Technology-led human development:
From ability to capability

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Abstract: The capability approach seeks to serve as a better alternative than human rights for approaching the issue of sustaining human development (sustainability) as a human capability. The expansion of capabilities valued by people in the context of their development is said to usher appropriate human development. Concerns of unsustainability are frequently attributed to the consequences of anthropogenic use of technology since the industrial revolution. If technology is seen to expand human capabilities, the fact that the consequences of its use result in unsustainability requires clarification. In an attempt to clarify, this article argues for distinguishing ability from capability and understanding tool as the means for extending abilities to capabilities. Design specifies the process of extension and technology is defined as the context of extension, generally. From the perspective of design, this paper discusses the expansion of capabilities as extensions of human abilities to capabilities for their development.

Keyword: ability, capability, tool, extension, technology, sustainability, design

1   Introduction

Prior to the WCED definition, sustainability is conceptually founded in a human rights and dignity core. Synonymous with the goals of human development, Articles 22, 26 and 29 of the UNDHR provide for the free and full development of the human personality. The intellectual issues that human rights discourse needs to overcome are not new and remain so affecting interpretations of human development, as sustainability is based in rights. Seeking to address these intellectual issues, the 'capability approach' is positioned as a better alternative to understand human development. *The process of development is not separable from the expansion of human capabilities for its intrinsic as well as instrumental value* (Sen, Development thinking at the beginning of the 21st century, 1996). Urgent concerns of unsustainability are frequently attributed to the consequences of anthropogenic use of technology since the industrial revolution (IPCC). If technological competence is considered fundamental to human existence, expands human capabilities and enables human development (Burke & Ornstein, 1995), the fact that consequences of the use of technology result in unsustainability requires clarification. This brings us to question whether sustainable human development (sustainability), in the context of being technology-led, is actually a (technological) capability that we should be

wary of wielding or an ability that resides more equitably, i.e. innately and universally, with all members of humanity. The WCED report pitches sustainability as ability, not of the individual but of humanity (Brundtland, 1987) to sustain human development. It is to be understood whether such ability exists innately (nature) or is learnt (nurture) akin to Sen's observation of Smith's remark on education being peculiar (Sen, Development thinking at the beginning of the 21st century, 1996). That anthropogenic change has affected the habitability of the earth helps us infer two possibilities: PosA, that we were oblivious to this fact while pursuing development so far, and; PosB, though we had knowledge of the consequences of our[1] actions we were not heeding them enough. PosB provides a case for the developing and underdeveloped nations to question the developed nations of shirking responsibility for a planet-wide humanitarian concern. More contemporarily, a similar behavior has led the European Commission to try UK for breaching an obligation to improve its air quality (McGrath, 2014). When technology-led developed nations falter, reason to believe in PosA is strengthened though we can no longer claim ignorance (Dechert, 2014). This also leads us to infer that sustainability can be a belief in our ability to conduct ourselves in full awareness of the consequences of our actions. Though the belief may have arisen from our technical capability to intervene into systems of the scale of the earth's systems for example, through climate engineering, geo-engineering etc., the degree of control that can reside with us post an intervention of such global magnitude is something that the intellectual circles are divided and uncertain about (Matthews & Caldeira, 2007) (Silver, et al., 2010). Proposals to counter global warming involving intervening into the ocean system are also exemplary in this regard. This brings us to question whether sustain'ability', in the context of being technology-led, is actually a capability that we should be wary of wielding or an ability that resides more equitably with all members of humanity.

The prevention and remedial of select consequences of technology is the subject matter for sustainability while it is also admitted that the ontology of sustainability is strange (Ehrenfeld, 2009). Further to the ontological status of artifacts espoused in philosophy (Hilpinen R. , 1992) (Thomasson, 2007) (Hilpinen R. , Authors and Artifacts, 1993) and gathering from cognitive ideas treating even language as an artifact (Clark, Is Language Special? Some remarks on control, coding and co-ordination, 2004) (Wheeler, 2004) enabling the extension of the mind (Clark & Chalmers, The Extended Mind, 1998) (Clark, Supersizing the Mind: Embodiment, Action, and Cognitive Extension, 2010), this article argues for conceiving all artifacts, authors and authorship as tools, tool-users and tool-making respectively. This conceptualization of tool is extended backwards to understand the ontological status of human being(n) and being(verb), as 'tool' and 'tool-use', respectively towards understanding/disclosing the entangled, co-constitutive relationship which humans and technology are in. This conceptualization enables understanding the role of design in the context of technology led transitions to sustain human development.

