ZooJamming: Designing Beyond Human Experience

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ABSTRACT

This is a report of three ZooJams that have taken place at the annual Animal-Computer Interaction conference. The ZooJam is a type of workshop whose aim is to extend the reach of UX design beyond human experience in order to become inclusive of other species and their interactions with technology. As organisers, our attempts have knitted together colleagues from a range of disciplines, all focused on developing practical solutions to different environmental enrichment challenges.

We describe the format of the event, explaining the rationale for this approach, and showcase some of the crafted design outcomes.

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CCS Concepts

• Interaction devices, Interaction design

Keywords

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1 INTRODUCTION

At the annual ACI (Animal-Computer Interaction) conference, we have been running a *ZooJam* workshop each year for the past three years, aimed at developing new "zoological" interactive experiences: interactive technologies for non-human animals. During the event, we try to imagine how to design systems that interface with noses, paws and beaks, and explore how to use a range of sensory modalities for providing feedback.

The aim is to become inclusive of other species that may need to interact with technology - examples include assistance dogs that can raise alarm calls and perform simple tasks for their handlers [17] [18]; intensively farmed animals that navigate various mechanical devices [21]; pets sharing our technology-laden domestic environments [23]; zoo-housed and lab-housed animals - in other words, non-human animals that are both in our care and in captivity.

ZooJam participants are a diverse and passionate bunch, and over the years have included zoo keepers, representatives from the RSPCA [27] and from Shape of Enrichment [28], engineers, computer scientists, game developers, dog trainers, animal welfare experts, UX practitioners and networking specialists. While this

melting pot of interests promises an exciting and productive event, it has been important to structure the sessions to facilitate creative expression, skills-sharing and goal-oriented outcomes.

The ZooJam concept was inspired by years of organising and participating in game jams, where the output is focused and design-complete - participants are required to design and develop a game within a limited timeframe. In jams such as GGJ (Global Game Jam [11]) and Brains Eden [1], teams rise to the challenge of working together to meet a specific brief. Creative exploration is a highlight of the experience and there is a strong sense of achievement at the end, with a tangible product, albeit in a prototype state. Many jammers (game jam participants) continue to refine their games after the event.

We wanted our workshop participants to have a similar experience during the ZooJam events, but instead of making a game, the focus would be on finding a playful solution to an enrichment goal provided by an animal welfare specialist. Previous attempts to use a game jam format to stimulate ideas for enrichment include "Orangujam", devised by Wirman [20], and "Design Challenges with Ants" by Westerlaken and Gualeni [30]. These jams, aimed at enrichment for orangutans and ants respectively, were successful in that they produced relevant concepts which were then developed and tested.

Animals in zoos (and other captive environments such as sanctuaries and laboratories) are typically provided with environmental enrichment aimed at enhancing their welfare by offering stimulation within several broad categories – social, cognitive, physical, sensory and food. The defining aspect of an enrichment plan is that it should promote natural behaviour and therefore every enrichment device must have a species-specific behaviour as its goal [32]. Captive animals are typically housed in enclosures with limited space and they have a highly managed lifestyle since keepers need to maintain regular schedules. As a result of these limitations, captive animals often lack opportunities to perform highly motivated natural behaviours. This can result in poor welfare states which can be described as "frustration" or "boredom", as well as having negative outcomes for health, and for cognitive and social functioning [5]. It was important that the ZooJam would produce *useful* outcomes – meaning that colleagues who work professionally with animals would be able to leave with appropriate, practical solutions for their enrichment goals, while ACI colleagues with computing backgrounds would gain deeper understanding of their potential users. In addition, a key aim of the event was to create space and time for participants to work in teams, sharing common themes and constraints in order to draw together expertise from different disciplines.

Moreover, regardless of participants' backgrounds, learning to appreciate some of the motivations and unique behavioural characteristics of non-human animals can offer fresh insights into how different users might benefit from novel designs - for example, some of the bubble toys aimed specifically at Magellanic penguins would not be out of place in a large leisure pool during the school holidays.

