

The Internet of Craft things ? : making, resilience, and proximity.

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This paper explores aspects of methodology, materiality and meaning in hybrid craft practices that synthesise conventionally unrelated disciplines, some with historical authority as hand craft, and others without. In doing so it frames a potential alternative to a dialectic of objects positioned as either analogue craft:past or techno fab:future. It commences by outlining a case study undertaken in Bandung and the Garud-Tasikmalaya region of West Java, Indonesia from 2013-2015; the Digital Bamboo Studio. This collaborative, practice-led research project engaged Indonesian bamboo artisans, Indonesian and Australian researchers, designers and design students to ideate and craft novel interactive objects using traditional bamboo techniques, digital fabrication processes and interaction electronics. The project's premise arose from a provocation - what might occur if the Indonesian practice of disrupting existing social media technologies and repurposing them for their own community needs, such as 'twitter trading', were applied to craft practice or production? Could the "internet of things" include craft objects?

Digital Bamboo drew inspiration from Indonesian precedents to conceive and explore links between hybrid crafting and proximity theory; for example crafted objects that function in intimate or personal spaces, but could also extend to connect with social and public spaces, or vice versa. In 2014, Indonesian and Australian students and designers, bamboo artisans and digital fabricators responded to the provocation, developing ideas and producing a range of works exhibited alongside a documentary video at the Institute of Technology Bandung and the University of New South Wales Galleries in Sydney, funded by UNSW and an Australia Indonesia Institute grant.

Analysis of the case study identifies hybridity relationships connecting digital and analogue technologies, processes and materialities, proximity theory and human-object engagement, small-scale making practices and community resilience. Hybrid bamboo/plastic/electronic craft works, their process of becoming, the ideas behind them and values they speak to are also evaluated; with intimacy, empathy and processuality emerging as important concepts for discussion across the range of analogue and digital hardware and software processes. Aesthetic indicators identified in hybrid and non hybrid works are compared, and the work's potential value discussed with respect to their provenance and contemporary value. The potential to connect small scale making communities through interactive, hybrid craft objects and processes is then discussed, speculating on what might be achieved through a better understanding of meaning creation in hybrid craft practices, informed by relationships between hybridity, neutrality and tangible/intangible interactions framed by Hall's proxemics.

In conclusion, the paper positions Digital Bamboo outcomes as a type of hybrid crafting yet to be substantially explored. It argues that the hybrid characteristics of hacking/makeshift /jugaad problem solving epitomised by many analogue and digital craft practices exemplify the type of resilience strategies supporting sustainability, which in the transition to a low carbon future, deserve further research and investigation.

Background

Artisans of the Tasikmalaya region of West Java have hand crafted elaborate bamboo bird cages and domestic utilitarian products for generations, yet sustaining their cohesive community and its traditions faces increasing challenges as part of Indonesia's modernisation, in particular from the movement of labour and industry from villages to cities. As people look to augment their additional farming income, migration becomes a mechanism through which social interaction is enhanced and wealth is distributed from cities to rural areas. By the middle of this century, Indonesia's urban population will rise to 82 percent. Urban migration is viewed by some researchers as a "positive rational choice for young people" because city migrants "usually have better skills and education levels than those who stay in the villages" (Hasan 2014). A flip side of employment driven migration is its impact on existing practices in rural areas, particularly in villages where the craft traditions of handing down skills, knowledge and acumen to younger members of families is disrupted. Other pressures faced by Indonesian bamboo artisans include shrinking land available for farming and loss of local income due to the replacement of bamboo products, by mass-produced utensils.