Section 2 describes the method for this inquiry. Section 3 elaborates on ability as pertaining to agents in general and to human constitution or being. Further it defines capability, technology and design broadly. Section 4 describes tools generically, as are artifacts defined in philosophy, and attempts to situate them in human history broadly. Section 5 explores the potential of the concept of extension and ontological parallels

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[1] This question can be divided across generations unless humanity as a whole is not bound by it

between being and tool through phenomenological explanations of authorship i.e. making artifacts and poverty. In the light of preceding sections, Section 6 conceptually explores what sustainability can be at the individual level though defined as a collective one and situates the prescription for sustainability as a human capability to communicate effectively. Section 7 discusses the implications of the ontology of tool and the concept of ability extending to capability. Summarizing the main messages, Section 8 concludes this research article.

2   Method

This research article is a conceptual exploration of the ontological status of all artifact kinds as 'tools'. The cognitive concept of 'extension' and the wider, anthropological and archaeological, sense of the word 'artifact' are leveraged to connect phenomenological approaches discussing tools, and development approaches discussing human capabilities. In the context of design this leveraging is central to inferences in this article.

3   Ability and Capability

Merriam-Webster online dictionary defines ability as follows (Idictionary, 2014),

> Ability (noun) – 1 a: the quality or state of being able; b: competence in doing. Date: 14th century
>
> Etymology: Middle English *abilite*, from Anglo-French. From Latin *habilitat-*, *habilitas*, from *habilis* apt, skillful

Ability is the agent's potentiality[1] for capability (explained further in this section). It is mere existence or being(ness) separated of any processes of consciousness, due to which, the event of the agent realizing its capability is plausible. An agent's substantiality affords this potentiality. Agent's responses that are reflexive like knee-jerk responses to certain stimuli are also abilities by definition as these are primarily required for securing that very substantiality of the agent from other prying agents. The process of realizing abilities complementarily requires the agent to expend energy in volition. The ingestion of resources converts them into forms fit for assimilation partly due to which the involuntary needs of the agent are automatically met. However, the event of the reserves or the results of assimilation being available for volition and subsequent action is not completely excluded temporally from that of their serving involuntary needs. The ways in which the reserves can be spent is informed by experiences of perceived value in return for their expenditure. A list of our abilities comprises those that are inaccessible for volition i.e. conscious (voluntary) control that nevertheless let us *be*. Some examples are breath, hearing, smelling, tasting etc which one can choose not to initiate but cannot control perceiving once the senses receive the signals.

Merriam-Webster online dictionary defines capability as follows (Idictionary, 2014),

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[1] On the concept of 'potentiality', see *A Hindu view of Life by* Sarvepalli Radhakrishnan and *Meaning* by Michael Polanyi

> Capability(noun)- 1: the quality or state of being capable; *also*: Ability 2: a feature or faculty capable of development : Potentiality 3: the facility or potential for an indicated use or deployment. Date: 1587

Capability (shared etymology with 'capacity') presumes an organ extending in space for eg. length, area, volume etc. providing opportunity. Capability is extended ability. Tools, as means of extension, can be substantial like a crowbar, car, stone etc. and can also be insubstantial like language, knowledge, institutions etc. Capability is realized in the agent's acts of volition which afford the fathoming of tools (naturefacts (Hilpinen, 2011 quoting Oswalt 1973)) and tool-use, for e.g. a Bonobo using a piece of available wood as a club for breaking nuts (Mammals by David Attenborough), and tool-making for e.g. the Caledonian crow creating a hook off a piece of available wire to create a hook (Weir, Chappell, & A, 2001).

Capability is generally attributed to active entities, like animals and individuals, equipped with tools. However, within anthropomorphic teleological explanations capability is also attributed to non-living entities, for example, the capability of a metal to be fused (Idictionary, 2014). Anthropomorphic and teleological accounts of tools suggest their ontological status to be comparable with that of agents. Observing further examples of the use of ability (Oxford Learners Dictionaries, 2014) and capability (Oxford Learners Dictionaries, 2014) it can be proposed that agents (active embodiments) are constitutionally, just able and when externally equipped with tools (passive embodiments) they assume capabilities i.e. they become capable. Technology is a context of extension and not a thing in itself. The process of specifying this context is design. Being capable to do more than one could ably do increases opportunities for achieving a life one values and can also accelerate this very process of achievement. Consequently, realizing one's full potential seems more plausible.

