



Qi2He: A co-design framework inspired by eastern epistemology

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ABSTRACT

The rapid development of rural societies mixed with the infrastructural transformation of emerging economies bring both challenges and opportunities to Human-Computer Interaction (HCI) design as illustrated through the emergence of the field of HCI for Development (HCI4D). A key challenge for HCI4D is how local knowledge, expertise, and culture can be constructively combined with global trends in digital innovation and socioeconomic development. Co-design and participatory design practices in HCI offer opportunities to engage diverse communities in design activities which embrace both transition and tradition in constructive ways. We present our co-design framework, Qi2He, which supports designers and local communities engaging in co-design activities. Qi2He is inspired by traditional Chinese epistemology and contributes (i) methods to support cross-cultural co-design engagement, and (ii) post-hoc critique of co-design participation. We illustrate the use of Qi2He through three case studies of HCI design over four years in rural China where local culture and traditions are in a state of flux from waves of migration to cities whilst also being an integral part of the broader national and global transformation. The first case study examines how local rural knowledge can be shared and acquired to create a design system for ethnic brocade production. The second case study explores how the creation of an interactive drama can be used as a driver for rural community engagement. The third case study focusses on the iterative design of cross-cultural interactive product innovation. We conclude by reflecting on lessons we learnt when structuring and restructuring our co-design process and offer suggestions for how our Qi2He framework could be used by others and in different cultural settings.

1. Introduction

Many communities in developing countries are undergoing rapid transformation through urbanization and infrastructure development strategies (Ji et al., 2017). In these situations of radical transformation there are opportunities for cross-cultural co-design and innovation with cultures and traditions that are inevitably changing. Human-Computer Interaction (HCI) researchers have increasingly become interested in looking ‘out there’ (Taylor, 2011) beyond the industrially advanced contexts from which HCI emerged in order to understand a wider range of design contexts, address global challenges of inequality, and inform design practice itself, as illustrated by the emergence of HCI for Development (HCI4D; see Ho et al. (2009) and Toyama (2010). For example, Bidwell et al. (2013) undertook extensive ethnographic studies of rural communities’ use and response to computing and technology, and Jin et al. (2014) carried out HCI design activities with rural populations to inform design. We build upon such research to explore how we can

develop methods to support engagement in cross-cultural co-design activities. Our research in this paper spans four years in the same village in rural China, and is brought to life through three case studies of cross-cultural co-design undertaken in the village.

In this paper, we first set the scene for our research by outlining the socioeconomic context of the rural village we work with in China. We then introduce the challenges of engaging people in co-design activities in rural locations. This leads to our research questions and definition of our cross-cultural co-design framework, Qi2He, in Section 2. To illustrate the use and development of our Qi2He framework we present a series of three case studies in Sections 3–5 of cross-cultural co-design we undertook in rural China. Our case studies are rooted in rural China and provide insight into how co-design can be undertaken in rural China whilst at the same time providing on the ground illustration of the rapid transformation of China. In Section 6 we critically reflect on the use and features of our co-design framework, and to conclude we reflect on the applicability of our approach in other cultural settings and how it could

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be developed and deployed in the future.

1.1. Life and technology in rural China

In this paper we engage in co-design with a local community in a traditional Chinese village which is home to a marginalized population and which for many years was a long drive from the nearest city. In such ‘off-grid’ locations, the historical lack of Information and Communications Technology (ICT) infrastructure means that on one hand the local community remained isolated from government led development initiatives whilst on the other hand they often suffered the side effects of economic globalization such as economic migration leading to family and community fragmentation (Lunstead, 2004). Marginalized populations here mainly include left-behind family structures in rural villages consisting of children, women and elders which is commonly referred to as the “38-61-99”¹ left-behind family structure (Wang et al., 2010).

To understand the context of case studies in this paper, it is worth noting that digital development in rural China is heavily driven by ICT infrastructure investment from central government— a top-down campaign in China’s unique institutional context. For example, from the 1990s “Village Access Projects” (VAPs) to the “Village Informatization Program” (VIP) in the first decade of this century, Chinese government ICT upgrades were an integral part of the e-government and political intent of the construction of so-called “Socialist New Villages” (SNVs) (Xia, 2010). However, not all government initiatives have been successful. For example, many Chinese villages were equipped with a “culture station”(文化站) that included a library, a television, computers with Internet connection, and printers (Oreglia, 2014). However, it was found that few local people actually used these culture stations which is striking in contrast to the wide uptake of mobile phones. Indeed, rural Chinese users’ technology acceptance and adoption process is typically more “mobile first” compared to urban Chinese users who tend to be more “PC first” (Wang et al., 2009). Indeed, Oreglia and Kaye called the mobile phone usage in rural China “a gift from the city” (Oreglia and Kaye, 2012).

Moreover, ICT has been found to heavily impact rural people’s life and their society, for example, Lin et al. (2016) showed that everyday life and the common values in rural China have changed in response to the development of the Internet economy. They described it as an emerging and unprecedented hybrid rurality in contemporary rural China. Whilst ICT development has increased the influence of modernity in rural communities, these local communities struggle to embrace new technologies in their everyday life and prefer to retain local cultural structures such as family, clans, religion, folks and arts as well as other cultural heritages.

The continuing transformation of Chinese society and infrastructure means that these rural areas are inevitably in transition. They provide opportunities for design exploration and the study of hybrid spaces between tradition and global technology trends which are inexorably being introduced through new infrastructure projects.

1.2. Hengling village

The research reported in this paper took place in Hengling village(横岭) in the mountainous Tongdao(通道) Dong Autonomous County, Hunan Province, China. Tongdao is one of the major residential regions of the Dong, or Kam, Gaeml(侗族) who are an ethnic minority of approximately 3 million people in China (based on Chinese National Census in 2000). The Dong people are traditionally rice farmers, hunters and foresters, and are distributed through Southeast Asia as a result of historical migration.

As an underrepresented population in China, the Dong people have a

distinct language (called Dong or Gaeml, as opposed to Mandarin Chinese), rich cultural heritage, for example, the Grand song of the Dong ethnic group was included in UNESCO’s Intangible Cultural Heritage in 2009,² and a polytheist religion. Most Dong retain some traditions such as eating raw meat and matriarchal community structures in their daily life whilst sharing contemporary education practices and many cultural elements with the majority Han Chinese population after living together for over one thousand years. The society is quasi self-governed by village based elder councils and the community based Dong clause(侗款), even during the New China period after 1949. Hengling village relies on agriculture, with around 300 households primarily of three clans with two last names. Fig. 1 shows scenes from Hengling village which is comprised of traditional wood and stone buildings with elaborate architectural features (see Geary et al., 2002 for an in-depth description of the Dong ethnic minority) mixed with fragmented modern elements and smart phones everywhere. As such it is illustrative of the hybrid rurality of marginalized populations in remote Chinese villages. The nearest ‘urban’ location is Tongdao town, a tier-4 township about 50 miles away and connected by only one single lane country road. In the village’s long history, the only people migrating in to the village are through a few marriages with local families.