Economic strategies in developing countries often favour technological 'leapfrogging' at the SME level, characterised by bypassing what are considered outdated industries for current, global models (Van Khoa and Ho 2008: 103). The Indonesian Government's 1,000 bamboo villages initiative is a good example. introduced at the COP2015 summit in Paris, it aims to elevate bamboo as one of Indonesia's major carbon sequestration contributors in their commitment to mitigating climate change. A model of community based bamboo forestry, it proposes transforming 1,000 century old "bamboo villages" across Indonesia into centres of excellence to farm, manage and harvest bamboo to support mid-level industries supplying bamboo laminate; a quality hardwood alternative, bamboo textile industry; a lower input alternative to cotton, and bamboo paper and pulp industry; a more soil friendly alternative to soft wood (Rabik 2015). The initiative is admirable as a sustainability strategy. By increasing bamboo production capacity, it hopes to enhance rural incomes whilst protecting natural resources and sequestering carbon into bamboo forests and products.

Lack of synergy in bamboo management however can contribute to an opportunity gap between the bamboo growers, bamboo utilisation and large industry sectors (Ekawati and Sidabutar 2015). This limits the potential of SME communities directly connected to the resource, particularly those bamboo craft and manufacturing sectors who transform raw materials into the furniture, home and utility products that make significant economic and symbolic contributions to Indonesian culture.

Bamboo is emerging as one of the most promising sustainable materials of our time, eaten, worn and traded by 1.5 billion people around the globe. Bamboo is durable, flexible and subtle, properties which make it an ideal building material in earthquake prone areas. Innovation in the use of bamboo as a design material is evident across the Indonesian Archipelago, possibly best known through the work of Ibuku and The Green School, a group of Indonesian architects, designers, and master craftsmen founded by John and Cynthia Hardy in Bali.

In the 1990s, Indonesian researchers began investigating bamboo, initially for its material properties, as a wood substitute during times of wood scarcity and controversy over widespread illegal logging. Those at the Industrial Design Department, Institut of Teknologi Bandung (ITB), study how traditional craftsmen of Tasikmalaya, famous for their rich variety of traditional bamboo products and production techniques, respond to the new methods of design and fabrication. They have built a significant body of knowledge on the material and working properties of bamboo, its design potential, and the conditions necessary for collaboration between designers and artisans. The researchers have also identified factors affecting the viability of bamboo crafts practices, including inconsistent supplies of raw materials, lack of technical and market knowledge.

Larasati et al. (2013) observed that without design input, traditional craft skills are largely inadequate to produce products with purposes and styles suited to contemporary markets. They developed adaptive collaborative methods to produce contemporary bamboo products, including modern tools and design methods, which create conditions of compromise between craftsmen's skills and demands in contemporary products, and have shown how this practice can lead to quality bamboo product design innovation.

Their results provide a positive outlook for village craftspeople who engage with new product development, provided designers are able to understand production and support conditions associated with village bamboo craft, in particular those that “distinguish among different skills in bamboo processing and match them to their designs” (ibid.: 7) Successful partnerships have led to increased demand for bamboo products suitable for contemporary living, and their research has shown a willingness of bamboo craftsmen in rural areas to gradually adjust to new methods of production (ibid.: 2).

The Digital Bamboo Studio

In 2013, discussions between academics at UNSW Art & Design and the Institut of Teknologi Bandung (ITB) Department of Industrial Design explored the idea of a Digital Bamboo Studio, a project that could combine and extend the interests of researchers at the two Institutions through student engagement in a practice-led investigation. The proposal introduced challenges associated with unfamiliar design processes, cultural contexts and different uses of technology. There was no intention to provide any particular development solution, but instead to explore the reaction to an innovation provocation through the introduction of new tools, design and production processes that may provide new opportunities for craftsmen designer partnerships that had shown earlier success.