4 Tools and human history

Man is unique among life-forms in being capable to communicate using language (Corbalis, 2003). Language as a tool enabled him to think (Wheeler, 2004), extend his cognition (Clark & Chalmers, The Extended Mind, 1998), gather groups, organize effort, enterprise and effect a change in the resources to better produce tools which in turn equipped him to combat survival better. Consequently, tools have been extending his rather frail abilities to unlimited capabilities and this has not been uniform across the world wherever people thrived into civilizations. Each progressed at its own rate determined by the resources that are locally available and personal limitations of the populace in effecting change for their advantage (Sen, 1995). This resulted in the great diversity of human beings, inculcating and thriving with worldviews that fit their local environment, determine their disposition and situate them in 'the'[1] world (Diamond, 1997). Though environment provides necessary resources for the sustenance of life, the spatial distribution of resources is unequal and dependent on various factors. Wherever, people had access to more resources they have grown to be more dependent on them. And within the governance structures of the world and its limited resources, this has

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[1] "The" world does not exist for us; we can only access "our" world, which is the world as it is disclosed *by us,* (Verbeek & Kockelkoren, 1998) quoting Don Ihde.

unfortunately meant that an increasingly larger group of co-existing people have lesser and lesser access to resources.

5   Potential of the concept of extension

Conceiving any intervention as a tool that extends human ability to capability can potentially explain (Section 5.1) the ontology of being. Section 5.2 situates the acquisition of tools and their use as the process of realizing and expanding human capabilities that is termed, human development within the capability approach.

5.1   Tool and being

An agent becomes capable in being able to fathom tools and tool-use, realized either in existing objects (naturefacts) or by synthesizing them(artifact) out of available resources for effecting change. Tools extend abilities to capabilities. Tools, as means, can be tangibles like a stone, crowbar, sling etc. and can also be intangibles like language, knowledge, institutions etc[1]. For human agency, tools afford to extend limited human abilities to unlimited human capabilities. Consider a situation of a craftsman making an artifact. The craftsman handles a tool to mend the artifact (in the making) till it meets his representation of the desired specification. Without the tool the craftsman may be incapable of achieving the specification and hence, making the artifact eventually. However, not all work needs a tool. There are vocations where the craftsman uses his hands to make the artifact as desired, modeling clay for example. In such a situation, back-casting the concept of the tool-making-the-agent-capable, it can be stated that the craftsman is using his hands (embodiment) as the tool. Such statement, though normal in language, would have been incomprehensible had we not (or our language) presumed that the craftsman's identity is split into the substantial embodiment, E and an insubstantial capability to intend, C. With this knowledge, it can now be stated that in the phenomenon of craftsmanship, C engages E as a tool in effecting the artifact. C, as a representation of specification X, assumes substance (to be) from being insubstantial (to not be i.e. *artifact of the mind* (Thomasson, 2007)) and becomes capable by definition, as substance also affords being a tool[2]. The structure of C (now as a capable artifact in the making), as an effect that has resulted as a Gestalt negative (in 3D, as sculpting clay is the phenomenon of interest) of the positive activity (impression) of E based on natural law/principle, indirectly provides a representation as knowledge (as that which will be part of C eventually and hence needs to be retained), say K. When E impresses without encroaching into K it continues to afford access to K and serves as a tool (*ready-to-hand, Heidegger*) till the capability C is fully realized (i.e. till artifact is made as intended). When the impression of E is insufficient or encroaches into K then it cannot serve as a tool (*present-at-hand, Heidegger*) that is involved in creating the artifact i.e. realizing capability C[3]. This, while the being (craftsman), as a whole, assumes ability i.e. *to be* in deed. The ability C that gets extended is its representational-indefinite-ontological status

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[1] While tangibles can possibly engage or disengage users (Borgmann, 1984), it seems that intangibles, as things, cannot but engage users unless they subvert the user, taking decisions and scripting (Akrich, 1992) themselves.

[2] The notion of designer's inscribing (Akrich, 1992) their value systems into the artifacts they design may be occurring in this manner.

