Context and Design Agents

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Abstract. Informal notions of context often imply much more than that captured in many computational formalisms of it. The view presented in this paper, built on our understanding of designing, is of context being larger than any one agent's representation of it. This paper describes how for an agent's reasoning about context it is the current situation that determines what the agent's interpretations of context are, not the reverse. The paper presents a typical scenario involving collaborating, sketching designers.

1 Introduction

Context is one of those words, like "life" [1], for which there is no universally accepted definition. Akman and Surav [2] on "context":

> "denotation of the word has become murkier as its uses have been extended in many directions and deliver the now widespread opinion that context has become some sort of conceptual garbage can "

Benerecetti et al. [3] on "context":

> "It is sort of commonplace to say that any representation is context dependent. By this, it is generally meant that the content of a representation cannot be established by simply composing the content of its parts"

Fields like AI present context formalisms that tend to mean much less by "context" than less formal, common sense descriptions would indicate. In this paper we present a view that builds on our understanding designers and design agents. Designing is the conscious effort to impose meaningful order [4, quoting Victor Papenek]. Conceptual designing is an early phase of design characterised by abstractness and an incomplete understanding of the problem and/or solution [5]. Designers cope with this by exploring the space of design requirements at the same time as they begin to try and understand the space of conceptual designs. Such designing has been labelled creative when the space of possible designs must be extended before a satisfactory design is found. This is achieved by interacting with the media of the conceptual designs as exemplified by Schön's [6]

"conversation with the medium". In this paper we start from our understanding of designing, describing a view of context that is bigger than any one agent's representation of it. We also describe how for agents to reason contextually, it is the situation that determines what interpretations of context are and not the reverse. A situation is a rich set of ideas and an interpreted context is the lesser by comparison. We finish by presenting a typical scenario involving collaborating, sketching designers.

2 Outside the box

The best known AI approach to context would likely be that of McCarthy [7]. This defines a relation $ist(c\,p)$ asserting that a proposition p is true in context c. Context here is an abstract, first-class mathematical entity in the style of a fluent. The "attitude" taken by McCarthy is a "computer science or engineering one":

> "it seems unlikely that this study will result in a unique conclusion about *what context is*" [7, emphasis is McCarthy's].

What *ist* does is introduce some *mathematical* context dependence. We don't find this to be very satisfying, partly because not saying what something is risks formalising the wrong thing and partly because we believe that this approach misses something important. Benerecetti et al. are correct: just saying that a representation is context dependent probably doesn't say much by itself.

The metaphor for context that Benerecetti et al. borrow is a box. Inside a box are expressions and outside of the box are parameters with values. Something inside the box is context-dependent when you need something outside of the box to determine what it means. Good examples are natural language texts using indexicals, like "I saw her yesterday".

The obvious question is why place some expressions outside of the box and some inside? One answer is that techniques like using indexicals have clear benefits not only to language but to an agent's interactions generally (think of deictic references). According to Perry, indexicals are expressions whose designation shifts from context to context. Consider the sentence "now I will tell her". The designation of *now* is [8]:

$$(u \text{ designates } t) \iff \exists x\,(x \text{ is the speaker of } u \wedge x \text{ directs } u \text{ at } t \text{ during part of } t)$$

So by this metaphor the (u designates t) goes in the box as does, presumably, the rule from the right of the if-and-only-if symbol. What the x, u and t designate go outside of the box. Now meaning is a property of types of expressions rather than of individuals, whereas content is a property of individuals [8]. So the meaning of (u designates t) is understood without having anything outside of the box, but the content of (u designates t) is only understood when x, u and t are known.

Another problem is that what (x is the speaker of u) and (x directs $u \ldots$) mean have their own contextual concerns, as do any objects associated with this meaning. Further, the context at the time of writing or speaking "now I will tell her" will differ from the context at the time of hearing or reading it even if the communicating parties designate x, u and t as the same external entities. Hence the concern of Derrida that "a context is never absolutely determinable, or rather ... its determination is never certain or saturated" [9].