The research cases presented in this paper were all undertaken under the umbrella of the non-profit social innovation program *New Channel* initiated by Hengling village and Hunan University which is the local state-level university in the provincial capital, under the DESIS (Design for Social Innovation and Sustainability; Manzini, 2009) China network. Since 2009, more than six hundred multi-disciplinary domestic and international participants have visited the village from universities, industrial research institutions, design agencies, NGOs, social entrepreneurs and sponsors, mainly focusing on: i) Craft design including new product development and localized production; ii) Village planning including architecture and local furnishing eco-systems; and iii) Local arts, heritage and culture revival. The New Channel team worked closely with local leaders to schedule and coordinate visits to Hengling village in advance and to mitigate the risks of collaboration fatigue in the village by engaging with different local groups over the years. The program and its outcomes were reported by Chinese and UK media, and UNESCO.³

During the years working with the same local community, we witnessed the dramatic changes of Hengling village which we anecdotally illustrate here to both unpack the context of our case studies and also to give a tangible sense of the rapid changes in China. For example, our first two case studies were conducted before the national highway opened in late 2015. It took us more than seven hours to transport most people and equipment from the airport in the provincial capital (Changsha) to the village by car. In contrast, nowadays it only takes 1 h to the nearest highspeed railway station and then within another 1.5 h people can arrive at Changsha, or within 4 hours can even arrive in Hong Kong by train. Similarly, when we arrived in Hengling village for our first case study in 2013, the mobile phone 2G network was poor. We had to install multiple WiFi hot-spots and landlines to provide adequate internet access for our work. When our third case study was conducted in 2016, the local area was already covered with 4G internet access with quite fast connection speeds. And, as a final example, when we conducted our second case study in 2015, we had to prepare all our making materials in advance and transport them to the village before we arrived. By the time of the third case study in 2016, we were able to use online shopping directly from the village with delivery to the village within a matter of days.

² <https://ich.unesco.org/en/RL/grand-song-of-the-dong-ethnic-group-00202>

³ <https://en.unesco.org/creative-cities/events/lab2030-inspiring-chinas-new-generation-artisans>

¹ In China, 3.8 is Women’s Day, 6.1 is Children’s Day, and 9.9 is Elders’ Day



Fig. 1. The local village Hengling.

1.2.1. Rural makerspace in Hengling village

We established a rural makerspace in Hengling village by renting a local house in the village and upgrading it with projects and facilities over several years. Our motivation for building a rural makerspace was that makerspaces have become an emerging site of HCI innovation (Lindtner et al., 2014) to which people have attached ideals of hopeful cultural intervention (Lindtner and Lin, 2017), activism (Asad et al., 2014), and technology imagination (Tsai et al., 2020). They also offer opportunities for knowledge transmission where participants can engage with research products in-situ, going some way to addressing the issue of academic research which “rarely communicate research insights to those we study” (Fox and Rosner, 2016). More broadly, Rosner et al. (2016) argued for rethinking design workshops as “bringing interventionist encounters into relief as sites, instruments and programs of collaborative study” whilst Williams et al. (2014) proposed design to be a site of engagement with, and interpretation of wider connections between different locales, and between local and global networks.

Aligned with the motivations of the use of various probes to stimulate and facilitate co-design such as Reitsma et al. (2014) and Soro et al. (2016), all three case studies discussed in this paper leveraged this physical venue to interact with local participants which itself grew to become a nexus and a so called “space portal” in which local people and outsiders could come together to share novel approaches and materials brought by locals and different cohorts of outsiders. In our first case study the makerspace was more like a satellite design studio equipped with PCs, WiFi and basic craft design tools. The second case study upgraded the space with the digital fabrication including 3D printers, a design shop, electronics tools and Arduino (Fig. 2). The third case study added a mini digital music studio, more sensors, microcontroller boards and digital making materials. Between each of our case studies, there were also regular local collaborators, on-site designers, and visitors frequently using, maintaining and upgrading the rural makerspace and the rural computing contained within it. Our rural makerspace also provided opportunities for local children to see demonstrations of some

of the digital technologies used in our case studies.

1.3. Co-design and cross-cultural design

Human-Computer Interaction’s (HCI) interest in looking ‘out there’ (Taylor, 2011) beyond industrially advanced countries to inform and understand design led to the emergence of HCI for Development (HCI4D), see Ho et al. (2009); Toyama (2010), and Dell and Kumar (2016). Numerous ethnographic studies of different cultures’ use of technology and ethnic marginalized communities’ responses to interactive technologies such as Bidwell and Hardy (2009), and studies of undertaking HCI design with such communities such as Brereton et al. (2012) have been undertaken. Participatory Design (PD - see Vines et al. (2015) for an overview of participatory research and design) has been widely used in designing with people in underdeveloped and developing regions to foreground their ethnic culture and underrepresented needs to HCI. Greenbaum and Loi (2012) proposed designing *with* local communities rather than *for* them. Hussain et al. (2012) suggested that the early stage of PD should be led by outside designers as they noted that true co-creation is very hard to facilitate at this stage. However, it should be noted that local people’s ambiguous understanding of externally initiated design can lead to a lack of local participation cf. Reitsma et al. (2014).

Considering the epistemological similarities between collaborative ethnography, design and critical making, Williams et al. (2014) suggested that *multisited* design, which can loosely be characterised as cross-cultural location based design, allows us to take design seriously without sacrificing an ethnographic commitment to nuanced description. However, recognizing the inherent challenges of undertaking traditional PD in remote rural locations cf. Brereton et al. (2014), co-design, or alternatively co-creation (Sanders and Stappers, 2008), where the end user becomes an equal partner and is actively involved throughout the creation process, has become increasingly popular in community-based design as an alternative to participatory design. For

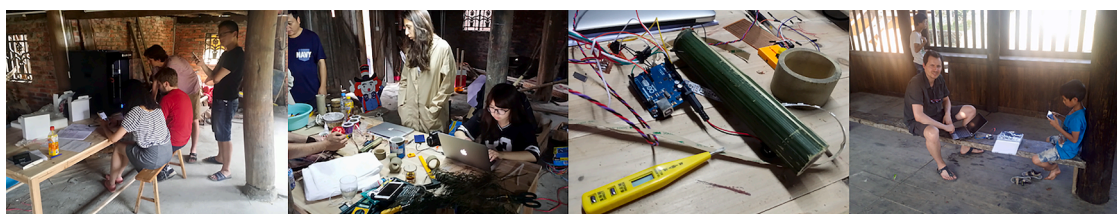


Fig. 2. Rural makerspace in Hengling village in 2015.

example, CrowdMemo (Balestrini et al., 2014), a technologically mediated collection of local stories developed in rural Argentina, was instigated, developed and contributed to by local community members in collaboration with outsider researchers.