[3] The same notions of C, E, K are applicable to the tool itself, as an artifact, as it also keeps wearing-out under the artifact-in-the-making (i.e. as a tool)

(as an artifact of the mind) to a material–definite-ontological existence in the form of the artifact that is effectuated through E. Hence, being can be phenomenologically considered to comprise three actions: activity that fits K, activity that encroaches into K and inaction. The first two involve the being as a tool, engaged by C i.e. the representation. Inaction, that cedes reflexive reactions also, is synonymous with vegetation, as a condition of (the) being just able. Hence the being and being can be conceived as tool and tool-use respectively.

5.2   *Resources, volition and poverty*

An agent's energy reserves afford its voluntary expenditure and many a time such expenditure is directed to afford reserves further. At times when the agent does not source and consume resources(tools) in accordance with its periodic energy requirements, its dwindling energy reserves may not be sufficient for maintaining itself while also leaving nothing for volition. In such situations the agent's ability to maintain itself is stressed and such a deprived agent needs to be primed (externally) with resources. In so being made capable temporarily, the agent can then choose to knowledgeably (tool) expend these reserves voluntarily towards regaining the state of maintaining necessary reserves by sourcing resources for continual consumption. If it fails to act so even after being primed with means(tools), the reserves dwindle bringing the agent back to a state where it needs to be primed again. To know how to gather and thereof, gathering resources required for priming oneself is a recurring problem for some either due to resource unavailability or due to their incapability. These people are categorized as the poor, and consequently they need of the state's help. Poverty can be defined as an individual's recurring incapability to gather sufficient reserves for performing productive work. This incapability makes them vulnerable to external disturbances that can threaten their very survival, sooner or later. This incapability can be attributed to various reasons that can be broadly classified under those within their control (lack of motivation, infirmity, and unwillingness to work) and those outside their control (lack of work, physical/mental disability at birth, affordability (low incomes coupled with high commodity prices), and employability). Consequently, they ride on the economy rather than contributing to it. This is a deplorable state if they are able-bodied, i.e. able to be capable, but continue to be unproductive. The recent National Rural Employment Guarantee Scheme or NREGS of the Govt. of India is exemplary in this regard.

6   Sustainability as a human capability to communicate

Sustainability is the ability to meet our needs without compromising the ability of the future generations to meet their own (Brundtland, 1987). Though mentioned as a collective ability it is primarily an individual ability to act in a way that does not consume opportunities that afford others, co-existing and to come, to act similarly. Action, as response to requirements, can be voluntary or involuntary. When voluntary it can be attributed to the being's volition and when involuntary it can be attributed to instinct and the self-organizing processes in response to changing environments[1]. Such adaptation affects populations through to the individual's constitution. In comparison with the

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[1]In connection with the evolution of artifacts and contexts this can be compared with the propositions of Petroski (Petroski, The Evolution of Useful Things) and Schlossberg (Schlossberg, 1977) respectively.

evolution of complex features like the eye, volition, is more recent and an ability that is characteristic of the extremely high interconnectedness of our constitution that the course of self-organization has resulted in and continually doing so. In this sense volition might be privy to humans. Self-organization is considered to be the character of all life, and thermodynamically, of all open systems. Entropy is the exhaust of the evolution engine and consequently all involuntary activity of life increases the disorderliness of the universe that provides for our larger cosmic being. The universe, taken as an isolated system comprising open systems, is progressing towards increasing its disorderliness, both through voluntary or involuntary action that is possible of its constituents. In such a scenario of both avoidable and unavoidable activity increasing the rate at which opportunities will be consumed, the prescription for sustainability as a human ability is to avoid as much voluntary activity as possible so that more opportunity is afforded for the co-existing and to come. As this should be the agenda for all human conduct, in a situation where such a prescription may not be fathomable to all, our constructive discontent should be directed to ensuring successful communication of this prescription to all. Beyond whatever that is necessary for self-maintenance and self-replication, this alone should determine the direction for all voluntary action. This is purposive action and hence meaningful. In a situation where everyone understands this and behaves accordingly, contented acceptance replaces constructive discontent. When the nature, variability and spontaneity of the processes of earth shift the balance of opportunities, it is our responsibility to adjust between such constructive discontent and contented acceptance and restore balance of opportunity. With this basis of the argument, it is appropriate to refer to our interventions as 'tackling unsustainability', in a Sisyphean sense, which involves more time and effort rather than a vainglorious phrase of 'achieving sustainability' which is only momentary. Hence, sustainability as a human ability requires us to be able to mutually inform ourselves successfully of purposive action; the particular purpose being the affordance of purposive action in others. The more such a purpose is afforded in people, the more such people afford similar affordances in others (Withagen, de Poel, Araújo, & Pepping), thereby sustaining habitable and enlivening conditions on the planet, longer.