Each year, the ZooJam has explored a different theme. Every new enrichment goal is an unsolved problem waiting for colleagues to brainstorm ideas and develop solutions. In 2016, the inaugural ZooJam responded to briefs that required hunting behaviour to be stimulated in specific zoo-housed animals [8] (sea lions, penguins and big cats). In 2017, the FarmJam focused on environmental enrichment for intensively farmed animals [7] (pigs, goats and chickens) and the associated challenges. In 2018, the SoundJam addressed opportunities for auditory enrichment for animals in a range of captive contexts [9] (chimpanzees, parrots, servals and elephants).

In this paper we discuss the methods used to stimulate fruitful collaboration and report on some of the outcomes as Case Studies - highlighting just how effective the cross-disciplinary synergy has been.

2 JAM METHODOLOGY

2.1 Themes and briefs

The organizing committees for each event comprised experts in animal behavior, technology, design and animal-computer interaction. To ensure that the design experience was grounded in real-life challenges, we asked participants who were animal experts to offer us briefs for the events. However, in keeping with the tradition of game jams, we withheld these briefs from participants until the event took place. One of the reasons for this was so that participants could engage spontaneously with the briefs during the brainstorming stage, working with fellow team members. Had people known too much information in advance, there would have been a temptation to come with pre-formed concepts; the jam would have then become a forum for exchanging existing ideas, rather than a fluid and evolving platform for collaborative engagement. We hoped that participants would be inspired and provoked by each other's creative outputs, would listen and be responsive "in the moment", thereby immersing themselves in the experience of the game jam. Similarly, we hoped to collect outputs that were generated during the event, rather than compile a set of contributions that were determined beforehand.

The briefs were succinct – each defined an enrichment goal for a specific animal and described or depicted the typical environmental context for that species in its captive context.

2.2 Brainstorming

On the day of the workshop, we cut to the chase, surmising that introductions would take place informally during the sessions. After the briefs were explained to the participants by the animal experts, the next stage for all jammers was to brainstorm as many ideas as possible for each brief. The animal experts were involved in this process as game jam participants, and we pre-selected groups so that people with different skills and knowledge were mixed as much as possible, making sure that each team had at least one animal expert participant who could provide inputs during brainstorming. There was time to network and reflect and make contributions, but the sessions were tightly managed so that people were required to focus on their tasks (See Figures 1 and 2).

In 2018, we used 20 minute pomodoros [22] for timing – a technique used for serial time management.

Figure 1: Participants in FarmJam 2017 - designing enrichment for pigs, poultry and goats.

Figure 2: Participants in ZooJam 2016 - designing hunting experiences for zoo-housed carnivores - big cats, sea lions and penguins.

2.3 Creative sharing

The next stage involved sharing the concepts with the larger group, answering questions and receiving feedback. The animal experts who provided the original pitches each moderated a short session during which initial ideas were presented, thus facilitating a filtering process based on early feedback. This corresponds to a "pitching" process often happening at game jams, when people who have ideas try to collect team members who have the skills and enthusiasm to help develop those ideas into working games.

In order to do present their ideas at the ZooJam, teams spontaneously used sketching and/or modelling – making very rough designs in order to communicate their thoughts more easily. We supplied a range of materials to facilitate this process. Key to this stage of the workshop was the imprecise and incomplete nature of the ideas, emphasizing that they were questions opening a discourse with other participants; no-one in the room knew the "correct" answers but we were all motivated to explore possibilities. At this stage, concepts could easily be adapted so that people could invest their own creativity into the designs, enhancing and refining them. This aspect of the design process is an important characteristic of a Research through Design approach [10].

During this session, participants were expected to be critical and start to make selections, based on various factors – feedback from animal experts (meeting enrichment goals), feasibility (technical considerations, expense, available skills and resources, potential for success), educational and research considerations.

2.4 Concept development and crafting

Figure 3: Crafting a musical toy for parrots, 2018.

After lunch, participants at the ZooJams were encouraged to re-form teams based on the animal enrichment device that they were most interested in developing to a higher level of detail. Participants were under pressure to develop an idea with the potential to be successful as a future full-size prototype and research project, and the limited time factor was a motivator that also aided clarity of thought. It is a common experience of jammers that they can achieve tremendous creative outputs in a concentrated period of time, because they are working with no distractions in a supportive atmosphere with other focused people [13] [4].