1.3.1. Challenges and opportunities for cross-cultural co-design

Aside from issues of poor rural infrastructure and low local literacy, cultural differences and the quality of engagement are core challenges when undertaking cross-cultural co-design. Furthermore, it is important to recognize that “design research and practice is culturally located and power laden” (Irani et al., 2010), and that designers’ positionality may inadvertently sideline other cultures’ values, beliefs, and conventions (Bidwell and Winschiers-Theophilus, 2012). Cross-cultural communication and empathy is needed and significant time is required in building cross-cultural trust, relationships and understanding (Brereton et al., 2012). The challenge for co-design is that care must be taken in building these relationships as collaborating between strangers across cultures carries with it an inherent risk of creating offense through misunderstanding, misinterpretation, and misrepresentation of cultural elements. Cultural difference is a key challenge but also an opportunity in cross-cultural co-design where the question becomes one of how we can “broaden the scope of HCI4D” and “engage with a wider audience” (Dell and Kumar, 2016). Cowen (2002) suggested that the benefits of cultural exchange usually come from dynamic settings with great imbalance. The huge differences provide a rich resource as well as raising pragmatic challenges in collaboration for both outsiders and the local community. Mulgan et al. (2007) presented a “connected difference” theory which highlighted that one value of cross-cultural co-creation with rural communities is that it results in qualitatively different experiences and outcomes than co-creation as practiced within technologically fluent and culturally similar communities.

Winschiers-Theophilus et al. (2019) examined cultural engagement and suggested a transcultural approach by building consistent collaboration between research institutes and local communities. However, this requires efficient mechanisms to immerse outside designers in the local culture and traditions, mechanisms to display their outside cultural value to the local community, for example through ice-breaking, and mechanisms to engage locals in co-design processes across cultural differences. Brereton et al. (2013) suggest that design teams build on familiarity to engage local expertise and cultural knowledge and demonstrate technological possibilities in concrete and culturally relevant ways, and Soro et al. (2016) suggest cross-cultural dialogical probes where design “inspiration and insight comes from dialogue”. It is not just about speaking the local language but more about thinking in their ways, and also helping local communities understand the designerly approach and motivation. An empathetic understanding between designer and local community is crucial in such approaches (Reitsma et al., 2014).

In keeping with Brereton et al. (2012); Irani et al. (2010); Reitsma et al. (2014); Winschiers-Theophilus and Bidwell (2013), and Soro et al. (2016) we found that design practices following a ‘standard’ design process can often be seen by local people as just a process of watching bustling outsiders’ fieldwork with just a few invited local participants, resulting in the design process and outcomes having little or no meaning for local people. Furthermore, we found that “if clear and tangible outcomes are not provided, local people become fatigued and even repelled by several rounds of interviews, pilots, observations, evaluations, and so on” (Wang et al., 2016). The challenge here is how to structure co-design activities which make sense to rural populations within their cultural frame of reference.

Finally, it is worth confronting the reality that behind every neatly written paper conducted “in the wild”, a practical challenge for co-design in most cases is that there must be a trade-off between a reasonable plan and limited resource. And it is not simply a constraint of outsiders’ limited time in local, but also the limited availability of local communities. Even with financial compensation, we found that “after

all, it wasn’t their [local community] business. They thought they are just doing a favor for us” (Wang, 2019). And, finally, a challenge for cross-cultural co-design is the changing nature of community and culture in such a transitional society. For example, in China, there are fewer and fewer subsistence farmers, but those who remain have experienced significant technology and infrastructure transformation in the last decade and will experience life-long and generational change. In these transformational times, rural computing may enable participants to re-imagine how their knowledge practices and cultural identities can adapt and shape economic circumstances and societal changes that appear seemingly out of their control. More broadly, it may provide a platform from which to imagine Indigenous Futures cf. Lewis (2016).

1.4. Research questions

Co-designing across cultures has the potential to generate value for many participants. However, it is difficult to achieve an equal level of engagement and motivation between participants. Rash attempts at cross-cultural co-design often result in urban designers parachuting into rural locations to get some design inspiration and leaving local populations with little engagement or residual value. On the other hand, long term ethnographic studies may be too time consuming and face the challenges in sustainability for both designers and locals themselves who may suffer from fatigue and lack of support. Our research explores: i) how cross-cultural groups of participants can be bridged to encourage co-design engagement in a relatively short time in-situ frame based on an established connection; ii) how traditions and cultural heritage can be bridged with interactive technologies; and iii) how we can reflect on our co-design activities to better understand what we have done and how it happened. Each of these interests holds in itself a contradiction which leads to our research questions:

- RQ1: How can a co-design process be inspired and structured by cultural epistemology to encourage engagement across cultures.
- RQ2: How can cross-cultural design activities be described in a way that allows for post-hoc reflection.

2. Qi2He framework

To explore RQ1 and RQ2 we developed a co-design framework consisting firstly of a co-design method and secondly a notation for analyzing the collaboration in co-design to help structure reflections on our co-design method. Both the method and notation were iteratively developed over the three case studies reported in this paper as we explored how to address RQ1 and RQ2. This paper is a journey through the development of our co-design framework through hard-won in-situ experience. In this section we introduce our methodological rationale and our method to structure co-design activities. Later, in Section 4.2.1, we introduce our notation and use it to reflect on our co-design method and practice.

Cross-cultural design necessarily involves people from different cultural groups. We follow Brereton et al. (2013) and take “culture” to mean “the way of life of a group of people” which in turn means that “participating groups tend to bring into focus different cultural perspectives” (ibid). Throughout our paper we differentiate our co-design participants in terms of their cultural group and roles as follows:

- Participants*: people who participate in the co-design activities directly as makers, or indirectly as audience, consumers, and providers of feedback;
- Local*: rural residents who live within Hengling village;
- Domestic*: urban participants from China, but not from the Dong minority;
- Foreign*: participants from outside China;
- Outsider*: a group comprised of foreign and domestic participants;

Facilitators: participants who structure and facilitate the in-situ co-design process, including the three authors (author one: foreign, UK; authors two and three: domestic), as well as local guides, rural and urban translators and contacts in local communities.