Living effectively is living with information (Wiener, 1989). The prescription off sustainability is to be able to mutually support successfully informing others of purposive action in the hope that people balance constructive discontent with contented acceptance. Given that the knowledge in this regard exists, it is a problem of design to communicate this knowledge successfully to as many as possible as soon as possible. It becomes a problem of design more so because of the amount of resistance we naturally face in conveying information, in the various elements at work that aim at distorting information, across the power and decision making structures that should be made to allow access to such knowledge to people etc. Effectively, it is a problem of communication and institutional design that ensures the dissemination of this knowledge to all. Also in the context of our dependence on current institutional structures the transition should be an informed one determined by understanding the process of expanding human capabilities i.e. knowing what abilities are appropriate and understanding how they should be extended to capabilities.

7   Discussion

Developmental literature does not differentiate capability from ability specifically. Differentiating ability from capability provides for the consideration of the process of expansion that is central to the capability approach. This differentiation affords the cognitive concept of extension by means of tools, making technology, as a context of extension, and design, as a process of specifying the tool, explicit. Design is the process of arriving at the representation of tools required for the extension of human abilities to capabilities. This representation may be for tool-use i.e. a process specification, or for tool-making i.e. a product and process specification. Tool-use by design involves matching specific attributes of already existing objects for the required purpose whereas design in tool-making involves coming up with a representation, for an object that will be the tool, abiding by and implementing which the tool can be made to be used for realizing the purpose. The process of design involved affords the examination of interventions in finer detail necessary for better evaluation of the effectiveness of alternative interventions. The idea of extension encompasses the design process in the context of institutionalization i.e. formalizing rules, procedures, norms etc. The idea of extension applied to the concept of sustainability as a human ability, with knowledge and language as tools for content and communication respectively, re-emphasizes human-centricity of the interventions. This emphasis can be positioned to counter criticisms of CA being individualistic, insensitive to social needs etc. (Robeyns, 2005). Also rather than having to list down capabilities (Nussbaum, 2000) which goes against the participative people-friendliness of CA (Sen, Human Rights and Capabilities, 2005), the distinction of abilities from capabilities and the concept of the tool provide for identifying 'capabilities' negatively i.e. as extended abilities. To start with those given by Universal Declaration of Human Rights (UDHR, 1948) of the UN and the various covenants that ensued can be identified as requisite capabilities to which corresponding human abilities should be extended. As abilities are not value-based, a list of human abilities, as defined in this article may not divide opinion as does the idea of listing capabilities or as to what should be listed and what not.

In the philosophy of artifacts, unintended consequences of the process of authorship i.e. making artifacts, either in the short-term or long-term, comprise what is called residue or debitage (Hilpinen R. , 1992). Problems of unsustainability like that of global warming can be characterized to be the consequence of accumulated debitage of the industrial revolution unattended to. As we can neither claim ignorance to the effects of anthropogenic climate change any longer nor can we suddenly halt industrial engines of growth, the prescription that entails is a requirement to make artifacts as well as attend to the debitage simultaneously. Emphasizing simultaneously is humanly impossible. And, as the consequences of accumulated debitage requiring remedial before ushering further debitage have assumed urgency, the process of making artifacts needs to emphasize the debitage positively more than the artifact in the making. Irrespective of the urgency, this is an ontologically strange problem. Well before proceeding to making artifacts this ontological problem affects their design itself as follows.

Design is the intentional process of arriving at specifications/representations (Galle, 1999) which if implemented transform situations of discontent to those of content(ment). In the context of products, implementation is production. In the form of intention, a nascent specification exists as an *artifact of the mind* (Thomasson, 2007). This is design intent which can then be realized with or without externalizing a representation of it. As

design and production were not treated differently, craft largely resulted out of fewer externalized representations as these largely passed down as *artifacts of the mind* through generations of apprenticeship and practice (Wischnitzer, 1965). Contrarily, mass-production was primarily made possible by the representable nature of the mechanical forms that the machinery of early industry could alone produce. Both, the process of craft as well as industrial production leave the consequences to be attended to as an afterthought, however with starkly different intensities. The ontology of the consequences i.e. *debitage* is dependent on authorship. Synonymous and as with design intent, a 'debitage of the mind', as a remedial intent does not exist standalone i.e. its existence is not active but reactive. This will be so unless we can install *debitage* so positively that design for the remedial of consequences that spawn off it automatically result in authorship as the unintended consequence. This seems impossible too.