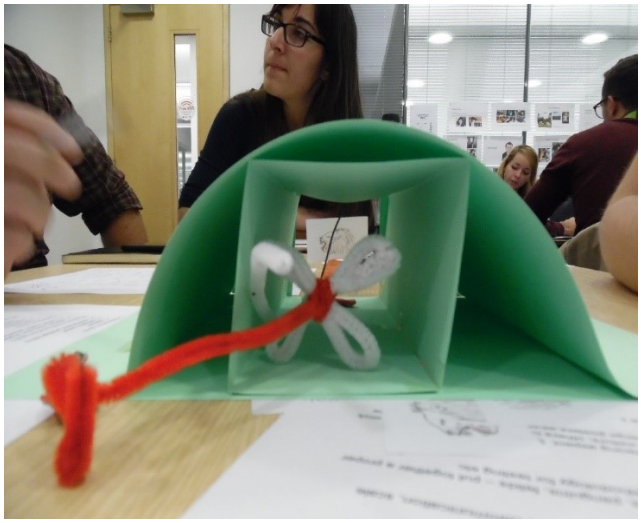

Figure 4: Big cat hunting device to promote stalking, 2016.

A key aspect of the ZooJam is the opportunity for participants to be in the same physical space, interacting with physical tools to conceptualise and demonstrate physical objects. One of the most useful and productive activities was the crafting and construction session, when colleagues were tasked with building a model of the device they had imagined, using a variety of making materials - cardboard, popsicle sticks, glue, pipe-cleaners, balsa wood, felt, modelling clay etc. (See Figures 3, 4, 5.)

Crafting models is an activity we have experienced during our youth, but this mode of expression is often ignored in favour of sketches, which require fewer resources. However, not only does 2D visual representation put the final design in the hands of those who are confident artists, but a mark on paper becomes a kind of signature for its author – it can be erased or written over, but that is a deliberate and destructive act. Collaborative drawing can be fun and productive, as long as participants remain respectful of each other's contributions. We argue that crafting is more inclusive and offers a more flexible, unassuming editing process, comparable with co-writing documents or code on a shared platform such as Google Docs or GitHub (but without the version control).

Physical pieces can be placed here or there until a decision is reached; paper and card can be lengthened or shortened easily; co-creation is such a fluid process that it is easy for everyone become involved [14] [15],

By comparison, in a traditional game jam, there is also a period when all team members' contributions are integrated into the final product. Nonetheless, the components of the game are discreetly credited to their creators; only the early design stage is sufficiently mutable in real time to be co-owned.

Sometimes ZooJam groups are tempted to break away from the shared table to sit at their personal computers in order to work on a more polished look for their designs – as we noted, in a traditional game jam this is the usual mode of working after the concept has been agreed. However, ZooJam facilitators are keen to maintain group cohesion.

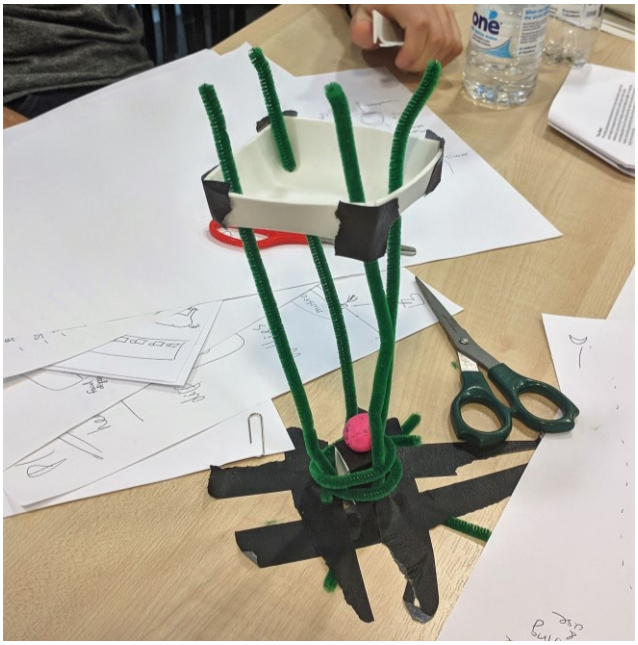

Figure 5: Cooperative ball toy for pigs, 2017.