2.1. Methodological rationale

To structure our co-design activities with rural communities we wanted to use approaches such as a Participatory Design (PD) and structure the activities as Initial Exploration, Discovery and Prototyping (Spinuzzi, 2005), or the co-creation process proposed by Sanders and Stappers (2008). However, we found that the terminological and cultural reference points of such approaches were not shared by local participants in Hengling village and their rich tradition of craft practice (Section 3). To address this challenge, we adapted a traditional Chinese literature composition method which follows four steps of 起承转合 (Qǐ-Chéng-Zhuǎn-Hé) to structure our co-design method. We call our method Qi2He (pronounced Chee to Hur) to mean that our process includes all the steps from 起(Qǐ) to 合(Hé), to acknowledge its roots in 起承转合, and to make it easier for non-Chinese speakers to pronounce, read, and write. In this way we built our design practice on local epistemology as argued for by Kapuire et al. (2015). The 起承转合 literary pattern is thought to date back to the poetic form which grew in the Tang dynasty (618AD-907AD) drawing on roots in Confucian (551BC-479BC) rhetorical style (see Kirkpatrick, 1997 for an overview of such methods) and is structured in four parts with “qi (beginning), cheng (continuation), zhuan (transition), he (conclusion)” (ibid.). Nowadays the 起承转合 structure is a widely taught literature composition technique in China which would be known to most Chinese including local Dong and domestic Han participants before leaving their basic education. Note that the aim of Qi2He is to provide a shared structure for co-design between the participants, not to explain the 起承转合 literature composition method itself to foreigners.

We adapted 起承转合 in our Qi2He method in a way which is not a literal translation of Western Design methods but which can be mapped to the design methods that most outside participants and our readers would be familiar with such as PD and co-creation mentioned above. Fig. 3 illustrates the mapping between our Qi2He stages and more familiar Western design methods. Table 1 illustrates how the terms of 起承转合 in the left hand column are realised in our Qi2He method as pragmatic design activities in the right hand column which we iteratively refined in our research and reflect on in this paper. The descriptions in the middle column are approximate English language translations of the 起承转合 stages and are used to help communicate the Qi2He design process between Chinese speaking and English speaking collaborators. The key rationale for choosing 起承转合 as the basis for our approach rather than other more local ideas or more common Western co-design processes is that it allows Qi2He to provide a common *in-between* ground to balance the trade-offs of differences in custom, education, languages and disciplines between local, domestic and foreign participants (three different cultural groups), as well as participants, facilitators and researchers (three different roles in the research setting).

Our approach to structuring our co-design method drawing on Chinese literature composition methods reflects a growing interest in the HCI community of building on trans-cultural engagements with communities (Winschiers-Theophilus et al., 2019) and new design methods for postcolonial computing (Irani et al., 2010) to address some of the concerns about cross-cultural design such as “even though differences between cultures are exposed, the intrinsic values of technology and their developers are continuously perpetuated within the design” (Winschiers-Theophilus et al., 2019). We build on research such as Bidwell’s use of “design-oriented walks” (Bidwell and Winschiers-Theophilus, 2012) which draw on local traditions and culture to structure design methodology, with an intention to construct a hybrid of

consensus and shared understanding. As such our approach attempts to bridge between the two epistemologies of Chinese literature composition and Western design thinking. Using Winschiers-Theophilus et al. (2019)’s classification of cultural engagements we could describe Qi2He as a trans-cultural methodology bridging Chinese and Western epistemologies.

2.2. Case studies

In the remainder of this paper we present three case studies of our cross-cultural co-design practice through which we developed and refined our Qi2He framework. These case studies are the footsteps of our journeys with locals through time and transformation. They cover four years from 2013 to 2016 in the history of Hengling village as summarised in Table 2. This journey is also a story of our learning and reflection on approaches to bridging between cultures which we reflect on later in this paper.

The first case study brought outside designers to Hengling village to explore how products and services could be designed drawing on local culture and heritage to create value for local populations. We found that our initial attempts at design engagement were not successful and so we developed a nascent version of our Qi2He process to structure cross-cultural co-design activities in which traditional crafts and techniques were mixed with digital design and online technologies. Reflecting on the use of the fledgling Qi2He process we then refined our practice to place greater emphasis on the 转Changing and 合Concluding stages, as well as aiming for a more collaborative approach in the 起Introducing stage, and more clearly defined activities for each of the Qi2He stages.

The second case study used our refined Qi2He framework and explored how outsiders and rural locals could co-design experiences together to generate in-situ community value and engagement. In this case study we bridged cultures by bringing together traditional stories, music, and materials, with digital technologies and outside performance values (mostly from European theatrical genres and styles). We also developed a notation for analysing participation in cross-cultural collaboration to help us to better understand the realities of the design process.

The third case study refined our Qi2He process by placing an emphasis on in-situ designing and making in the 转Changing stage to explore how new products can be imagined and co-designed in a rural village drawing from local resources and preferences. This case study re-imagined local and traditional objects through the lens of physical computing, aiming to connect local cultural heritages with technological innovation through co-design.

3. Case study: brocade design system

The first case study is about a brocade design system we built in 2013 to support local craft production revival (Wang et al., 2014). Local people’s ethnic brocade weaving (Dong brocade, Dong Jin 侗锦 in Chinese) is a national Intangible Cultural Heritage, and was the traditional fashion in the rural Dong minority community. However, the local brocade industry has been facing a crisis with the impact of the external economy, the modernization of local society, the increasing preference of the rural youth to move to suburban areas as migrant workers, and the plentiful availability of cheap textiles from factories in Guangdong. Even for people living in the rural area, weaving brocade by hand is considered a low-profit job and deemed an out-of-date custom by rural populations. Also, because of the influence of outside fashion culture through mass media, local customers prefer cheaper mass-produced fashion rather than traditional handmade brocade. For example, a skillful weaver takes 15–20 days to make a handmade scarf. This would cost 100–180 USD which exceeds the price that local communities and customers are willing to pay as the average local salary was about 7–10 USD per day in 2013. Much like other Intangible Cultural Heritages, both the local brocade culture and its industry were dying out in

