEXT AND AI

While reacting to their environment, humans are supremely capable of non-algorithmic thinking but that is not the case with AI systems. It is a great challenge for AI systems to represent and produce such contextualised responses in an efficient manner. The following are some definitions of context cited in the AI related literature:

- 'Context is a generalization of a collection of assumptions' [13].
- 'In AI, context can be either a situation in the general sense of the term, a part of knowledge, or both of them. A situation contains both problem related and environmental facts' [14].
- 'Context is everything surrounding an item of interest, including the mindset of any humans involved in the context' [15].
- 'When we talk about the role of context in cognitive psychology, we mean the role that information surrounding a target might have in using a specific cognitive process' [16].
- 'Context is what constrains a problem solving without intervening in it explicitly' [17].

- ‘Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves’ [18].
- ‘Context is the set of all entities that influence human (or system's) behaviour on a particular occasion i.e. the set of all elements that produce context effects’ [19].

The above listed worldviews have naturally influenced the representation schemes used by AI systems. AI's primary interest is in the modelling and the use of context in real-world applications featuring the problem solving by a human and a machine. AI systems have always relied on notion of context, representing it either implicitly or explicitly. In rule-based formalism context is coded, generally implicitly, to control knowledge. For example, as pre and post conditions that defines the scope of a rule when fired. This approach of formalism relies on the assumption that context is static in nature.

As pointed in *Cyc* case [12], AI soon realised that in order to make the system flexible and more efficient explicit representation of context is required. De Kleer was among the early developers who attempted to explicitly use context in AI [20]. These new representations used views from the domains of logic and cognitive science. Cognitive science views context as a way, using human behaviour as a key, to model interactions and situations in a world of infinite breadth. Similarly in logic, the focus is on the infinite dimension of context. Logic treats context as rich objects, in the sense that they cannot be completely described - one reason for such view being the relativity between the contexts. According to McCarthy and Buvac [13]:

- a context is always relative to another context contexts have an infinite dimension
- contexts can not be described completely
- when several contexts occur in a discussion, there is a common context above all of them into which all terms and predicates can be lifted.

Brezillon observes that in logic, ‘A context is a type of representation with its semantics and its syntax. Thus, a given proposition P can have different expressions in two contexts’ [17]. Approaches defined by cognitive science and logic assert that context is dynamic in nature.

The descriptions above, point towards a lack of consensus about the nature of context. In a comprehensive review of context in AI, Brezillon observes, ‘An important question is: Is context known a priori or a posteriori? Considering context known a priori supposes that it may be modeled in a discrete representation and is static. Conversely, considering context known a posteriori implies that context is dynamic and can be modeled only during a problem solving (or interaction)’ [17]. The interpretation of the notion of context seems to be dependent on the point of view - a cognitive science view versus an engineering (or system building) view.

5 RELATIONSHIP BETWEEN CONTEXT, KNOWLEDGE AND CONSTRAINTS

Since the failure of researchers in Artificial Intelligence in Design (AID) to completely automate design process, capture and codification of designers' knowledge has become an important issue. The theory of core competence of organisation proposed by Prahalad and Hamel has also provided a push to this issue as organisations strive to capture their ‘intellectual assets’ [21]. It has driven research in design to an old issue of ‘expertise’ not only from an educational and training point of view [22] but also from the perspective of ‘capture’ for later utilisation [23, 24]. One aspect eluding such studies is the delineation between data, information and knowledge. This is where context comes into the picture. The classical view of the information processing systems defines data as, ‘the stimuli which enter the interpreter’ [25]. On the same lines, information is, ‘the structured data with a semantic content expressible by natural language’ [26]. However, defining *knowledge* has always proved to be an insoluble problem for epistemology, philosophy, logic, AI, to name just a few subjects. The Western philosophical definition of knowledge as *justified true belief*, suggested by Plato, has been refuted in the light of the Gettier problem [27] and Eastern philosophies. The question is whether there is any connection between the notion of context, data, information and knowledge? The answer could lie in Brezillon's observation that ‘context plays an important role in all domains with activities as reasoning and interpretation, and can only be caught by experience’ [17]. The following passages explore this relationship.