The project evolved through preliminary workshops at UNSW Art & Design in Sydney and the Institut of Teknologi in Bandung, where Australian and Indonesian researchers exchanged technical and cultural knowledge pertinent to bamboo craft and digital fabrication. The first of these, in 2013, explored physical relationships between the precise versatility of 3D printing and the natural inconsistency of bamboo. With the researcher’s previous digital fabrication experience limited to working with manufactured materials, the dimensional inconsistency of bamboo proved a challenge, the material demanding tacit interpretive knowledge and adaptive hand work that was not part of their lexicon. Consequently, workshop explorations initially grappled with bamboo’s variability, testing 3D printed plastic jointing systems for bamboo poles, adaptive fitting derived from 3D scans of pole profiles or collapsible ferrules, clip joints and connectors (Figure 1). Despite many of these explorations being speculative, it was important to allow the imagination to generate design possibilities without ‘known’ limits, to start by asking the question, what could Digital Bamboo look like in Indonesia?

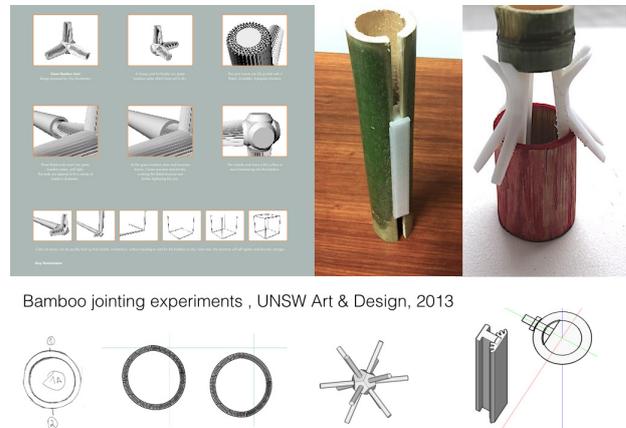


Figure 1 . Examples of bamboo joint systems explored in the initial Digital Bamboo Workshop.

Follow up site visits to workshops in Bandung, Garud and Tasikmalaya deepened an understanding of bamboo craft processes and the thinking of artisans, revealing bamboo material and process innovations that could potentially accommodate 3D printing and laser cutting processes. Workshop observations included mechanically augmented hand processes such as prefabricated bending jigs, the invention of specialised electric drills and sanders, and the use of printed patterns for carving. A more unexpected discovery was the innovation associated with sms technologies and social media across the Indonesian community, such as the use of Twitter accounts for trading purposes and data collection.

A second preliminary workshop, part of the Feral Experimental Design Symposium at UNSW Art & Design Campus in August 2014, provided the opportunity to extend the initial brief via a challenge to design interactive prototypes that might leverage the potential of object functionality through social media. Open source electronics and computer codeⁱⁱ were used to augment the tangible interactivity of bamboo objects via electro mechanical sensors that corresponded with people, computers and mobile phones. Examples of the designs produced included lights that changed colour in response to a text message and public seating which displayed updated traffic density data for pedestrians and bicycle users. Some bamboo connector experiments from the earlier workshop were also developed into larger scale modular lightweight structures, one which collapsed spectacularly whilst nearing completion.



Figure 2. Fitting electronics to a prototype, Feral Experimental Workshop, UNSW.

The final Digital Bamboo Studio, a 2 week intensive course at ITB Indonesia during September 2014, redirected the challenge, asking students to conceive furniture, lighting and related objects that engaged Indonesian people at a personal and interpersonal level. Informed by field trips and intensive workshops, the students worked small teams, responding to the theme of 'security' - what it meant for Indonesians and Australians in 2014. Their designs needed to employ components and processes appropriate to village bamboo craft, plus digital visualisation, 3D printing and laser cutting services available in Bandung. Three types of bamboo craft specialisations of the Tasikmalayan area were introduced : soft, delicate weaving used for flexible structures, bamboo bending methods used to create utensils and bird cages, and the more rigid common weaving used for containers and walls. Designs were to be hand assembled and could utilise open source physical computing code and electronic components. Students were asked to focus on developing objects that materially expressed functional and aesthetic narratives framed by their own cultural and technical exchange.