Dewey [10] described context as having a number of aspects that can be collectively called background and selective interest. Ekbia and Maguitman [11] summarise this nicely with the graph reproduced as Figure 1. Background context influences the behaviour of an agent without it being the target of explicit reasoning. A good example, in this case of existential background context, are the un-modelled environmental influences on a sensor. Such background context is anything that influences behaviour that the agent does not explicitly reason on. The context of an agent's experiences is context of the system, and that which an agent reasons as being the context is the interpreted context. There is background context but it is partly in the agent and partly not. Selective interest

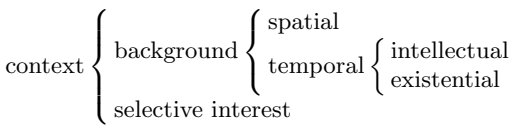

Fig. 1. Aspects of context, after [11]

is the attention and subjective biases of an agent:

> "Everything which exists may be supposed to have its own unduplicated manner of acting and reacting, even atoms and electrons, although these individual traits are submerged in statistical statement. But in any event that which I have designated selective interest is a unique manner of entering into interaction with other things" [10].

Much work on context uses natural language as examples. The risk is that such texts come supplied in a symbolic form and consequently "what is context" gets recast as deciding the content and meaning of those symbols.

To see why we consider this to be a problem, consider designing tasks. Figure 2 is an example of a designer thinking with pen and paper [12]. Such drawings may contain visual and non-visual signifiers plus other shapes that are not intended to signify anything. They do not come pre-supplied in symbolic form. These sketching activities are part of dialogue between the designer and the drawing; they are of a dialogue even if nobody else is present as the designer sketches. Drawings like this are often part of a sequence and have contexts that are part of the process of conceptual designing and of communicating. There are sequences of sketching actions within one drawing and there are sequences of

past drawings that the designer may or may not refer back to. The following is the architect and engineer Santiago Calatrava describing how he designs:

> "To start with you see the thing in your mind and it doesn't exist on paper and then you start making simple sketches and organizing things and then you start doing layer after layer ... it is very much a dialogue" [13].

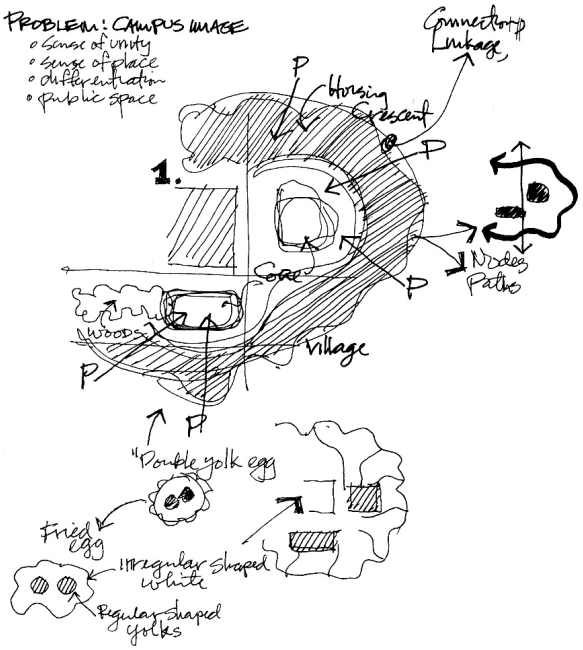

Fig. 2. Designer drawing, taken from [14], of a conceptual design of a proposed site.

The drawing of Figure 2 includes text labels that highlight a design metaphor in use (of providing a "sense of unity" to distinct artifacts via a "double yolk egg" metaphor) but this certainly need not be the case. In a collaborative designing session such sketches will constitute a conversation along with the concurrent verbal communication and so the text labels may not be included. Shapes in such sketches need not depict two or three dimensional forms and need not be associated with concepts in the concurrent verbal communication, if there is one.

> "In many cases their drawings contributed relatively little to the meaning simultaneously conveyed verbally, and in most cases the drawing made almost no sense at all when viewed out of the context of the conversation" [13].

Neither of these drawings comes supplied as a particular sequence of symbols to be interpreted, and both involve visual signifiers (sketched shapes) and non-visual signifiers (text). Even to a single designer there are many ways to look at these sketches, and research evidence suggests that designers "get inspiration and ideas from their drawings that they did not imagine in advance" [12]. Each designer interprets the context according to the situation as they understand it.