Marsh in his doctoral thesis referred to knowledge as the *state of knowing* [23]. For his proposed computer-based knowledge management system (KMS), he argues that data and information exist in the storage media, information and knowledge exist in the real world (where experience is generated), and knowledge and understanding exist in cognitive space. He uses the notion of context informally, when he refers to the *frame of reference*, while outlining the process of flow or conversion from data to information and then into knowledge. Whilst differentiating among experts and novices, and different types of novices, Ahmed *et al.* have concluded that data, information and knowledge are relative concepts that cannot be defined in absolute terms [28]. In contrast to Marsh's approach, Ahmed in her doctoral thesis has explicitly referred to context while describing the interrelationship between data, information and knowledge [29]. She suggests that knowledge is warranted true belief that can be derived from sensory experiences, reasoning and interpretation of information. According to Pomerol and Brezillon, 'Data are the stimuli that enter an interpretation process. Information is then data with meaning. Information is also the input to a knowledge-based process of decision making' [26]. They suggest that knowledge is used:

- to transform data into information,
- to derive new information from existing ones, and
- to acquire new knowledge pieces.

Though the discussion presented above is far from being comprehensive; concept of data, information, and knowledge seem to be dependent on context and the interpreter. Now the question remains: What is the relationship shared by knowledge and context? It is clear from the various considerations above that context plays a role in interpretation of data as well as acquisition of knowledge, and that knowledge is required both to transform data to information and then to knowledge. In a review paper, Brezillon concluded that, 'There is a consensus on the fact that *context is inseparable from its use*. Context is considered as a shared knowledge space that is explored and exploited by participants in the interaction' [17]. This point's to the overlapping relationship between the two concepts.

Ozturk and Aamodt argued that context is related to both 'the situation' and 'the state of the mind' [30]. They explain that the term 'situation' captures the 'ground facts' existing in a situation, while 'situational context' contains the pertinent contextual aspects to that situation. They note that these facts exist independently of the reasoner, or in other words that they are there before and after the reasoner notices them. On the other hand, the 'state of the mind' component of a context emerges while the reasoner solves a problem, and captures the goals, interests and information needs of the reasoner in the progress of problem-solving. Pomerol and Brezillon base their discussion on primary and secondary context, to distinguish between the general, relatively fixed primary characteristics of a situation, and the secondary characteristics which are more mobile [26]. Here while describing the primary context they confess that, 'it is difficult to avoid the word knowledge about this general background used by the operators to carry out their task'. Thus they refer to this primary context as *contextual knowledge*, defined as, 'all the knowledge which is relevant for one person in a given situated decision problem and which can be mobilized to understand this problem and explain the choice of a given action'. They observe that contextual knowledge is evoked by situations and events, and is loosely tied to a task or a goal [31]. Thus they distinguish between the part of the context which is relevant at that step of the decision making or task performing, and the part which is not relevant. They call the former part *contextual knowledge*, and the latter part as *external knowledge*. The third category proposed by them is the *proceduralized context*, part of the contextual knowledge which is invoked, structured and situated according to a given focus. 'The contextual knowledge is a backstage knowledge whereas proceduralized context is immediately useful for the task at hand' [26]. They suggest that contextual knowledge is useful to identify the activity, whereas proceduralized context is relevant to characterize the task.

The *context elements* of Ozturk and Aamodt, and the *contextual knowledge* as well as *proceduralized context* of Pomerol and Brezillon, are related to the parts of knowledge and/or information that reasoner uses to accomplish the task at hand. An important fact to be noticed here is that Ozturk and Aamodt as well as Pomerol and Brezillon emphasize the role of *reasoner* or *interpreter* to describe context. Thus we can say that context comprises a special kind of knowledge, which is necessarily held by individuals though it can also be shared by a group of individuals up to certain extent. Another aspect of context to be considered is its relationship with constraints. Broadly, from the above discussion it appears that context is a mechanism helping the interpreter to establish relevance. As Ozturk and Aamodt explain, 'The essential aspects of *context roles* are captured by the notions of

relevance and *focus*' [32]. They explain that relevance refers to the usefulness of a solution to a problem in a particular environment. The focusing aspect of context roles refers to the efficiency of the problem-solving process while maintaining relevance. The following passages explore this relationship between context and constraints.