As well as working very well as a collaborative activity in which everyone can take part, cooperative making is also an excellent way to focus participants on practical and structural aspects such as the dimensions, materials, location and feasibility of their designs - exploring engineering and manufacturing constraints. At the same time, technical details and electrical hazards such as exposed wiring can be considered in relation to the overall design. Moreover, a physical prototype is ideal for demonstrating functionality - it is easier for an audience to comprehend, acts as a showcase piece and facilitates the design team to appreciate the device from the animals' perspective.

2.5 Wrapping up

Usually at the end of game jams, the final artifacts from each team are presented to a wider audience for feedback and to showcase creative efforts; similarly, we asked participants to present their work using graphical and physical representations as well as verbal descriptions. The platform for presentation emphasised clarity, economy, level of detail and communication skills, additionally providing an opportunity to answer questions.

Full development of concepts including links to presentations can be found at the ZooJam website: http://www.zoojam.org.

3 CASE STUDIES

In this section, we describe some of the solutions devised during the three ZooJam events (ZooJam 2016, FarmJam 2017 and SoundJam 2018), without explaining details of embedded technology or engineering, which are beyond the scope of this paper.

Figure 6: Marble run sound synthesiser for chimpanzees, 2018.

3.1 ZooJam 1 (2016): Hunting Experiences for Zoo Animals

The challenge for designers was to promote a full repertoire of hunting behaviours in various carnivores. Depending on the species, this might involve locating, stalking, ambushing, scavenger hunting, chasing down, working in packs etc. Live prey is unethical from the perspective of an institution whose mission is to nurture and protect its animals, as well as a turn-off for many members of the public. This meant that the designers had to come up with systems that created the illusion of prey so as to encourage the predators to engage in natural behaviour patterns.

The final design for big cats was a system that used hidden sensors to detect movement (a combination of passive infrared sensors and pressure plates), with environmental lights, sounds and scents to attract attention to specific areas in the enclosure. If the cat was successful in negotiating the sensors (by moving very slowly or by waiting), it could trigger a trapdoor to be released, giving access to a carcass. (See Figure 4)

Magellanic penguins generated a lot of entertaining ideas for devices because we were told how much they love to play. The brief required that the penguin toys should also be capable of entertaining and educating aquarium visitors, potentially by giving visitors some control over how or when the toys were activated. Concepts included devices that emitted lights and bubbles to simulate moving fish that the penguins would have to chase before obtaining a food reward.

Ideation of design for sea lions was initiated by showing participants an existing (empty) sea lion enclosure. This gave participants an appreciation of the difficulty of providing sufficient exercise to such active creatures. Sea lions could benefit from a strong current (lazy river) in their environment, and teams came up with the idea of a cannon that shot fish so they would have to move fast to catch it. This would have the added benefit of making the sea lions less keeper-focused.

3.2 ZooJam 2 (2017 FarmJam): Designing Enrichment for Farm Animals

The notion of engaging with intensive farming organisations was an uncomfortable proposition for some ACI colleagues, so we deliberately avoided discussing ethical questions during the jam in order to keep our focus on possible enrichment solutions.

There was a lot of interest in pigs, with briefs for big pigs in Italy, regular pigs in UK and Irish pig production facilities. It was useful to hear the different perspectives and take financial considerations into account for the final designs. As wild pigs spend a lot of time exploring the environment but intensively farmed pigs often lack substrate or interest in their pens, enrichment devices should ideally be chewable, edible, investigable and deformable, while remaining hygienic. Teams devised a toy that several pigs could play with, enabling them to root around with their snouts. (See Figure 5)

For goats, the main design idea was a climbing wall construction to be used inside their sheds, with structures that measured weight so the animals would have to cooperate by standing on the same piece of wall in order to trigger a hay drop. Teams suggested that tags could be useful in order to identify which goats were most active, and hopefully match meat quality with enrichment quality as a useful leverage for inducing farmers to invest in novel welfare systems.

Poultry are kept in dense conditions and would benefit from interesting foraging devices to distract them. The brief requested alternatives to rope, which is popular for pecking but bad to ingest. Two interesting concepts were a robot grain dispenser that would move slowly around the floor and a low-tech edible hanging device made from bamboo and cotton with embedded seeds.

3.3 ZooJam 3 (2018 SoundJam): Acoustic design for auditory enrichment

Auditory enrichment is an underexplored area of research and can be both positive and negative – it can entail the provision of a rich acoustic environment but also the removal or dampening of unwanted sounds. Designing for sound-based experiences is problematic because of the pervasive nature of sound and the individual preferences of animals – how to enable one to enjoy the jazz while the other has peace and quiet?