Following the development of concepts, Bamboo craftsmen attended the ITB Faculty to discuss student ideas and work with them and academic staff towards their realisation.ⁱⁱⁱ The intense workshop event created opportunities to observe how students and craftspeople interacted, and in particular how they approached problem solving between digital and analogue domains of production technology.

The responses were broad; some personally focussed, some more social, for use in domestic and personal spaces. The material narratives varied from those that notably privileged the 'analogue' qualities of bamboo, to others that offered a more technological perspective. Different strategies were used to achieve aesthetic cohesion between what may be considered disparate materials, particularly the contrast of raw 3D printed plastic and bamboo. Some groups exploited the functionality of 3D printing but hid its materiality. Some found a visual and tactile balance between the two. Others reduced the visibility of bamboo or transformed it in ways that repositioned its strong symbolic properties. Despite the variety of approaches, the work demonstrated cohesion and distinctive material and processual characteristics.



Figure 3. Craftsmen working on early prototypes, Digital Bamboo Studio, ITB Bandung.

The results of the Digital Bamboo Studio were presented in two exhibitions, the first at Institut of Teknologi Bandung (September 2014) and later at UNSW Galleries (August 2015). Posters of the designed objects accompanied the 3 dimensional works and a student produced project documentary video was launched at the Sydney exhibition opening along with 3 newly commissioned works.^{iv}



Figure 4. Figure Digital Bamboo Exhibition UNSW Art & Design

Proximity, hybridity and neutrality aesthetics.

Digital Bamboo works display elements of material and conceptual hybridity. The Gestalt principal of proximity describes how we perceive a collection of objects close to each other as a group, anticipating their capacity to merge. This convergence may involve a new synthesis of genetic characteristics, such in animal or plant hybrids, between materials at an atomic level, visual or other information data at a conceptual level. It is not difficult to imagine the binary structure of digital environments as a meta-medium providing ideal conditions for hybridisation, a state that Derrick de Kerckhove (2005) describes as a signature of our age, something so familiar that it becomes casual. This observation resonates with Manovich's (2007) observation, drawn from the film industry, of the 'invisible effects' of deep remixing in the digital domain, where authentic representational origins dissolve. Interactivity could be considered hybridity's digital handshake in our increasingly networked world of communication devices, now wirelessly free to rapidly colonise all sorts of objects.

An anthropological interpretation of proximity provides us with a way to think about how interaction might occur between people and hybrid digital objects. Hall's (1963) theory of proximity provides a simple, yet useful starting point by defining psychologically activated spaces that surround individuals. Close intimate space is reserved only for the closest friends, families or lovers. Next, social and consultative spaces of routine interactions with acquaintances and strangers, and of furthestmost proximity, the remote, public spaces where interactions are impersonal and relatively anonymous.

Hall also argued that human perceptions of space, although derived from senses shared by all humans, are moulded and patterned by cultural understandings and behaviours.

The complexity of proximal relationships raised interesting questions for Digital Bamboo student teams who were encouraged to consider designing objects that on one level connect with people through the intimate, visceral material spaces of craft, and at another via the internet's remoteness. This particular type of 'hybrid object' belongs to an emerging class of Internet 'Things', likely to epitomise objects of the twenty-first century. The popular meaning of the 'Internet of Things' (IOT) emerged from the Massachusetts Institute of Technology Auto-ID Centre in the late 1990s with a frightening prospect: that objects and people embedded with radio-frequency identification tags (RFID) could be inventoried and possibly managed by computers. Today the term is largely understood as a network of objects embedded with technologies capable of sensing their environment, transmitting information, and then leveraging the available data using cloud based internet services to enable different types of dynamic interaction between people and objects. Smartphones and watches are the first wave of these devices, able to detect body movement and offer fitness information. GPS 'apps' monitor and alert us to traffic conditions, and others will soon analyse household appliance performance and advise on optimal energy consumption. Larger scale implementations are already under development, including smart bridges that communicate their condition to inspectors over the internet by analysing fissure and movement data from sensors embedded in bridges and the vehicular loads that cross it.