We can step back from designers and drawings by modelling designers as agents interacting with one or more worlds. The environment ξ is taken to be a set of entities aggregated into one or more worlds. Some of these entities are agents (denoted $\mathfrak{a}_1, \mathfrak{a}_2, \ldots$) and some are things (denoted $\gamma_1, \gamma_2, \ldots$). Designers have bodies and a nervous systems, although for agents we call these agent-things (denoted $\alpha_1^1, \alpha_1^2, \ldots, \alpha_2^1, \ldots$) and constructs (denoted $\beta_1^1, \beta_1^2, \ldots, \beta_2^1, \ldots$) respectively. The reason for allowing ξ to contain multiple worlds is to allow the description of designers in different space-time locations to collaborate via a virtual world.

The role of context extends well beyond designers sketching. Someone who had never seen a baseball game would probably still hold the bat at the correct end and swing it with both hands [15]. To a chimpanzee, a stick can be a tool for collecting termites [16]. By Kirsh:

> "Agents "seed" the environment with attention-getting objects or structures. These can be harnessed to not only reduce perceived choice but to bias the order in which actions are undertaken ... Such features work because we have sufficient knowledge of our tasks and plans that when, in the course of activity, we notice these felicitous events, or surprises, we are reminded of aspects of our tasks that must be performed" [17].

The classic cognitive work on this is by Gibson on affordances and the use of contextual cues. The message here is "artifacts mean what their contexts permit" [15].

Context as described is not just something in the "mind" of a designer. The context of a drawing (a thing) is not a representation by the sketching designer (agent); it emerges from interactions between the designers, from what is currently on the drawing, from the sequence of sketch acts until now, and from other recent drawings that led to the currently attended one. It also emerges from that coffee that Mungo did not get this morning, from Boris noticing that the sun shining through that dirty window makes a nice pattern, from ...; that is, from influences of other entities on the agents, whether they are aware of them or not. Viewing context in these terms means viewing it as emerging from the aggregation of interacting entities that is ξ. The context is to do with entities in the environment that influence entities with which the agents interact.

Consider a transducer in a sensor as an example from a different domain. There may be many environmental influences and other effects that may not be in the model of the sensor but which nevertheless are part of the context of sensing the environment. Such effects were highlighted by Beer in his dynamical systems agent model [18]. They include effects of variations in temperature,

pressure, viscosity etc.; limits and drifts in zero or sensitivity; invalid assumptions of linearity or similar, noise, interference, hysteresis or aliasing; use beyond designed limits; mechanical wear; and so on. The same idea goes for the CPU and the memory of the agent (temperature limits and nonlinearities, etc.) - all of these are influenced by the environment.

At the location and time at which Figure 2 was drawn there was a context that was of the system of interacting agents (designers) and non-agent things (paper, pens, and so on) that was that world at that time. For that set of designers at that particular time and location there was a context, but each designer had their own view of the situation and so their own interpretation of the context. So we come to a crucial consideration in our view: that there are contexts, there are situations, and there are interpretations of contexts.

The difference between situations and contexts are that a situation is a characteristic of a system of interacting agents and things but it does not exist without there being an agent present to interpret it. If I strike a tuning fork, waves of air pressure result. If I ping a sonar, waves of water pressure result. These are part of the context but neither of these waves are sounds. Sound requires a sensor (an ear or microphone) and perception, and interpreting sequences of sounds as music requires conceptual reasoning. Now agents are embodied in world(s) that they can only experience indirectly via sensors and effectors. That being so, it must be the agent that individuates what is in the environment and situations must be interpretations of an agent. Recognising that there is a situation is like recognising that there is music, and so requires an agent: situations are of the system but exist only within agents.

So there is a context, but as agents individuate what is in the environment, there is for each agent an interpreted context. An interpreted context is those representations whose designations depend on the situation. Notice that we distinguish the interpreted context of an agent from the situation for that agent. An interpreted context is something that the agent is involved in and is something of a passive notion. A situation is something that the agent is involved with and is something of an active notion. But what is this context? We could try to say something like "the context for agent $\mathfrak{a}_i$ is all of those entities that influence the behaviour of $\mathfrak{a}_i$ but that it is not necessarily aware of or is not focused on". The problem is that it is an agent that individuates what is in the environment so we prefer to talk of how the agent is coupled to its environment. We want a description of context that suits our constructive, situated notions of agency and that tends to notions of processes rather than to a reductionist enumeration of environmental objects and properties. The basis of our views on agency, memory and context are experiences.