The emphasis during this jam was very much on providing choice and control for the animals. The brief for chimpanzees required that they should have the opportunity to create their own sound tracks, and the design evolved from a looping synthesiser

system to a more physically interactive marble-run activated acoustic toy. (See Figure 6) This concept also included the idea that chimps could take a sound-cube to the "recording studio" and imbue it with their own noise (possibly with keeper support), which could then be triggered in the synth.

Parrots usually inhabit a raucous environment and love to make a noise, so the brief was to design musical instruments that they could play cooperatively. The team developed dynamic perches with sensors that could trigger noises as well as a call and response sound studio game.

Servals brought us back to hunting behaviours again. This time the team devised a system that used sounds underground to simulate rodent prey running in their tunnels. Squeaky robo-rats could be remotely controlled by keepers or via artificial intelligence and would lead the servals to pursue them above ground to their tunnel entrances.

4 REFLECTIONS

There is a widely held view that human interest in playing games is associated with our cognitive development and ability to perform in more critical situations. For example, in the field of game design, Koster [12] describes games as "brain exercises", citing dynamics that mimic real-world challenges; Schell uses the framework of mental modelling to explain gameplay and its relationship with reality [29]. For humans, game dynamics include collecting, chasing and evading, trading, cooperating, puzzle-solving, territorial acquisition, prediction, spatial reasoning [2]; we notice that all these activities also have relevance for other species.

If we accept that games give us opportunities to stimulate our brains in ways that may ultimately enhance our survival, there is every reason to suppose that playful activities might similarly augment the cognitive well-being and health of other animals. For animals in captivity, opportunities for play can be devised that mimic survival strategies required in the wild. Markowitz [16] described this as "behavioural engineering" and countered criticism that his enrichment games were "unnatural" by pointing out that the captive environment is contrived by definition. There is increasing recognition that games and interactive devices can play an essential role in stimulating species-specific behaviours. [24] [32]

It follows that a game jam could be a suitable vehicle for developing new ideas that promote animal welfare by encouraging the expression of natural behaviours through artificial means. The ZooJam format illustrates how games for non-human animals could target species-specific environmental enrichment goals – using the jam themes to guide jammers' creative outputs.

4.1 Outputs

In a traditional game jam, the output is a playable game that meets the brief (the designated theme). In our ZooJams, the output was a clearly defined blueprint or design for a prototype device. These challenges are similar, in that the specifics of interactivity and functionality (gameplay) have to be clarified and explained, as well as the aesthetics of the artifact.

For a game, aesthetics might correspond to the look and feel. However, for an object designed for an animal, different sensory modalities need to be considered. For example, it is not enough to add scent to an object – the nature of the scent becomes very important, its provenance, its strength, its purity, as well as the fact that it is pervasive and will dissipate over time. A bear will be able to gain much more information from an olfactory stimulus than a human. Thus the requirement to investigate different kinds of interfaces and feedback mechanisms becomes critical for the designer, because it relates to the usability of the device, rather than being research undertaken for innovation per se.

Interestingly, when small teams are faced with the same brief, yet work independently, they regularly come up with both unique solutions and similar solutions - the same ideas occurring spontaneously within different groups. How can we interpret this? It might be that the best solutions are the ones that most people have converged on - or it might be that these are in fact the most anthropocentric solutions and we are all drawn inexorably towards them because of our human experiences.

In each final design, technology has been used to facilitate a system that has a specific animal-centred purpose. Some concepts use the technology to simulate conditions as they would be in the wild – a Wizard of Oz approach so the animal has no knowledge of unusual interventions. Others use the technology more explicitly, as an enabler, giving the animal some choices and control over aspects of its environment.

It seems probable that devices for animals are more likely to be successful as tangible objects than as graphical interfaces, if only because animals might be expected to learn the relevance and purpose of a physical object faster than an abstract representation, since they use this skill as part of their normal behavior [31]. Therefore making physical objects becomes one of our priorities in a ZooJam - because we are designers trying to understand our users. In a Research through Design approach to finding a solution to a brief, the iterative *making* of designed objects is emphasized in order to fully appreciate their qualities and to enable sharing and testing with users [10]. In this respect, a ZooJam, and specifically the crafting session, can be an early stage in a Research through Design process, stimulating fresh perspectives by facilitating new ways of framing old challenges [6].