Whether intended or unintended it is noteworthy that archaeology and anthropology treat both outcomes of human endeavor as artifacts (Schick & Toth, 1993). From such a wider embrace of the word 'artifact', consequences assume equal emphasis though their ontological status is dependent on that of the artifact. Nevertheless, such emphasis can be closely approximated by gradually reducing the cycle-time of the make-reflect-modify cycles as theorized in some models of learning and design (Schon, 1996) (Srinivasan & Chakrabarti, 2010). This results in tests/evaluations being done more frequently providing hope within three possible situations: one, that designers made so aware of reflection will be better at foreseeing possible consequences to humans (in an ongoing process of engagement or otherwise), society and the environment in extension; two, the deleterious consequences of the process of coming about with technology will be identified early in the design stage and can hence be averted, and; three, that the amount of impact that technologies designed so, will not be so grossly underestimated to ponder later of how ignorant were we in not accounting for it before accumulating so much of these consequences.

8   Conclusion

This article argued for treating abilities as separate from capabilities. A definition for technology, essentially as a context, in which abilities are extended to capabilities by a tool is proposed. Prevailing arguments of degree, i.e. basic, focal, normal and central capabilities are explored as a division of kind i.e. abilities and capabilities, and the extension. A broad definition for design is proposed in this context as the process of specifying the tool, and hence the context in which capabilities (and hence human development)are realized. Having defined technology so makes it appropriate to conceive development to be design led properly rather than being led (or misled) by technology. The concept of extension is back-casted to understand human agency, as (human) being able to be capable. This is shown to be synonymous with human development as is defined through the capability approach. It is proposed that the problems of listing capabilities that undermine the participative nature of the public self-determining capabilities can be resolved by identifying the abilities as these don't involve judgment as capabilities do. The problem of unsustainability is pitched as a human capability to communicate. From the perspective of averting consequences of the use of technology as a major concern for unsustainability, the phenomenon of designing artifacts is observed

identifying ontological problems. A suggestion, based on the iterative nature of design, is given to approximate the simultaneous emphasis that artifacts and their debitage require.

Acknowledgments

References

1   Ability.   (2014).   Retrieved   March   4,   2014,   from http://oald8.oxfordlearnersdictionaries.com/dictionary/ability

2   Akrich, M. (1992). The De-Scription of Technical Objects, Shaping Technology/Building Society. (W. E. Bijker, & J. Law, Eds.) Cambridge: MIT Press.

3   Borgmann, A. (1984). Technology and the Character of Contemporary Life. Chicago: University of Chicago Press.

4   Brundtland, H. (1987). Our Common Future. Oxford University Press.

5   Capability. (2014). Retrieved March 4, 2014, from http://oald8.oxfordlearnersdictionaries.com/dictionary/capability

6   Clark, A. (2004, November). Is Language Special? Some remarks on control, coding and co-ordination. Language Sciences, 26(6), 717-726.

7   Clark, A. (2010). Supersizing the Mind: Embodiment, Action, and Cognitive Extension. Oxford University Press, USA.

8   Clark, A., & Chalmers, D. J. (1998). The Extended Mind. Anaysis, 58, 7-19.

9   Corbalis, M. C. (2003). From Hand to Mouth: The Origins of Language. Princeton University Press.

10   Dechert, S. (2014, March 31). UN authors: 'We can no longer plead ignorance' on climate change. Retrieved April 10, 2014, from http://digitaljournal.com/news/environment/un-authors-we-can-no-longer-plead-ignorance-on-climate-change/article/379030

11   Diamond, J. (1997). Guns, Germs and Steel. The Fates of Human Societies. W W Norton & Company.

12   Ehrenfeld, J. (2009). Chapter 5: A radical notion of sustainability. In Sustainability by Design: A Subversive Stategy for Transforming our Consumer Culture. YALE University Press.