Dewey described the quality of an experience as having two aspects called continuity and interaction:

> "The principle of continuity of experience means that every experience both takes up something from those which have gone before and modifies in some way the quality of those which come after" [19]

> "Experience does not simply go on inside a person. It does go on there ... but this is not the whole of the story. Every genuine experience has an active side which changes in some degree the objective conditions under which experiences are had" [19]

An experience is only an experience if it is of an embodied agent. It is to do with interaction of the agent with an environment. An experience is also not something static; it is dynamic and is of certain kinds of entities that are coupled to their environment. A coupling between ξ and an agent-thing α_i is an e-experience (an exogenously generated experience) of $\mathfrak{a}_i$. An example is robot navigation experiences involving sonar sensual experiences and motion effectual experiences. Denote an experience of agent $\mathfrak{a}_i$ as $\mathfrak{e}_i^k$. An e-experience involves entities perturbing each other, where one of the entities is an α_i and the other is either another agent $\mathfrak{a}_j \neq \mathfrak{a}_i$ or a thing γ_m. A coupling in $\mathfrak{a}_i$ between the agent-thing α_i and agent constructs $\{\beta_i^j\}$ is an a-experience (an autogenously generated experience) of $\mathfrak{a}_i$. An a-experience also involves entities in an agent perturbing each other, where one of the entities is an α_i but where the others are constructs $\{\beta_i^j\}$.

For one experience to perturb another requires two things: that experiences can have parts that are themselves experiences, and that some experiences can be parts of multiple experiences. An experience that is a part of, but not identical to, another experience is a proper part. An experience with no proper parts is atomic. If the experience is temporally atomic but spatially not, we call it an event (Something spatially atomic but temporally not is an entity). Two experiences with one or more common parts are said to overlap. Experiences that perturb each other must overlap. Experiences are disjoint if they never overlap. An experience $\mathfrak{e}^x$ is emergent[1] from experiences $\{\mathfrak{e}^y | y \neq x\}$ if:

- $\mathfrak{e}^x$ is a part of the sum of $\{\mathfrak{e}^y | y \neq x\}$
- No part of $\mathfrak{e}^x$, including itself, is a part of any $\mathfrak{e}^y$ (for $y \neq x$)

We write $\mathfrak{e}^x \sqsubseteq \mathfrak{e}^y$ to mean "experience $\mathfrak{e}^x$ is a part of experience $\mathfrak{e}^y$". We write $\mathfrak{e}^x \sqsubset \mathfrak{e}^y$ to mean "experience $\mathfrak{e}^x$ is a proper part of experience $\mathfrak{e}^y$". We write $\mathfrak{e}^x \bigcirc \mathfrak{e}^y$ to mean "experience $\mathfrak{e}^x$ overlaps experience $\mathfrak{e}^y$". So

$$\mathfrak{e}^x \sqsubset \mathfrak{e}^y \widehat{=} (\mathfrak{e}^x \sqsubseteq \mathfrak{e}^y \wedge \mathfrak{e}^x \neq \mathfrak{e}^y)$$
$$\mathfrak{e}^x \bigcirc \mathfrak{e}^y \widehat{=} (\exists \mathfrak{e}^z \bullet \mathfrak{e}^z \sqsubseteq \mathfrak{e}^x \wedge \mathfrak{e}^z \sqsubseteq \mathfrak{e}^y)$$
$$perturbs(\mathfrak{e}^x, \mathfrak{e}^y) \implies \mathfrak{e}^x \bigcirc \mathfrak{e}^y$$

These relations can be generalised to processes in the manner of [20]. Let the type of experiences of $\mathfrak{a}_i$ be E_i such that $\mathfrak{e}_i^1, \mathfrak{e}_i^2, \ldots \in \mathsf{E}_i$. Let P be the type of processes of entities or processes emerging from interactions of entities. Given these, we say that a coupling of an e-experience of $\mathfrak{a}_i$ is where some part of an experience of $\mathfrak{a}_i$ overlaps a process not of $\mathfrak{a}_i$. Let $exp(\mathfrak{a}_i) \in \mathbb{P}\mathsf{E}$ find the experiences