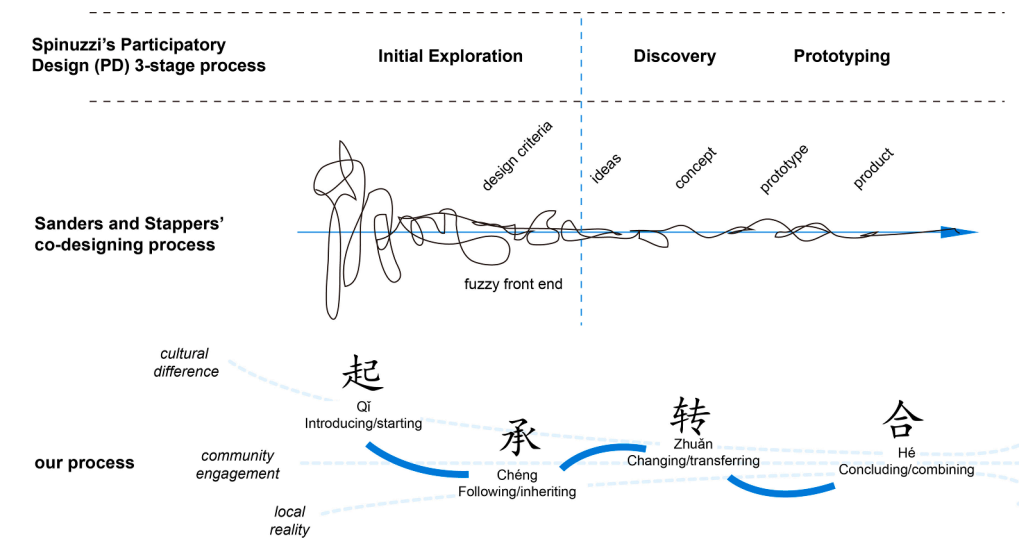


Fig. 3. Qi2He method compared to participatory design and co-design methods.

Table 1
Stages in the Qi2He co-design process.

Stage	Translation	Activity
起 (Qǐ)	Introducing/ starting	Start by learning and sharing new technical skills. These technical skills then underpin the making in the later stages of the process.
承 (Chéng)	Following/ inheriting	Follow by culture sharing between participants which is used to build understanding and cultural appreciation and to inform the design in later stages.
转 (Zhuǎn)	Changing/ transferring	Co-creation and mutual inspiration involving hands on co-design innovation and evaluation using in-situ making. This is where divergent design thinking occurs and offers the chance for participants to explore the combination and re-imagination of cultural elements and skills from the起 Introducing and承Following stages.
合 (Hé)	Concluding/ combining	Conclude by co-design refinement together of the ideas and low-fi prototypes of the转Changing stage, along with production, presentation, and evaluation of more robust and interactive artefacts. This stage is where convergent design thinking happens in partnership with reflection on the转Changing stage and iterative evaluation and refinement of the artefacts.

Table 2
Summary of case studies.

Section	Case study	Topic
3	Brocade Design System	Co-designing new brocade products drawing on local traditions to address cultural and economic issues
4	Interactive Performance	Co-design of interactive performance combining local intangible cultural heritage with digital technologies to generate community engagement and societal value
5	Cultural Product Innovation	Co-design of culturally inspired possible future products combining digital technologies with local traditional crafts and culture

Hengling village and the region more broadly. This situation motivated us to explore what technological solutions might bring to addressing this cultural and economic crisis.

3.1. Co-design process

Dong brocade, much like many other traditional crafts, involves craftspeople who are both the producers and the designers. In comparison to “outsourcing the hands” (Murray, 2010), we are more interested in how co-design with digital technology can revive the local Dong brocade eco-system. Specifically, we focus on exploring whether a new platform could allow outside designers to easily learn the essence of Dong brocade and then leverage their modern design expertise to co-design new products with the local community which could then be produced in the local eco-system. At first, we tried to send domestic designers to the local community to introduce some modern design

approaches to the rural community and to educate local craft women in new product knowledge (Fig. 4), most of whom were middle-aged with low-literacy. Very soon we faced push back from the local community and realized that this approach did not work due to a mismatch between the local participants’ cultural background and their use of warp and weft yarns⁴ to directly design their brocade, and the domestic designers’ use of computer based graphic design tools and design thinking to create graphical representations of brocade designs. As an example of the mismatch, local craftwomen who attended our training reported that they felt that it was very hard to imagine how “screen-based graphic patterns” would actually look as brocade, and in interviews, most local trainees reported that it was a struggle to sketch out design ideas before weaving, with one of the local weavers commenting that they could only “make it by trial-and-error with the loom and the hand rather than the paper and the pen”. Moreover, most participants reported that they did not see what the benefit would be to them of learning a different design approach. This was in part due to a lack of local ICT literacy which caused the computer based design system to be a barrier to collaboration, and also a lack of local appreciation of their unique cultural value from a broader domestic and international customers’ perspective - i.e. understanding why it would be valuable to combine traditional brocade making with outside design values and approaches.

To build more engaging collaborations between local and outsiders

⁴ The core components of woven fabrics are warp and weft yarns with the vertical yarns of a brocade referred to as warp, and horizontal as weft. Fig. 5a illustrates the overall arrangement of warp and weft yarns in a brocade design, and Fig. 5b illustrates how warp and weft yarns are woven together to create patterns.



Fig. 4. Introducing design to the local community.

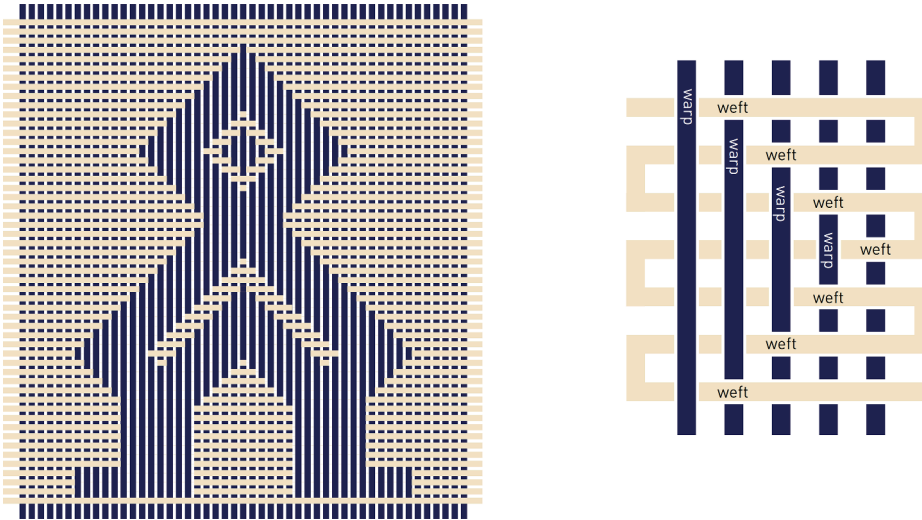


Fig. 5. (a) Example Brocade design (b) Detail of the weaving together of warp and weft yarns to create a pattern.

we searched for a way to structure our collaboration which would be rooted in local cultural practices and norms and struck upon the 起承转合 pattern as a starting point for our Qi2He approach as outlined in Section 2. Below we reflect on this first version of the Qi2He approach.