4.2 Looking forward

The ZooJam format has worked well to bridge some interdisciplinary gaps in the ACI community, between the technologists and the species specialists, by helping to build trust and respect. In this respect, we believe the sessions to have been highly successful; feedback from participants has been positive and networks have been established.

However, vital to the continued viability of ZooJams is the recognition that the output must be the start of something, not the end of something. In order to contribute to animal welfare by providing new behavioural opportunities, design ideas need to jump from the page, screen and table to be transformed into life-size physical working prototypes, so that the process of shaping

and refining them can continue in conjunction with their end users (the target species).

As well as finding immediate practical solutions that enable species-specific behaviours within captive environments, there is a potential for longitudinal studies that investigate how the introduction of novel devices impacts on a community of animals over time. Riede et al. [25] suggest that niche construction theory (how a species modifies its environment and thereby shapes its own and others' evolution) can explain human culture – that children's toys (object play) may lead to adults' materialistic behaviour and aptitude for innovation. What might happen to a group of primates, for example, who were continuously offered cognitive enrichment via playful objects in a restricted environment where overtly aggressive behaviour was curtailed yet choice was permitted in the selection of mates? Would reproduction favour brain over brawn? Would the animals begin to invest their creative energy into the development of other artifacts, following the example of chimpanzees at Belfast Zoo, who recently improvised a ladder from tree trunks so they could escape their enclosure [33]? In the same way that humans have shaped the evolution of domesticated species, might our well-intentioned interventions have unexpected consequences for captive "wild" animals? What, indeed, are the ethical considerations?

We hope more developers and animal behaviour experts will be motivated to take part in more jams and that our respective communities will be able to enliven, enhance and inform each other.

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- Auditory enrichment for **servals** – Valerie Hare from Shape of Enrichment;
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6. REFERENCES

[1] Brains Eden Gamejam: http://www.brainseden.net/

[2] Brathwaite, B. and Schreiber, I. 2008. Challenges for Game Designers (1 ed.). Charles River Media, Inc., Rockland, MA, USA.

[3] Elephant Welfare Group: https://biaza.org.uk/elephant-welfare-group

[4] Falk Olesen, J. 2017. Design Processes in Game Jams: Studies of Rapid Design Processes - CHI-Play17 https://doi.org/10.1145/3130859.3133226

[5] Fraser, David. 2008. Understanding Animal Welfare: The Science in Its Cultural Context. John Wiley & Sons.

[6] French, F., Mancini, C., Sharp, H. (2017). Exploring Research through Design in Animal-Computer Interaction. In: Proc. Fourth International Conference on Animal-Computer Interaction, ACI2017, 21-23 November 2017, Milton Keynes, United Kingdom, ACM Digital Library. DOI>10.1145/3152130.3152147

[7] French, F.,Baskin, S., Wallace, B., Cheok, A., Zamanzky, A., Nannoni, E. 2017. FarmJam 2017: Designing Enrichment for Farm Animals. In Proceedings of the Fourth International Conference on Animal-Computer Interaction (ACI2017). ACM, New York, NY, USA, Article 21, 6 pages. DOI: https://doi.org/10.1145/3152130.3152154

[8] Fiona French, Mark Kingston-Jones, David T. Schaller, Sarah Ellen Webber, Heli Väätäjä, and Mark Campbell. 2016. Don't cut to the chase: hunting experiences for zoo animals and visitors. In Proceedings of the Third International Conference on Animal-Computer Interaction (ACI '16). ACM, New York, NY, USA, Article 19, 6 pages. DOI: https://doi.org/10.1145/2995257.3014066

[9] French, F., Gupfinger, R., Kendrick, P. 2018. SoundJam 2018: Acoustic Design for Auditory Enrichment. Workshop at the Fifth International Conference on Animal-Computer Interaction, Atlanta, Georgia. https://doi.org/10.1145/3295598.3314845

[10] Gaver, W. 2012. What should we expect from research through design? In Proceedings of the SIGCHI Conference on Human Factors in Computing Sys-tems (CHI '12). ACM, New York, NY, USA, 937-946. DOI: http://dx.doi.org/10.1145/2207676.2208538