[1] This formulation of process emergence is derived from [20], where it is defined more precisely, as are the part-of and overlap relations.

of agent $\mathfrak{a}_i$, where $\mathbb{P}$ denotes a power set. Let $is\_eexp(\mathfrak{a}_i, \mathfrak{e}_i)$ be true only if $\mathfrak{e}_i$ is an e-experience of agent $\mathfrak{a}_i$, and let $is\_aexp(\mathfrak{a}_i, \mathfrak{e}_i)$ be true only if $\mathfrak{e}_i$ is an a-experience of agent $\mathfrak{a}_i$.

$$is\_eexp(\mathfrak{a}_i, \mathfrak{e}_i) \iff \exists p \in \mathsf{P} \bullet p \notin exp(\mathfrak{a}_i) \wedge p \bigcirc \mathfrak{e}_i$$
$$is\_aexp(\mathfrak{a}_i, \mathfrak{e}_i) \iff \mathfrak{e}_i \in exp(\mathfrak{a}_i) \wedge \neg is\_eexp(\mathfrak{a}_i, \mathfrak{e}_i)$$

These e-experience overlaps may be of sensors (causally from the environment to the agent) or effectors (causally from the agent to the environment).

The notions of an agent at time t are its experiences restricted to that time. A trajectory is these $n \in \mathsf{N}_i$ changing over time. These notions are what an experience is if we fixate it at a particular time $t \in \tau$. The fixation is a function from E_i onto a subspace that has meaning to the agent. We use the word "notion" to maintain independence from any particular kind of agent representation. Any subset of N is a notion, including $\emptyset$ and N_i itself, as is the intersection of two notions, and a notion may itself contain other notions.

We are now in a position to say what we believe context to be. Let $path(e, p)$ be true only if there is from e to p a sequence of overlapping experiences and processes. Then the context is

$$context = \bigcup_{i \in agents} context(\mathfrak{a}_i)$$
$$context(\mathfrak{a}_i) = \{e : \mathsf{E}_i; p : \mathsf{P} \mid e \in exp(\mathfrak{a}_i) \wedge path(e, p) \bullet p\}$$

Sensing and effecting processes of things and other agents are parts of e-experiences, and interpreting sketch processes (such as of ink on paper) as depicted objects are parts of a-experiences. These processes and experiences are part of the context of the interaction of an agent with its environment.

The situation current at a time is an influence on how the world is viewed and so will direct the attention of the agent to some of the interpretations in the a-experiences of that time. Notice that the situation is not "a view of the world"; it is a process that changes how the world gets viewed. Let a target experience be that experience if the role of the situation is ignored, and call it $\mathfrak{e}_i^{k\emptyset}$ (the un-situated experience). The experience $\mathfrak{e}_i^k$ is the target experience after the influence of the situation with respect to one or more other experiences are included. That is, in this document an experience is situated unless it is explicitly denoted otherwise such as in $\mathfrak{e}_i^{k\emptyset}$. The type of situations is Ψ such that $\psi_i^1, \psi_i^2, \ldots \in \Psi_i$. The type of experiences of $\mathfrak{a}_i$ is E, so situations Ψ_i are functions from notions N_i and experience E_i to a result that is also a E_i.

$$\Psi_i : \mathsf{N}_i \to \mathsf{E}_i \to \mathsf{E}_i$$

The current situation as seen by an experience $\mathfrak{e}_i^{k\emptyset}$ is one or more functions Ψ that each use another experience to influence this one.