起(Qi) Introducing/ starting (3 days in the local area and rural maker-space) To start the new design process, we provided five domestic design students (senior graduates who all had more than three years experience in graphic design) classical brocade examples, and asked them to learn the patterns, and use these as inspiration to create pattern innovations (see Fig. 6). They needed to sketch out different elements, iterating

details then integrating these into the final design. We then invited three local brocade experts who had many years' experience in weaving as well as pattern design to review the students' designs. The formal educational background of these middle-aged women ranged from elementary school to high school education with no design or similar college education. They all learned weaving from their community and family heritage. An interesting finding was that all local experts believed that the students' patterns were not related to Dong brocade and could not be woven even though they were inspired by classical brocade examples. For example, a local master said she appreciated students'

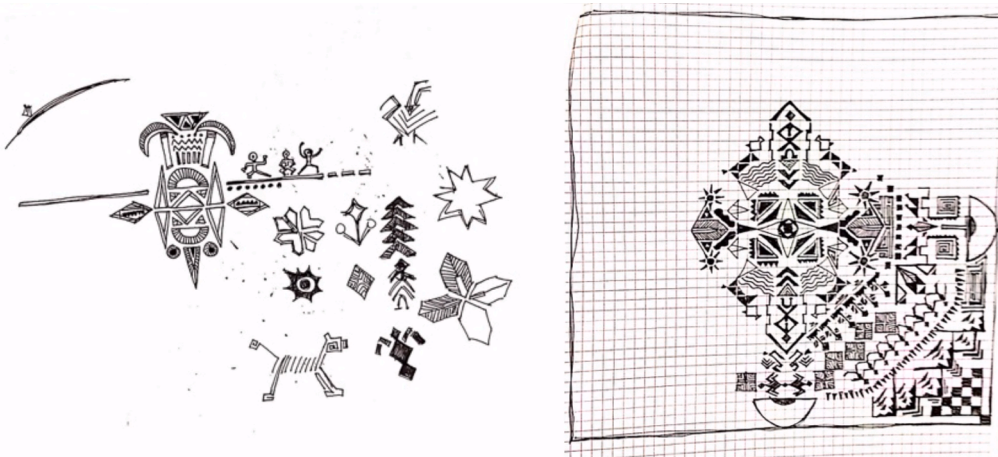


Fig. 6. Design students' initial brocade designs in the 起Introducing stage. Left: sketch; Right: pattern design from sketch.

drawings but had “no idea how to use them in brocade, maybe good for packaging design rather than brocading”. One of the major problems was that the whole graphic structure was an outsider’s thinking from a modern graphic design perspective even though it included elements modified or copied from their original brocade. The grammar of the designs, the composition rules behind graphic patterns, could not work with the Dong’s loom production skills. This also highlighted that the design students really needed to learn some weaving skills before they could contribute meaningfully to shared creativity.

承 (Chéng) Following/ inheriting (5 days in the local area and rural makerspace) We then ran a week long workshop in which all domestic students learned weaving skills and tried to weave some basic patterns from the local masters. For most of them, this was the first time they worked with the looms, threads and shuttles, and to try to use their ‘muscle memory’ to understand a pattern’s composition (Fig. 8). For example, they learned how to count the sequences of combinations of warp and weft yarns which represent brocade patterns. Students reported it was a totally new experience compared to working with pixels in the front of computer which helped them to better understand how a pattern not just “looks like” but also “works like” in the local technique and knowledge. One design student stated that she used to design the graphics from a “top-down view, but now will think it more from a bottom-up perspective from the mechanism of materials”. In the end of this stage, we asked students to make another set of design sketches. The differences in the new designs such as the continuous patterns of the cater-cornered design in Fig. 7 compared with earlier designs in Fig. 6 showed that the students had a better understanding of the brocade’s composition rules based on its production technique. This difference was reflected on by local experts and three local masters who all agreed that students’ designs from this round would be more feasible to create in their loom system. Local brocade experts who attended the workshop also reported that they learned new pattern ideas and design knowledge, such as how to represent ideas by sketching, from students when they discussed technique together. Additionally, a local master mentioned that she “now has a better sense on what those outside youth like” (sic). Indeed several of the local experts kept long-term contact with domestic students after they left, and then went on to become the production backbone when the new designs started to be locally produced.

转 (Zhuǎn) Changing/ transferring (2 months in the outside research lab) As with other field study inspired design processes, students returned to their urban design studio after their short time in Hengling village and developed new product designs (Fig. 9) for e-commerce as well as developing a new brocade design tool (Fig. 10) based on their experience from their collaboration in the local community. To better iterate the design, a loom was shipped to their studio which allowed hands-on iteration of their designs which were then checked with the local collaborators remotely. A prototype of the digital tool’s user interface was

also designed to support the interactive design of Dong inspired brocade patterns, which included a design system of style templates, pattern library and design constraints that combined the rules of traditional patterns and elements with traditional stylistic and loom weaving constraints (Fig. 10). The concept of the browser based digital tool was designed to support a larger-scale collaboration between designers and local craftspeople remotely in the future.

合 (Hé) Concluding/ combining (1 month in the local area and rural makerspace) Design students then took their product design proposals and the design system prototype back to Hengling village. For the product design proposals, local craftwomen reported that they could understand and produce the samples very well. Indeed, a local master who attended the previous sessions said that “it was much easier to make these products as exact as it is designed compared to the very first ones they showed us. For most details, we can understand without asking them [students]”, indicating to us that the students’ designs had successfully drawn on both the traditional design style and production methods. The local community now produces these new products and sells them in an e-commerce channel on the Chinese online shopping platform Taobao which has significantly increased their new revenue stream. For example, in a follow up visit 12 months later we found that local craft women who constantly produce and sell the designs can earn 300 to 500 USD income per month which was relatively high in 2014 (Fig. 11). Furthermore, it made some local youths realize for the first time the new commercial value of their grandmother’s out-of-fashion brocade when incorporated into new designs and even encouraged them to start to learn Dong brocade weaving. In a return visit in 2014, we met some younger local people in their 20s and 30s who had joined the local makers who we had never met in 2013 or before. This success also built the trust with local community leader which allowed us to continue our exploratory works in the next case studies. However, all local weavers faced challenges in understanding the design system and user interface prototype (Fig. 10), and didn’t think that it would be useful or improve the brocade design collaboration. When we tried to propose the design system as the second phase collaboration to local community in 2014, their responses were quite cold compared with their enthusiasm to continue on the real product design proposals. Part of the reason may be that there was a mismatch between the user interface and the design system content - whilst the design system embedded local knowledge and practice the user interface was designed in a computer-assisted or computer-supported collaborative work paradigm and was not sensitive to local practice and knowledge. Moreover, whilst participants did not express any concerns about the possible loss of craft skill to a computer their low levels of ICT literacy remained a barrier to engaging with a computer based system which relied on metaphors of windows, mouse, icons, and pointers.