Ozturk and Aamodt provide insight to the role of context in problem-solving [32]. They reiterate the generally held opinion that context facilitates the selective processing of information, the disagreement being as to what context actually is, and in how it affects processes of problem solving and learning. They note that the term 'perspective' is often used in relation to context. Perspective, in their account, 'is the set of relevant aspects one takes into consideration when accomplishing a particular task'. According to them, context is used to identify the appropriate perspectives, and in turn the perspective is used as a kind of filter. In general in the problem-solving scenario, where people face a huge search space, they suggest that pruning of some parts from the search occurs through focusing attention only on particular regions of the memory, as early as possible. For this they say, 'context serves as a focusing mechanism through determination of goals, and epistemological and physical needs of the reasoner in order to accomplish the tasks that active goals evoke'. In a review paper Brezillon uses the analogy of a filter to describe contextual knowledge that defines, at a given time, what knowledge pieces must be taken into account (explicit context) from those that are not necessary or already shared (implicit context) [17]. In his view, contexts define - when some piece of knowledge should be considered. A context contains:

- sets of concepts (also called schemas, frames, or structures) that describe the basic terms used to encode knowledge in the ontology, and
- a set of constraints that restrict the manner in which instances of these concepts may be created and combined.

Referring to MacCarthy and Buvac he describes context as a structure, a frame of reference that permits - not to say all the things in a story [13]. He further argues that contextualized knowledge is knowledge that is explicitly considered in the problem-solving. He suggests that 'contextual knowledge intervenes implicitly in the problem-solving, often as constraints'. Pomerol and Brezillon present an account of proceduralization of context [33]. While noting the fact that the context is not under the control of the observer, they suggest from an engineering point of view that context can be defined as, 'the collection of relevant conditions and surrounding influences that make a situation unique and comprehensible'. For them, contextual knowledge is more or less similar to what people generally have in mind about the term 'context'. Further they argue that, 'contextual knowledge implicitly delimits the resolution space. It is always evoked by a task or an event, but does not focus on a task or on the achievement of a goal but is mobilized according to a set of tasks, even though it has not yet been proceduralized for use'.

From the above discussion it may be concluded that context has a role in constraining problem-solving. However, the question left unanswered is whether context is a mere collection of constraints. Consider the assignment used for protocol analysis study by Dorst and Cross in which designers were asked to create a concept for a 'litter disposal system in a new Netherlands train' [34]. They observed that the designers used different strategies to organise their approach to the assignment. Some began by deciding whether the process should be one of design or redesign, others focused on which stakeholder should have priority in this project - the client manufacturing company, the railways, the passengers or the cleaners. Another interesting observation was that all the designers considered addressing the problem of the newspapers that people leave behind in trains, as one of the key features in their subsequent design process. Despite this commonality of focus, a number of different designs were obtained. For instance, the system level at which they incorporate this idea in the end differs widely among designers: one can take the level of the whole train, a railway carriage or just a compartment as the scope of the design, or simply add a newspaper rack to a litter bin. That is to say that the perspective adapted by the designers led them to focus different areas of the problem as well as on solutions. Constraints on designing a system for the entire railway carriage as opposed to that for a compartment will certainly differ. The strategy and system level at which the problem is addressed, defines the context, from which subsequent constraints are to be derived. However, context does not fully constrain all the degrees of freedom. Considering an example from mechanics, if all the six degrees of freedom are fixed to make an object rigid, no solution is possible except the default one, which in most cases would mean not to design. Context produces a relevant bounded space for designing, specifying constraints, encompassing opportunities for creative and innovative solutions.

What is important to note here is that context is also a 'state of mind', the perspective imposed by an individual influenced by 'ground factors'. Thus to conclude, while context is what constrains a problem-solving - it is not just the mere collection of constraints, but rather the knowledge which helps to derive the constraints and increase the design space around them.