Given these we say that background context is that part of context that is not selective by an agent. Selective context is those situated a-experiences that the agent is attending to. Without going into more detail here we just say that

it is some of those a-experiences that depend on the situation for their values. For agent $\mathfrak{a}_i$,

$$
\begin{aligned}
&\mathit{selective}(\mathfrak{a}_i) \subseteq \{e_1, e_2 : \mathsf{E}_i; n : \mathsf{N}_i \\
&\qquad\qquad \mid (\exists \psi \bullet e_1 \in \mathit{exp}(\mathfrak{a}_i) \wedge e_2 = \psi(n, e_1) \wedge \mathit{is}_a\mathit{exp}(\mathfrak{a}_i, e_2)) \\
&\qquad\qquad \bullet\ e_2\} \\
&\mathit{background}(\mathfrak{a}_i) = \mathit{context}(\mathfrak{a}_i) - \mathit{selective}(\mathfrak{a}_i) \\
&\mathit{interpcontext}(\mathfrak{a}_i) = \\
&\qquad \{e : \mathsf{E}_i \mid \mathit{is\_aexp}(\mathfrak{a}_i, e) \bullet e\} \cap (\mathit{selective}(\mathfrak{a}_i) \cup \mathit{background}(\mathfrak{a}_i))
\end{aligned}
$$

Akman and Surav [2], quoted earlier, are two of a number of researchers seeking to formalise ideas like context in terms of the "situations" of Situation Theory. That theory has some notions that we find to be appealing, such as that an environment is individuated by an agent into objects on the basis of perceived uniformities. An object is a uniformity across situations, where a uniformity is a locally predictive coherence [21]. However that which situation-theorists call a "situation" we regard as a mathematical entity along the lines of McCarthy's "context". Perhaps it should be given another name along the lines of "fluent". Situation-theorists like Barwise [22] and Devlin [23] tend to be realists: there is a "real world" that agents are situated in, that world is objectively a certain way, and a situation theory expression is a description of how that world actually is.

> "Situations are parts of the world and the information an agent has about a given situation at any moment will be just a part of all the information that is theoretically available ... situations are taken to be real, actual parts of the world, and the basic properties and relations the situation semantics deals with are taken to be real uniformities across situations (and not bits of language, ideas, sets of n-tuples, functions, or some other mathematical abstractions)" [23].

This idea that situations are actual parts of the world is one that we do not accept. To us a situation is something constructed by an agent, and a context is something that emerges from the aggregation of agents and things that is the environment but that which agents have no direct access to. We do not accept a Situation Theory notion of "situation", neither do we accept a Situation Theory notion of "context".

3 Experiences and Interpreted Contexts

For descriptive purposes we build this section around an invented design scenario inspired by our past experiences (such as [24]) with protocol sessions involving real designers and by Figure 2. The reason for inventing a scenario is that the size and complexity of a real scenario would obscure what is important in these descriptions. In this section, descriptions of the scenario are disguished *by this font.*

There are two designers collaborating on a design task. The brief is for the design of buildings and other artifacts on a site at a university campus that is to be publicly accessible. The functions required of these artifacts are disparate but broadly divide in two groups, so the groups should be differentiated some how. An overall sense of unity and place is required despite how disparate the artifacts composing it may seem.

There are two designers, and we model designers as agents, so there are at least two agents that we can denote as $\mathfrak{a}_1$ and $\mathfrak{a}_2$.

One designer is sketching, of which Figure 2 is the most recent drawing. Both designers are communicating verbally. Both designers are communicating non-verbally by looking and at the sketches and gesturing.

Apart from $\mathfrak{a}_1$ and $\mathfrak{a}_2$, ξ contains things. Among these things are the sketches $\{\gamma_s^k\}$ and a pen γ_p. We only need consider one world for this scenario, which we denote ω_o for "the world that contains the office".

$$\{\mathfrak{a}_1, \mathfrak{a}_2, \gamma_p, \gamma_s^1 \ldots \gamma_s^k\} \subseteq \omega_o \subseteq \xi$$

Let γ_s^k be the last of these sketches to have been drawn and let it be as shown as Figure 3.