13   Galle, P. (1999, January). Design as Intentional Action: a conceptual analysis. Design Studies, 20(1), 57-81.

14   Henry Dreyfuss Associates. (n.d.). Measure of Man and Woman: Human factors in Design.

15   Hilpinen, R. (1992). Artifacts and Works of Art. 58, 58-82.

16   Hilpinen, R. (1993). Authors and Artifacts. Proceedings of the Aristotelian Society, 93, pp. 155-178.

17   Hilpinen, R. (2011). "Artifact", The Stanford Encyclopedia of Philosophy (Winter 2011 Edition) (Winter 2011 Edition ed.). (E. N. Zalta, Ed.) Retrieved March 4, 2014, from http://plato.stanford.edu/archives/win2011/entries/artifact/

18   Idictionary. (2014). (Merriam-Webster, Inc) Retrieved March 4, 2014, from http://i.word.com/idictionary/capability

19   Idictionary. (2014). (Merriam-Webster, Inc) Retrieved March 4, 2014, from http://i.word.com/idictionary/ability

20   Mammals by David Attenborough (n.d.). [Motion Picture].

21   Matthews, H. D., & Caldeira, K. (2007, June). Transient Climate: Carbon simulations of planetary engineering. Proc. Natl. Acad. Sci. USA 2007 104 (24) 9949-9954.

22   McGrath, M. (2014, February 20). BBC NEWS Science & Environment. (BBC) Retrieved February 24, 2014, from EU Commission launches legal action over UK air quality: http://www.bbc.com/news/science-environment-26257703

23   Nussbaum, M. C. (2000). Women and Human Development: The Capabilities Approach. Cambridge: Cambridge University Press.

24   Oxford Learners Dictionaries. (2014). Retrieved March 4, 2014, from http://oald8.oxfordlearnersdictionaries.com/dictionary/capability

25   Petroski, H. (1992). The Evolution of Useful Things. New York: Random House.

26   Petroski, H. (n.d.). The Evolution of Artifacts. American Scientist, pp. 416-420.

27   Robeyns, I. (2005, March). The Capability Approach: a theoretical survey. Journal of Human Development, 6(1), 93-114.

28   Schick, K., & Toth, N. (1993). Making Silent Stones Speak: Human Evolution and the Dawn of Technology. New York and London: Simon and Schuster.

29   Schlossberg, E. (1977). For my father. In J. Brockman, About Bateson. NY: Dutton.

30   Schon, D. (1996). The Reflective Practitioner. Massachussets: MIT Press.

31   Sen, A. (1995). Inequality Re-examined. Oxford University Press, Oxfrord.

32   Sen, A. (1996). Development thinking at the beginning of the 21st century. Development Thinking Pratice. Washington D.C.: Inter-American Bank. Retrieved March 3, 2014, from http://eprints.lse.ac.uk/6711/1/Development_and_Thinking_at_the_Beginning_of_the_21st _Century.pdf

33   Sen, A. (2005, July). Human Rights and Capabilities. Journal of Human Development, 6(2), 151-166.

34   Silver, M. W., Bargu, S., Coale, S. L., Benitez-Nelson, C. R., Garcia, A. C., Roberts, K. J., . . . Coale, K. H. (2010, November). Toxic diatoms and domoic acid in naatural and iron enriched waters of the oceanic Paciifc. Proc. Natl. Acad. Sci. USA Early Edition.

35   Srinivasan, V., & Chakrabarti, A. (2010). An integrated model of designing. JCISE, 3(10).

36   Thomasson, A. (2007). Creations of the Mind. Theories of Artifacts and Their Representation. In M. E, & L. S (Eds.), Artifacts and Human Concepts (pp. 52-73). Oxford and New York: Oxford University Press.

37   UDHR. (1948, December 10). Retrieved from The Universal Declaration of Human Rights: http://www.un.org/en/documents/udhr

38   Verbeek, P.-P., & Kockelkoren, P. (1998). The Things That Matter. Design Issues, 14(3), 28-42.

39   Weir, A., Chappell, J., & A, K. (2001). Shaping of hooks in New Caledonian Crows. Science, 297:981.

40   Wheeler, M. (2004). Is language the ultimate artefact? Language Sciences , 26, 693-715.

41   Wiener, N. (1989). The Human Use of Human Beings: Cybernetics and Society. London: Free Association Books.

42   Wischnitzer, M. (1965). A History of Jewish Crafts and Guilds. New York: Jonathan David.

43   Withagen, R., de Poel, H. J., Araújo, D., & Pepping, G.-J. (n.d.). Affordances can invite behaviour: Reconsidering the relationships between affordances and agency. New Ideas in Psychology 30 (2012) 250–258.