6 CONTEXT AND COGNITION

In addition to the many design methodologies originating from Germany, design theory has also inherited the Gestalt psychology from there. According to Gestalt psychology, the goal of problem-solving is to achieve a *Gestalt*, loosely translated as 'form' or 'configuration'. Gestaltists believe that thinking is much like perceiving. For them, finding a solution to a problem is like trying to see things from a different perspective. As problem-solvers our task is to mentally recombine the elements in a problem over and over again until a stable configuration or *Gestalt* is achieved [16]. This view was out rightly rejected by cognitive psychologists, who believe that problem-solving is not accomplished by insight, but rather is continuous [16]. The last decade has seen an intense interest in accommodating the principles from cognitive science in design education and practice. Some recent studies have focused on differences between the cognitive activities of experts as opposed to those of novices [35]. The following passages describe some of the cognitive science issues in relation to context and designing. One of the pioneers in the domain of cognitive psychology, Ulric Neisser, who wrote the first and the classical text titled *cognitive psychology*, defined it as [16]:

- Cognitive Psychology refers to all processes by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used.

The term in the above definition which is of concern here is *elaboration*. It refers to the task of connecting incoming information from stimuli to more specific or general representations. Elaboration may add more information to the current representation. The cognitive system establishes a context for the representation in question by elaboration. 'This context includes other representations, permanent or temporary, which are used to identify or interpret the incoming representation' [16]. This means that both consciously and unconsciously context is present in our cognitive space and thus in everyday experience. Best explains that, 'When we talk about the role of context in cognitive psychology, we mean the role that information surrounding a target might have in using a specific cognitive process'. He observes that, 'We use context in the broadest possible way to describe any environmental or internal stimulus that may be present at the same time as we are trying to learn and remember anything'. Another interesting fact is the bias produced by context, even though the context itself may not apparently be so encoded. Best cites the results of experiments from the literature, which shows that context possibly biases the memory system to create constructions and therefore pathways toward reconstructing specific memories. Several similar experiments in cognitive psychology have drawn the same conclusion that memory seems to be context dependent and that context improves the retrieval process. Coyne describes the theory of cognition in relation to design [36]. He uses the term *types* to represent the notion of categories, which he looks upon as generic descriptions of artefacts. Design can be then, he says, 'characterised as identifying the appropriate type for the particular context and then instantiating (exploring the scope of variation allowed by the type to arrive at a design instance)'. A promising development focusing on explaining the intimate interaction between cognition and designing is described by Gedenryd in his Doctoral thesis [37]. His thesis reveals the problem (shared by both the fields of design and cognition) of a discrepancy between the *received*, theoretical views of how things ought to work, and how they actually work in reality. He criticises that, 'design methodology portrays, or rather prescribes, design as an orderly, stringent procedure which systematically collects information, establishes objectives, and computes the design solution, following the principles of logical deduction and mathematical optimization techniques'. However, he says that discontent with this approach is widespread and quite old, even though no substantive replacement has yet been proposed. Then, moving to cognitive science, he argues that it's in a similar state. He explains that the conventional theories of cognitive science are highly sophisticated, most stringent in their form, and written in the language of computer science, mathematics, and formal logic. Pointing to the accumulating mass of evidence on design processes and cognitive performance under 'authentic' circumstances, he notes that, there is still an absence of a real theoretical alternative that can account for this growing body of knowledge. He argued in his thesis that, 'not only the mind but also action and the physical world have roles in cognition'. Kokinov presents a dynamic model of context formation [19]. He presents the definition of context in accordance to psychological studies.

‘Context is the set of all entities that influence human (or system) behavior on a particular occasion, i.e. the set of all elements that produce context effects'. But then he argues that these *elements* cannot directly influence human behaviour unless perceived and the corresponding internal representations built. Thus he refers to context as a set of internal or mental representations and operations rather than a set of environmental elements. In other words, context refers to the current *state of the mind* of the cognitive system rather than the state of the universe. He observes that the mental representations involved in the current context are formed by interaction between at least three processes – ‘*perception* of the environment that builds new representations and activates old ones; *accessing* and *reconstructing memory* traces that reactivates or builds representations of old experiences; and *reasoning* that constructs representations of generated goals, inferred facts, induced rules, etc.’ It is also assumed that context in turn influences perception, memory, and reasoning processes

The above discussion does indicate that better theories from cognitive science are required to describe the act of designing. The few results of importance here are that memory seems to be context-dependent for recall and recognition, those effects of context can be produced without the subject's intention and awareness, and that context seems to be fuzzy due to its dynamic dimension.