Personal IOT objects communicate at both the closest and beyond the farthest proximal zone. Hall derived his proxemics system before the appearance of the Internet, and presumably could not have imagined how the psychological activation of objects may cross the spheres of proximity so radically. The internet has opened new spaces where cultural behaviours are transformed, not only between humans but between humans and computers (HCI), and between computing devices themselves, making the extent and nature of interactive possibilities even more difficult to predict.

Despite grappling with these challenge of extended proximity, Australian and Indonesian had tactical precedents to work from. Indonesians use the term “gapték” to describe the feeling of being technologically challenged, but it is a country where digital communication ‘take up’ and innovation is surprising. Indonesia was recently described^{vi} as the social media capital of the world. There are more than 30 million plus twitter users in Jakarta alone. Despite relatively slow internet speeds, the massive adoption of mobile technology, particularly text based applications, has made Indonesia a site of data innovation, where Twitter and text messaging are being explored for a huge range of purposes other than personal messaging, for example to gather health data, or as community warning systems (Muhammad and Meutia 2014). A UN data mining project^{vii} used an analysis of twitter conversations to monitor relationships between food price inflation and external events.^{viii}

These observations underpin one of the key questions upon which the Digital Bamboo project speculates; could makeshift, or ‘jugaad’ style adaption of emerging design and fabrication technologies follow a similar course? Perhaps with the right mix, technology adoption can cross accessibility barriers, suggesting entrepreneurial outcomes might arise through the creative exploration of distributed, lower cost digital fabrication technologies, especially when linked with social media based communications.

Towards a crafted internet thing.

The aesthetics of vehicles and domestic appliances, the historical precedent for hybrid objects or Internet things, has its origins in Louis Sullivan’s ‘form follows function’ aphorism. Its limits became apparent with complexity linked to competing functions in objects, and the challenges of emotional connectivity demanded in consumerism. There is now a sense that this connectivity is moving, through the private gaze, towards cyberspace via the window of interactive screens, accompanied by a re-emergence of rational, black box solutions proposed by Mies van der Rohe.

This continuing trend towards abstraction, perhaps a reaction to complexity alongside an unabating miniaturisation of components, could be interpreted as a type of ‘aesthetics of absence’ in recent architecture and design, described in Hans Ibeling’s ‘Super-modernism’ (Ibelings 1998: 80) as a visible neutrality of surfaces where there are few distinguishing marks.

For a time, before the turn of the century, designers moved away from trying to achieve invisible interfaces towards one that situates them more as a curated experience, an integrated aesthetic of form, surface and operation. Apple’s 1998 iMac is a commonly cited example of successful product design that changed stereotyped twentieth century associations of information technology. The translucent plastic colours of its case subtly reveal the internal circuitry, creating a sense of mysterious embodiment that recoded the computer’s technological identity as a fetishised information tool, and rebooted the companies fortunes. The ‘truth to material’ turn in this design was a nod, for a short time, towards a familiar aesthetic of craft. Apple has since has moved towards neutrality with aluminium notebooks offering a luxurious minimal aesthetic that juxtaposes a vibrant seductive screen showcasing its operating system as a window the cyber world.

Digital Bamboo works exhibit varied aesthetic characteristics, but none are ‘super modern’. Their hybridity is visible, but not the visual blend of embodied technical functionality seen in the iMac. They speak strongly of craft, the visual evidence of raw materiality revealing the marks of making. There is a direct functionality which comes partially from the short time available to create the work, and from the short amount of experience working with new and incongruous material configurations, combined with novel, untested ideas. They share too some of the qualities of steampunk arising with the co-mixing of old and new, perhaps an aesthetics of procedural material aesthetics that conveys a sense of necessity and empathetic, adaptive expression (Bamford 2011).