[11] Global Gamejam: https://globalgamejam.org/

[12] Koster, R. 2005. A theory of fun for game design. Scottsdale, AZ :Paraglyph Press

[13] Kultima. A. Defining Game Jam. https://pdfs.semanticscholar.org/84f7/5190fad7e306f23423ade1e31966323951ac.pdf

[14] Löwgren, J. 2016. On the significance of making in interaction design research. interactions23, 3 (April 2016), 26-33. DOI= http://dx.doi.org/10.1145/2904376

[15] Luck, R. 2018. Inclusive design and making in practice - bringing bodily experience into closer contact with making. Design Studies, Vol 54, Jan 2018 p 96-119. DOI: https://doi.org/10.1016/j.destud.2017.11.003

[16] Markowitz, H. *Behavioral Enrichment in the Zoo*. New York: Van Nostrand Reinhold, 1982. p83-84

[17] Moore Jackson, M., Zeagler, C., Valentin, G., Martin, A., Delawalla, A., Blount, W. et al., 2013, September. FIDO-facilitating interactions for dogs with occupations: wearable dog-activated interfaces. In Proceedings of the 2013 international symposium on wearable computers (pp. 81-88). ACM.

[18] Mancini, C., Harris, R., Aengenheister, B., Guest, C. 2015, April. Re-centering multispecies practices: a canine interface for cancer detection dogs. In Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (pp. 2673-2682). ACM.

[19] Nannoni, E., Martelli, G., Sardi, L, 2017. "Enrichments For Pigs: Improving Animal-Environment Relations". Proceedings of the Fourth International Conference on Animal-Computer Interaction. ACM.

[20] Orangujam: http://ludusanimalis.blogspot.com/2013/09/orangujam-at-social-innovation-festival.html

[21] Juul Pedersen, L. 2018. Overview of commercial pig production systems and their main welfare challenges. In Herd and Flock Welfare, Advances in Pig Welfare. Woodhead Publishing, 2018, Pages 3-25. ISBN 9780081010129. https://doi.org/10.1016/B978-0-08-101012-9.00001-0.

[22] Pomodoro Technique: https://francescocirillo.com/pages/pomodoro-technique

[23] Pons, P. and Jaen, J. 2016. Towards the Creation of Interspecies Digital Games: An Observational Study on Cats' Interest in Interactive Technologies. In Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '16). ACM, New York, NY, USA, 1737-1743. DOI: https://doi.org/10.1145/2851581.2892381

[24] Quick, D. L. (1984), An integrative approach to environmental engineering in zoos. Zoo Biol., 3: 65-77. doi:10.1002/zoo.1430030107

[25] Riede F, Johannsen NN, Högberg A, Nowell A, Lombard M. 2018. The role of play objects and object play in human cognitive evolution and innovation. Evolutionary Anthropology. 2018;27:46–59. https://doi.org/10.1002/evan.21555

[26] Robinson, C.L., Mancini, C., Van Der Linden, J., Guest, C., Harris, C. 2014. Canine-centered interface design: supporting the work of diabetes alert dogs. In Proceedings of the 32nd annual ACM conference on Human factors in computing systems, pp. 3757-3766. ACM.

[27] RSPCA: https://www.rspca.org.uk/adviceandwelfare/farm

[28] SHAPE of ENRICHMENT: https://theshapeofenrichmentinc.wildapricot.org/

[29] Schell, J. 2008. The art of game design : a book of lenses. Amsterdam; Boston :Elsevier/Morgan Kaufmann

[30] Westerlaken, M. and Gualeni, S. 2016. Situated Knowledges through Game Design: A transformative Exercise with Ants. In Proceedings of The Philosophy of Computer Games (2016, Malta p.1-25). The Game Philosophy Network. http://hdl.handle.net/2043/22422

[31] Wirman, H. "Games for / with Strangers - Captive Orangutan (Pongo Pygmaeus) Touch Screen Play." *Antennae*, no. 30 (2014): 104–12. P.111

[32] Young, R.J. 2003. *Environmental Enrichment for Captive Animals*. John Wiley & Sons.

[33] https://www.bbc.co.uk/news/uk-northern-ireland-47186124?