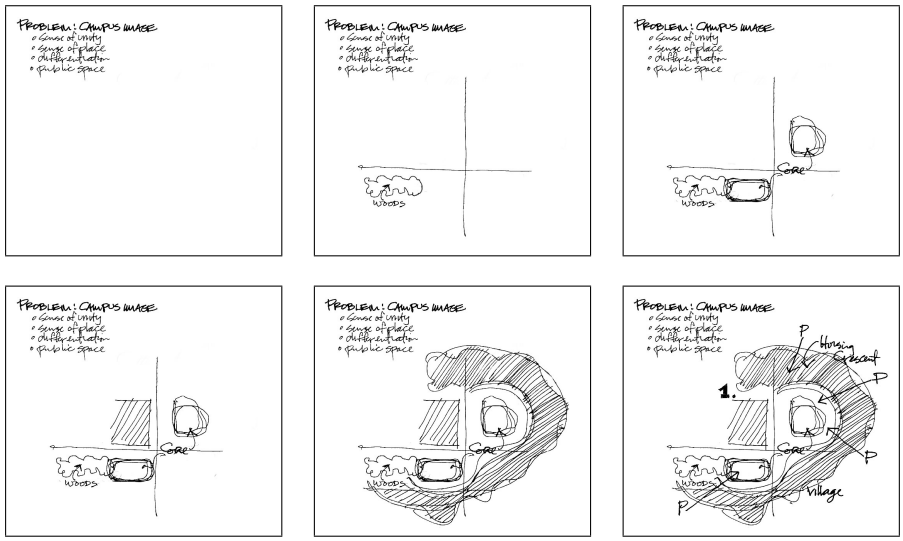

Fig. 3. Thing γ_s^k shown as six frames of the process of sketching that led to Figure 2. The sequence is of time increasing left-to-right starting from the top-left.

Designer $\mathfrak{a}_1$ is sketching on γ_s^k and so controls the depiction of text and non-text signifiers on that drawing.

Providing that $\mathfrak{a}_1$ isn't sketching randomly, $\mathfrak{a}_1$ must be both reasoning and interacting with γ_p and γ_s^k. The agent is experiencing this interaction and reasoning. Designer $\mathfrak{a}_1$ looks at the drawing and at the tip of the pen as they sketch. So there are sensor couplings (process overlaps) from both pen and paper processes to e-experiences, and there are effector couplings from e-experiences to pen-processes. Consider the fourth frame of Figure 3. At that time there are a number of processes that overlap the visual sensor e-experiences of $\mathfrak{a}_1$: processes of the paper, the pen, the existing ink on paper (third frame), the new ink on paper and so on. This includes processes that clearly are attributable to particular things as well as well as emergent processes; the same applies to experiences. The sketched characters "woods" and the corresponding shape that appears at the second frame are example processes or parts of processes of γ_s^k. There are also processes that overlap the effector e-experiences controlling γ_p. Further, other less obvious processes influence the behaviour of the paper, pen and designer, and other even less obvious processes influence these in turn. Sensing and effecting these processes are part of an e-experience, and interpreting them as depicted objects are parts of a-experiences. These processes and experiences are part of the context of this interaction, distinct from the processes of "woods" noted above. The situation current at the time of the fourth frame will direct the attention of the agent at that time to some of the interpretations in the a-experiences of that time. These are the selective interest $selective(\mathfrak{a}_1)$, and the background is those processes and experiences of $context(\mathfrak{a}_1)$ that are not selective. The current interpretation of the environment, the interpreted context and the entities attended all depend on the situation at that time.

Designer $\mathfrak{a}_2$ is looking at the sketches, gesturing and talking to designer $\mathfrak{a}_1$.

E-experiences of designer $\mathfrak{a}_1$ include communication sense-data and effect-data with respect to designer $\mathfrak{a}_1$, and a-experiences of designer $\mathfrak{a}_1$ include interpretations of these e-experiences. Designer $\mathfrak{a}_2$ is communicating with $\mathfrak{a}_1$ and is looking at γ_s^k and γ_p but is not effecting control on γ_s^k and γ_p. The designers are autonomous so they each have their own interpretation of what is in the environment and each have their own interpreted context. We could describe the verbal communications as speech acts the content of each communication would not be understood without understanding the context. The success of a speech act doesn't guarantee that either party understood what the other really meant. The same applies even more strongly for gestural communication as it relies on each agent interpreting the sketches and gestures to them the same way.

The designers have previously been briefed and are now working on the conceptual design when they reach an impasse. They have ideas for the partial conceptual design of a pair of buildings, and structuring the site as this pair seems to achieve the differentiation requirements. Somehow, though, they need to achieve an overall unity and sense of place. Trying to cross the impasse, they begin reframing.