Whilst the stigma of “poor man’s wood” may still exist in Indonesia to describe bamboo, the perception appeared distant from the thoughts of those attending the workshop. Most design teams approached the material with a sense of wonder and were open to exploring it’s history, material character and potential, often leading to unorthodox outcomes. Observing craftspeople work with bamboo assisted participants understanding of the process of thinking through making.

Using a combination of simple cutting and bending techniques, craftsmen revealed relationships between the plants growth structure, physical material properties, visual appearance, form and functional possibilities. The observations reaffirmed relationships between bamboo's symbolic visual design language, the characteristic striated linearity of a stem interrupted by regular nodes. By splitting bamboo, strips of a multitude of dimensions can be fashioned, that strengthen the linear geometry of constructed and woven forms. Cutting bamboo into sections across nodes provides a circular discs and tubes that can be modified in numerous ways to create joints, clamps and screen structures. By contrast, 3D printed and laser cut objects have a much younger provenance. Like all digital fabrication processes, they embody numeric precision. In Digital Bamboo, these are nuanced in laser cutting by sheet flatness and characteristic 'burnt' edges, and the stratification of solidified, molten plastic in 3D printing.

Some information about materiality can be derived by observing machines, partly because the materials they work are constituted for their processes. Other physical characteristics become apparent once 3D printed objects are assembled, evidencing the more abstracted connection between their computer originated design and performance. Most Digital Bamboo works carried the clear signature of bamboo craft, the result of team interests in capturing the romance of bamboo's materiality, it's cultural reference, and the qualities of artisanal handwork. However, they also evidence the abstraction of design thinking and digital processes. The craftsmen's familiarity with design specifications enabled quick results with little compromise, achieved through visual and material communication. On occasions one could observe a discussion between a student holding a computer screen and a craftsman presenting a bamboo model. Some designs aimed to minimise or make invisible the evidence of digitally fabricated components, such as in 'Tension'^{ix} a wall cabinet defined by its innovative concertina screen mechanism made from bamboo and brass. 'Putar', a novel indoor table lamp light made from wound, glued and woven bamboo, activated by opening and closing a lid via an invisible 3D printed auger. The sliver of light cast across space was conceived to enhance intimacy in 'lounging' customs shared by the students from Australia and Indonesia. 'Ceritera' is a projector lamp, designed to augment storytelling for children by projecting light through an animated strip of cut-out images recalling traditional Indonesian shadow puppetry.

The original prototype called on traditional crafting methods: a direct process of splitting, expanding and tying a single piece of large bamboo. 3D printed and laser cut components were used for the projection winding mechanism, but were hidden from view. The limitations of this design soon became obvious, the focal length of the projection requiring the positioning of the animation cut out a distance from the light source that could not be met using curved inter-nodal arcs of bamboo. The second prototype adopted a bamboo bird cage construction technique where design limitations were less limited by the production technique. It was constructed as a series of flat pack components created by Indonesian craftsmen and digital fabrication devices, shipped to Australia for assembly. This approach permitted the desired functionality, but also necessitated a reconsideration of the visual and material language. The final 'Ceritera' work (Illustration 2) expresses a greater degree of geometric precision to meet design specifications accurately, a task the craftsmen excelled in, and evidences an innovative signature of hybrid crafting visualised through a mix of cultural and processual symbolism.



Figure 5 . The Ceritera storytelling projector lamp.

In contrast, 'Tara', a series of detachable hand held lamps created from 3D printed plastic and woven bamboo, offered a technical challenge to craftsmen and a distinctive set of aesthetic properties that privileged 3D printed plastic. The 'Tara' prototype was also redesigned to include a new lamp hub. It emphasised the fluidity of 3D printing and the technology's capacity to build difficult, accurate shapes to house connector magnets.