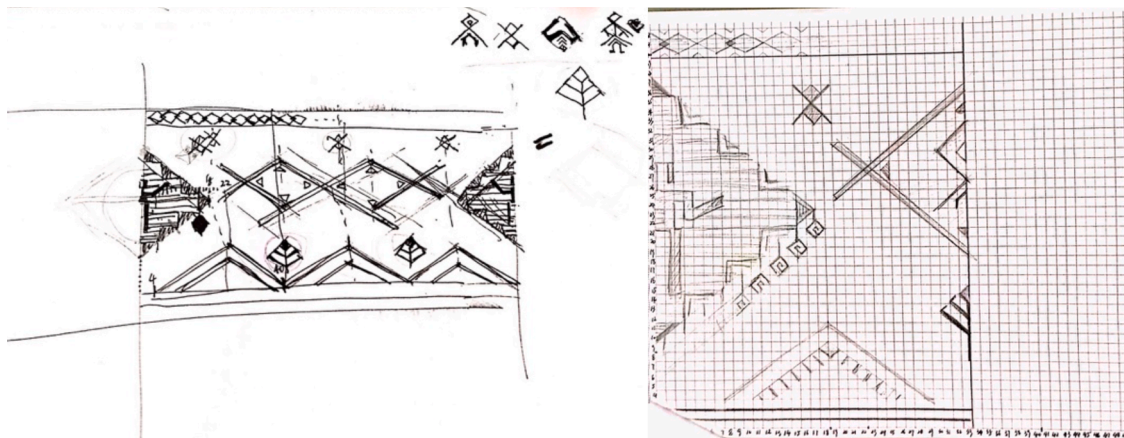


Fig. 7. Design students’ revised brocade designs after learning traditional weaving skills in the承Following stage. Left: sketch; Right: pattern design from sketch.



Fig. 8. Learning weaving from the local experts.



Fig. 9. New product designs.

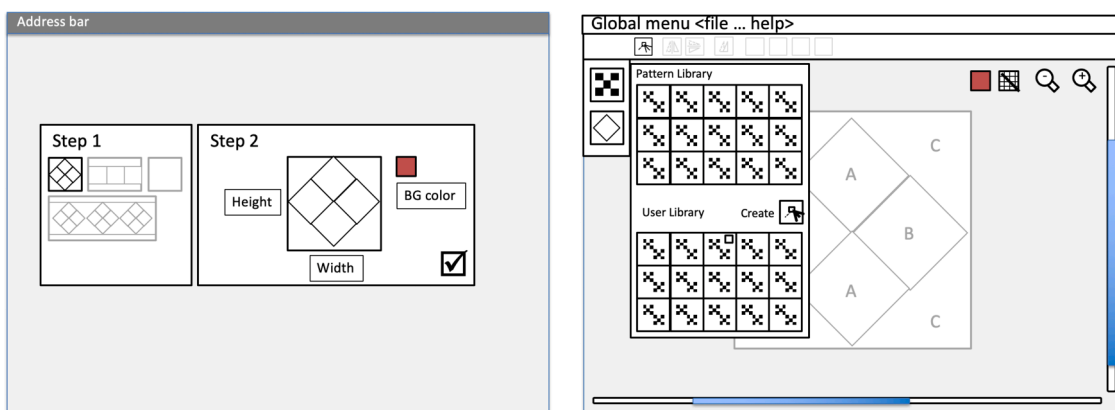


Fig. 10. Prototype interactive system for brocade design.

3.2. Post-hoc reflection

Reflecting on this case study we realized that it is critical that the *转* Changing stage should be undertaken in the rural location to ensure that locals and outsiders can participate together closely. This is especially true for the complex or more exploratory design questions such as the conceptual digital tool in this case versus the more concrete product

designs. If this is not done, there will be challenges in the *合* Concluding stage as there is a greater risk of producing designs which rely too heavily on sensibilities from one culture which then does not meet the expectations of all collaborators, and in the end the whole project may fall into the common pitfall of parachuting designers who merely glimpse the veneer of rural communities and then undertake the creation activities outside.



Fig. 11. E-commerce website channel (2019).

In addition to the need for greater in-situ work in the *转* Changing stage, we found that it was difficult for us to identify and follow the patterns of engagement between people in the co-design process afterwards. All activities in the local village happened in a responsive and impromptu process meaning that most of them were unplanned and we found that we needed a more structured way to understand the emergent collaborations. This in turn made it hard for us to reflect on what would improve the opportunities for co-design engagement and how we would be able to identify differences in engagement if we changed our approach to co-design processes. This called on us to explore a post-hoc analysis method in the next case study.

4. Case study: interactive performance

Critically reflecting on our first case study in which the emphasis was placed on the *起* Introducing and *承* Following stages, we decided in our second co-design activity to refine Qi2He to increase the engagement of local participants throughout our co-design process, especially the *转* Changing and *合* Concluding stages. The facilitating team contacted local craftspeople and village elders several months before the planned visit to the local village, Hengling, in order to identify a range of possibilities for collaborative activities, to introduce the idea of using the Qi2He stages to structure our collaboration, and to identify local participants who would be interested to take part. In these discussions with locals we co-developed the idea of co-designing and producing an interactive drama for public performance. The local collaborators felt that this had the potential to engage a wide section of local participants and also build a combination of the researchers’ expertise in digital making, interactive sound, and interaction design, along with local Intangible Cultural Heritage music and performance as well local interest in developing new ways to perform their traditional material. Moreover, local community leaders, such as the matriarch of a large local clan and local administrators, also backed this theme because they believed it could enrich local residents’ entertainment through public participation. These pre-arrival conversation and preparation were similar to the “deliberate interactions” of *Wyche et al. (2010)* in which we defined the scope and focus of our co-design with locals prior to arriving to maximize our use of in-situ time. When we introduced our Qi2He idea to the local community leaders using the *起承转合* phrasing, it was quickly understood, as evidenced to us when they showed us the location options for making (which they called the *转* Zhuǎn stage) and rehearsal (which they referred to as the *合* Hé stage). This also gave us confidence that the Qi2He structure and approach could feasibly be introduced to other locals. The detailed Qi2He schedule was then introduced to outside participants shortly before they departed for Hengling village to prepare participants for their stay in the village.