Reframing is one of the techniques used in creative designing when an impasse is reached. One important way of reframing is suggesting and following alternative metaphors for a situation [15]. A-experiences of the designers are

constructed "on the fly in a situated way" [24]. Applied to the reframing example, this is

- partly bottom-up as a sketching designer thinking with pen and paper, and
- partly top-down by recognising a change in the current situation by shifting an analogy or metaphor.

This works by suggesting and following up different analogies and alternative metaphors for a situation. The case of Figure 2 is applying a visual metaphor. A metaphor change may be a case trying to re-interpret an entity using different concepts but sketching and perception are situated, interactive processes that these visual metaphors rely on. Visual metaphors are subjective and rely on the interpretation of the viewer in the current situation. They are not objective, observer-independent interpretations [15]. $\mathfrak{a}_2$ may suggest the double yolk egg metaphor and $\mathfrak{a}_1$ may sketch it but that doesn't guarantee that they understand either the suggestion or the sketch the same way. Further, if the site being designed was built it would be its visitors that judged the meaning of the built artifacts. The visitors may or may not be aware of the metaphor; indeed, the designers may or may not prefer it that way.

> "Designers may well convince themselves that they have "found" a metaphor, but it may well mean nothing to users unless it brings familiarity to the design" [15].

Perhaps $\mathfrak{a}_1$ and $\mathfrak{a}_2$ want it to look that way, or perhaps the metaphor was just a device to bridge the impasse.

Designer $\mathfrak{a}_1$ notices in the sketch (Figure 3 frame 3) a pair of similar cores surrounded by "whitespace", and that triggers a different way of thinking about core/yolk and whitespace/white.

Work by Suwa et al. [24] shows that unexpected visuo-spatial discoveries and cues can trigger different interpretations of the functions supported by a design. Expressing the designer protocols of Suwa in our terms, we could say that there are four kinds of experiences:

1. Physical experiences: e-experiences perturbed by external processes or a-experiences; approximate Suwa's physical actions such as depicting shapes, looking at previous depictions, gestures and movements of the pen.
2. Perceptual experiences: e-experiences perturbed by e-experiences; approximate Suwa's perceptual actions such as attending to spatial relations and comparing depicted elements.
3. Functional experiences: a-experiences; approximate Suwa's functional actions such as exploring design issues between artifacts and considering the psychological reactions of people. They may be perturbed by physical experiences or by perceptual experiences.
4. Conceptual experiences: a-experiences; approximate Suwa's conceptual actions making aesthetic evaluations, setting goals and recalling knowledge.

Knowledge, strategies and goals sometimes trigger design actions, but physical or perceptual actions also trigger design actions.

As designers $\mathfrak{a}_1$ *and* $\mathfrak{a}_2$ *looking at, gesturing and sketch on* γ_s^k *they interpret the world* ω_o *of* γ_p *and* γ_s^k *whilst concurrently imagining a world* ω_o' *that is yet to exist.*

Designing as an activity is more complex than sketching a representation of existing artifacts because the sketching designer must imagine a world that is yet to exist. There is, as described, the world ω_o containing $\mathfrak{a}_1, \mathfrak{a}_2, \gamma_p, \gamma_s^k$ and so on. There is a context with respect to ω_o as well as an interpreted context of each designer. There are also, for each designer, one or more imagined worlds. Further, if the designers are collaborating across space or time in our world there may be an additional virtual world.

What is imagined depends on the situation and each designer interprets γ_s^k as a building site with existing buildings, the woods, the shape of the crescent for the housing, etc. according to their interpretation of the current metaphor and context. Some of this interpretation is of those a-experiences that are what the agent is currently attending to, and so the agent's selective interest depend on the situation and changes over time.

4 Conclusion

The use of context by many that study linguistics and AI is impoverished compared to the notions needed to describe activities like designing. Such formalisms tend to mean much less by "context" than less formal, common sense descriptions would indicate. Some mean much more by context but, in our view, often conflate contexts with situations by describing the benefits of situated action and reasoning but by then labelling this as context. Our view follow from work on understanding designers and design agents. These are interesting not only because of their potential for developing systems and tools for designers but also because designing is notoriously difficult to describe in cognitive or AI terms. Our view is that context is bigger than any one agents representation of it, and that when agents reason contextually it is the situation that determines what interpretations of context are and not the reverse. A situation is a rich set of ideas and an interpreted context is the lesser by comparison.

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