This revision extended the functionality and symbolic meaning of the portable way finding security lamp. Enabling the lamp to be hung in the doorway of a house, it signalled group connectivity by allowing family members to signal their presence by placing the lamp in the hub when they arrive home. Another lighting design prototype, 'Mata', adopted a re-use approach, using a clever 3D printed clip to convert a commonly available bamboo craft product into a wall lamp. Examples of responsive internet connected designs include 'Emergency', a SMS triggered warning lamp that glows red when the hashtag '#earthquake' is sent from a Twitter account to the object. Wifi networked lamps, created from bamboo rods connecting translucent 3D printed plastic components that house the circuitry, were designed to be positioned in homes and cafes so that a record of earthquake sightings could be made publicly visible. (Figure 3) The 'Snapshot' interactive stool is a public photo booth that celebrates the selfie, using a sensor to sending an image of anyone who sits on it to Facebook, to capture the surprise of unexpected portraiture.



Figure 6. 'Danger' The Twitter Emergency Warning Lamp

In 'Ceritera', 'Tara' and 'Putar', to different degrees, digital technologies played a supporting role in the design's visual appearance, but also transformed it through light. 'Emergency' and 'Snapshot' presented new challenges associated with their cyber responsiveness. Software was coded for the 'Emergency' lamp to increase the intensity and glow time of its led lights relative to the number of tweets received. It operated as expected for a time, however accumulation of multiple tweets led to illumination lags, highlighting need to redesign more timely, scalar feedback. 'Snapshot' was technically demanding and challenging in terms of usability, also raising ethical questions about privacy and surveillance.

It was a popular exhibit, but observations demonstrated the attention of participants was directed towards the enabling technology at the expense of the crafted object. This highlighted the influence of screen activated functionality in hybrid objects.

Conclusion

The Digital Bamboo Studio explored how a type of hybrid strategy, combining digital 'maker' technologies, contemporary design and traditional craft practices might affect aspects of sustainability relationships in Indonesian craft and design communities. Aspects of the idea have already gained traction in advanced economies, evidenced in the rise of the Maker Movement, but exploring what might happen in others, such as traditional crafting communities, is quite new. At the commencement of the project, similar precedents to Digital Bamboo were difficult to locate, which is unsurprising given its complex collaborative engagement and speculative aims. Sustainability concerns in this project have largely been directed at human : craft relationships, largely socio cultural and economic. Although bamboo is considered comparatively sustainable, this alone is an insufficient justification to avoid future study of how undertakings in this project may affect future material impacts on the environment, should the idea gain traction. Similarly, claims that 3D printing is a more sustainable production method because it produces little waste must also be qualified, even when using biodegradable plastics. The assumption that parsimonious approaches to production associated with craft practices are environmentally less damaging cannot be taken for granted, although failure of smaller scale enterprises appears comparatively benign, or at least concentrated, compared to that of larger industries.

Nevertheless, the project has resulted in a number of concrete outcomes and observations. A generally explorative, inventive attitude demonstrated by participants dispelled some anticipated adoption barriers to new technologies. One of the participating craftsmen described the experience as 'an opportunity to share traditional ways and to learn about new ideas using new technology, to have a natural style bamboo, but to also diversify it with other materials, such as plastics and textiles'^{TX} . The response of other participants suggests that selective combinations of digital technologies and traditional processes are acceptable to craftspeople and are perceived as enhancing the variety and scope of their products, despite technological and material novelty.

This is not to say that accessibility to new technologies or materials present adoption challenges, but innovative precedents with communication technologies suggest that they can be adaptively overcome. The project did not aim to identify particular ways that SME scale industries can integrate industry and traditional village bamboo practices. However some potentially useful observations regarding this potential are offered.