7 CONTEXT AND PHILOSOPHY

While the above sections dealt with approaches emanating from different worldviews, it is however necessary to deliberate on philosophical reflection on the subject of context. Hence, now is the time to revisit Dewey [11] because one of his concepts, *situation*, has been explicitly used by Schon in his theory of *reflection in action*, which has been under wide discussion in the design literature for the last decade. The notion of a problematic or indeterminate situation has a central role in Dewey's thought. Thinking, according to Dewey, ‘is a process of inquiry in which a confused, obscure, or conflicting situation is transformed into a determinate one’. Ekbia and Maguitman observe that [38], while this claim might be agreeable to many, the core idea behind it might not necessarily be so — namely the idea that situations are doubtful not only in a ‘subjective’ sense, but also in an ‘objective’ or non-subjective way. ‘It is the situation that has these traits (confusion, ambiguity, conflict, etc.). We are doubtful because the situation is inherently doubtful’. Context, according to Dewey, has two components:

- background, which is both spatial and temporal, and is ubiquitous in all thinking; and
- selective interest, which conditions the subject matter of thinking.

The background is that part of context that ‘does not come into explicit purview, does not come into question; it is taken for granted’. According to Dewey, relevance within a global context is determined by the individual inquirer.

- There is selectivity (and rejection) found in every operation of thought. There is care, concern, implicated in every act of thought. There is someone who has affection for some things over others; when he becomes a thinker he does not leave his characteristic affection behind. As a thinker, he is still differentially sensitive to some qualities, problems, themes.

Ekbia and Maguitman [38] quote Haugeland, who has argued that, ‘context informed phenomena ... are recognized for what they are, quite apart from any *independent* recognition of the context or of anything which is *in* the context’ [39]. In other words, the phenomenon and the context are recognized jointly, not as separate entities one happening inside the other. Ekbia and Maguitman further explain this, ‘A behavior such as a smile, for instance, could be understood either as reassuring or as a cautionary gesture, depending on the circumstances in which it is made’. Neither it is the case that one first recognizes a smile, nor that one first detects the context as such. ‘The context determines what the smile means as much as the smile defines and reinforces the context’. Haugeland calls this the *joint recognizability of instance-cum-context*.

Again the above discussion stresses the role of the individual in determining context. Dewey talks about context in the very broad sense of settings. He insists that relevance is directly determined by the selectivity of an individual, and at the same time the thought process in constrained by the spatial and temporal aspects. On the other hand, Haugeland unveils the dynamic nature of context. He also emphasizes that knowledge of context is neither only *a priori* nor only *posterior*, but is both. In other words he suggests that context is *emergent*.

8 DEFINING CONTEXT

The salient features of context drawn from the presented dialogue above should be sufficient here, to propose a new definition of context. Here the intrinsic question is: Why do we need context? The primary answer is - To interpret or make sense of incoming information from outside the body and/or the internal thought processes. Every second our senses, especially the eye, transmit about 11 million bits of 'information' to the brain. At the same time, our conscious experience processes only about 40 bits [40]. Thus, a major chunk of information is processed unconsciously. The cognitive processes transform the incoming information to the relevant one of which we become aware. The entire processing happens at the *neural level*, knowledge of which is absent at our *mind level* or, in other words we are unaware of it. This process of transformation which provides us with the relevant information and knowledge is aided by the world knowledge already existing beneath in our memory, which is termed as *categorical knowledge* in cognitive science. Once categorical knowledge has been applied, we have some idea about the object's (one under question) range of action, and we may have expectations about its behaviour [16]. Thus we establish the context. If we detach the term context into its two parts, [con]-[text], we come across a marvellous superimposition and not just juxtaposition. The Merriam-Webster dictionary traces the etymology of the word 'con' to the Middle English term *connen* - to know, learn, study. It defines the word 'con' in the transitive verb sense as - to study or examine closely. One of the meanings it provides for the word 'text' in noun sense is- a passage from an authoritative source providing an introduction or basis (as for a speech). Putting them together we can view 'context' as - to know or learn about the authoritative source providing a basis. Thus, in a sense, context provides us with a basis for the thought process.

Before moving further, let us examine closely the salient points from the discussions in the last sections. For AI, context seems to be puzzling because it possesses a dual nature - static or dynamic. In case of design which operates at the broader level of society, context appears to be pervasive. The intimate relationship between context and knowledge suggests that context is rather a special kind of knowledge, which constrains problem-solving as well as helps derive the constraints. Further, cognitive science studies suggest that context has often an unconscious and unintended influence on people's behaviour and that this happens continuously and is triggered not only by all sorts of incidental elements of the environment but also by the previous memory states. Philosophical perspective suggests that context relies on the subjectivity of the individual. One common factor running across the discussions in all the domains is the *individual*, *interpreter*, *knower*.

Now let us reconsider the informal definition of context presented at the beginning of section - 'the frame defining the occurrence of *something* in the coherent backdrop of *something*'. *Frame* means a structure, carefully chosen words or meaning; *definition* means description of features and limits; *occurrence* means something that happens, as well as the fact of something existing; *coherence* means logically or aesthetically ordered or integrated; and *backdrop* is the general situation in which the particular event happens. Put together it means - a structure describing features of something that happens or facts about something existing in an integrated way with the general situation. This description captures vaguely the dual nature of context as perceived by AI. Further it adheres well to the perspective of knowledge and constraints, though tacitly. What it does not account for is the unconscious effects described by cognitive science and, most importantly, the significance of the *individual* from the philosophical perspective. To conclude, this definition falls short of conveying the important elements of context and hence a better one needs be envisaged.

Based on the gamut of discussions presented above, this paper proposes a definition of context as - **Context is the frame of mind, defined by the individual's meta-knowledge and beliefs that are active at that particular instance, invoked to characterise an entity**. The elements that this definition of context comprises are necessary on the following grounds:

- Context is a frame because its scope and meaning are bounded; else it can expand infinitely causing regression.
- Context is in the mind, because an individual perceives. Environment may contain endless context elements, but unless perceived by a cognitive system, consciously or unconsciously, their effect is nil.
- Context inherently belongs to the individual. Though most of the time we share it, the sharing is never in its entirety. For instance, the significance of the Nobel Prize to a laureate and to a science student differs.

- Context comprises meta-knowledge. It is not the entire knowledge space of the individual, but knowledge pointing to the relevant and appropriate chunks at that instance.
- Context comprises beliefs, because it involves subjectivity which the individual may bring in at that instance.
- Active, because an individual has a whole range of meta-knowledge and beliefs, and certainly not all are instantiated at that instance.
- For a particular instance, because context is temporal as well as dynamic - context at that instance may trigger some action, and this, in turn, modifies the context of the next instance. The term *instance* provides varied resolutions - a step, stage, or situation viewed as part of a process or series of events.
- Characteristic, because aim is to achieve description of an entity, and context points towards such a relevant description.
- Entity signifies a person, place, object, subject, or situation whose interpretation is required.

The definition of *context* proposed above explicitly includes the individual and his/her meta-knowledge as well as beliefs. It may be argued that this definition does not fit the general usage of the term context where no explicit mention of the individual is made. Keeping in mind that context is always related to an individual's interpretation, the definition can then be simplified for informal usage as: **Context is the frame of mind invoked to characterise an entity**.

9 DISCUSSION

Definition is a statement expressing the essential nature of something. The definition of *context* proposed in the last section clearly takes the advantage of various debates about the notion of context, already present in different domains of study. For example Brezillon's definition that, 'Context is what constrains a problem solving without intervening in it explicitly', talks about what context does, but does not provide details of what context is [17]. The definition by Kokinov that, 'Context is the set of all entities that influence human (or system) behavior on a particular occasion', does not talk about the spatial aspect of context, and the elements constituting the set [19]. The definition of context proposed here using the notion of frame of mind, meta-knowledge, and beliefs well describes these factors. Thus, by integrating the various worldviews, the definition proposed here is inclusive as well as generalizable. The generalizable nature of definition is due to its ability to answer the five basic questions - what, when, where, why, and how. It is this generalizable nature, which in general is lacking in the various definitions discussed from the literature. However, the proposed definition is based on an important argument that individual's role is central to define the context, the opinion which is held in most of the domains in which, context has been studied. To claim that epiphany has been achieved in any theoretical interpretation, is no less than a fallible hypothesis and would be foolhardy. The definition of *context* proposed in last the section is rather a conflation of critical elements of the understanding of context from different domains. It is believed here that this definition will pave a way to better understand context and its interrelationship that with designing [8].

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