The authenticity observed in Digital Bamboo works is clearly connected to the particular way hybrid processes leave a mark on an idea, in some cases evidencing benefits of optimisation, such as the ease and accuracy of positioning holes in 3D printed and laser cut discs. The works demonstrated, particularly in 'Ceritara' that adaptive design for assembly/ disassembly strategies could also be applied to bamboo craft products, facilitated by accurate and customisable flat pack components that reduce freight and improve co-operative manufacture or collaboration. Interest in exploring 'open source' digital fabrication technologies was apparent amongst participants, notably some Institut of Teknologi Bandung academics^{xi}, and the recent establishment of the new Bandung FabLab. Such initiatives have the potential to catalyse technology skill development. A sense of connectedness and respect between artisans and designers arising from sharing their work and knowledge was also evident, and it is likely that future collaborative initiatives would be driven by designers rather than craftspeople.

Lastly, forays into crafting 'internet things' created a strong degree of interest alongside quizzical reactions. Whilst it is too early to know the future of these unusual hybrids, the approaches explored in this project appear as a disruption to the "super modernist" aesthetics that neutralise contemporary architectural spaces and diminish opportunities for engagement with 'object-ness' beyond the digital monitor. The increasing levels of screen represented materialism appears to advance a denatured meaning of 'things' that parallels the loss of proximate, material intimacy we normally experience through tangible interaction with objects, especially craft objects.

The works created in the Digital Bamboo project also show, through the ways they employ technology, that stories can be embedded in emerging types of interconnected objects that are culturally symbolic, privileging contextual narratives that reference more intimate personal connections between people, materials, specific times and places. They are arguably a new type of object demonstrating a capacity to contextualise threads of digital and material information through artisanal narratives. 'Craft things' offer potential as an antidote to denatured information objects, a reincarnated, proximally extended interpretation of Walter Benjamin's craft workshop (Bamford 2011), perhaps as a disruptive storytelling space of the twenty-first century.

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- i Small to Medium Enterprises
- ii Based upon Arduino and Raspberry Pi computers and components small enough to incorporate into lighting, furniture similarly scaled scale objects.
- iii The final workshop was led by Dr Tita Larasati from ITB and Roderick Bamford from UNSW. Harry Marwadi contributed a depth of design experience working with bamboo craftsmen Mr Mostafa, Mr Yana and local fabricators. Harmein Khaji provided valuable digital fabrication assistance. Dr Adhi Nugraha contributed export focussed furniture design perspectives that incorporated bamboo, rattan and coconut shell. Contributions were also made by Drs. Dodhi, a bamboo expert with decades of experience working with bamboo across Indonesia, whose knowledge enhanced understanding of the national economic context of bamboo, and Dr Andar Bagus, designer of unique Bamboo violin introduced bamboo's acoustic potential.
- iv Digital Bamboo exhibition posters, videos and other information can be viewed at <http://digitalbamboostudio.blogspot.com.au/>
- v http://www.labspace.net/94799/Smart_Bridges_Under_Development_with_New_Federal_Grant. Accessed 20/1/2016
- vi <http://www.slideshare.net/OnDevice/indonesia-the-social-media-capital-of-the-world>. Accessed 23/3/2015,
- vii 'Using Mobile Phone Data and Airtime Credit Purchases to Estimate Food Security', *Global Pulse Project methods paper*, UN Global Pulse (2014). <http://www.unglobalpulse.org/sites/default/files/Global-Pulse-Mining-Indonesian-Tweets-Food-Price-Crises%20copy.pdf>. Accessed 20/8/2016.
- viii London Design Week 2015, held just prior to the Making Futures Conference, included the competition and exhibition 'Powered by Tweets', where similar approaches to twitter innovations were explored. <https://creative.twitter.com/uk/>
- ix Images of each of the works described can be viewed at <http://digitalbamboostudio.blogspot.com.au/>
- x Interview with Indonesian craftsman, Mustofa. 26/9/2014. Translation I. Liu, Sydney, 2015. One example is the range of flat packed Rattan furniture designed by Dr Adhi Nugraha, Head of the Industrial Design Programme at IT Bandung, developed from explorations using 3d printed connectors.