4.1. Co-design process

In 2015 we spent 13 days in Hengling village co-designing with locals a drama performance including six digital interactive elements co-designed and made in-situ in our makerspace (*Bryan-Kinns et al., 2018*). We assembled an outsider team of five foreign multi-disciplinary European students with backgrounds from geography to materials engineering paired with five domestic Chinese postgraduate design students, a local team of five experienced local musicians who were all middle-age farmers or migrant workers who have music performance experience in local bands and clubs, and the three authors of this paper who facilitated the co-design process. Our process culminated in a two-hour public performance on the village’s Drum stage to over 300 local people and a few outsiders (*Fig. 16*) and an exhibition of the interactive pieces which was reported as being well received by the local audience based on a sampling survey with 30 responses just after the show, and was reported as most people’s first experience of interactive art and physical computing (*Bryan-Kinns et al., 2018*). The Qi2He stages were undertaken as follows.

起 (Qǐ) Introducing/ starting (2 days in the local area and rural makerspace) As this first stage is about learning and sharing new technical skills we ran two one-day making workshops in Hengling village to expose outsiders to interaction design and physical computing tools and techniques (e.g. Arduino), and to orient them within the village. In this stage we bridged outsiders with the local environment by using local found materials and sounds in creation of physical computing in-situ (see *Fig. 12*). These playful creations were shared with local passers-by in the village being the connection between local and outsiders and to raise awareness of the potential of making and physical computing. Using found materials in physical computing combines traditional elements with digital transition, for example, adding interactive sound to found wooden toys from the village.

承 (Chéng) Following/ inheriting (3 days in the local area) In this stage which is about culture sharing we aimed to expose outsiders to local culture through workshops with local musicians on traditional songs and musical instruments, visits to local families in their homes, and visits to local schools (see *Fig. 13*). Traditional and modern were bridged through, for example, learning local songs and playing them on modern (digital) instruments. In this stage, the wider local community including people from four nearby villages had the chance to interact with this new cohort of outsiders and learned about the purpose of their visit. For example, the first “town hall” style open discussion meeting we conducted started at 7pm in the grounds of a local elementary school (see right of *Fig. 13*) and attracted more than forty people who attended our meeting at the end of their workday which was quite beyond our expectation.

转 (Zhuǎn) Changing/ transferring (4 days in the local area and rural makerspace) To recap, this stage is about co-creation and mutual inspiration and involving hands on co-design using in-situ making. The



Fig. 12. Making in the rural makerspace.



Fig. 13. Conversations with locals.

majority of the co-design work was focused around the idea of producing “Dong’s Romeo and Julietta” - a love story derived from a local drama found by outsiders during their visit to a nearby festival in the承Following stage, but with an outsider twist. Participants included the outsider team and 5 local musicians who joined from the承Following stage. Participants were split into cross-cultural teams to work on the script, acting, props and costume, set, and music. An emphasis was placed on using interaction design and physical computing to bring these aspects of the performance to life, for example, co-designing interactive props for the performance. Design concepts and prototypes

were created and mocked up in our rural makerspace (see Fig. 14). The participating local musicians reported that the music was co-created with the outsiders through a process of iterative selection and adaptation of traditional music repertoires. In this way traditional musical elements were combined with modern performance techniques and staging through a process of co-design.

合 (Hé) Concluding/ combining (4 days in the local area and rural makerspace) The final stage of the Qi2He process involves co-design refinement along with design production, presentation, and evaluation. The teams worked together to build the props and sets (see Fig. 15),



Fig. 14. Scripts, props and set design.

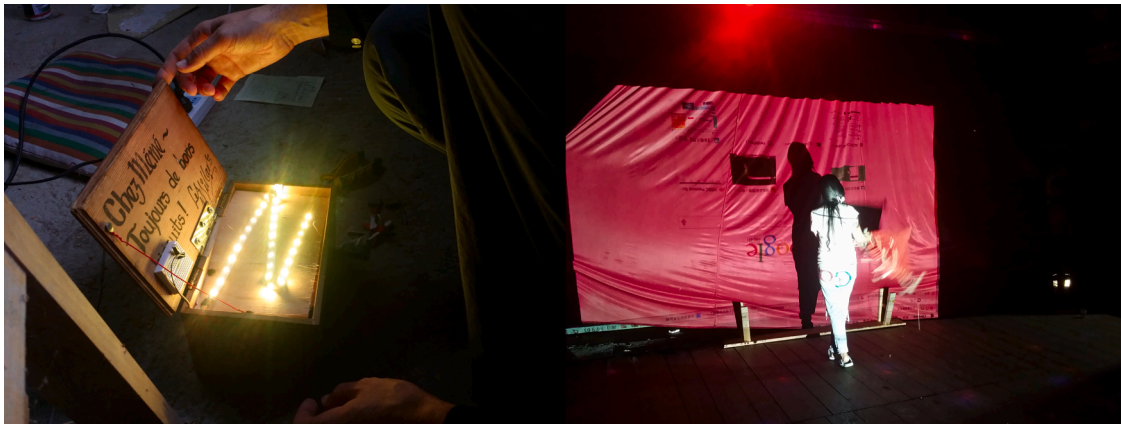


Fig. 15. Prototyping, testing and rehearsal.



Fig. 16. Public performance.

make costumes, and rehearse the performance, culminating in the public performance and exhibition. This making mostly took place in the rural makerspace in Hengling village using traditional materials and tools in combination with digital tools such as 3D printer and Arduino. During this stage participants needed to frequently engage with local people from nearby villages to help in the design and production of the props and costumes, and these serendipitous interactions led to further points of co-design. For example, in sourcing materials for a bamboo shoulder pole participants additionally learnt how the shoulder pole would traditionally be carried, and were introduced to some basic basket weaving and bamboo carving techniques from other local craft community members who were not involved before this stage. Local musicians and participants reported that such expertise sharing experience was also novel and interesting for them. Moreover, they commented that they would probably have no chance to learn of such expertise even though they lived closely together. Locals mentioned that the co-making not only gave them a shared language to understand the intention of outsiders but also a new lens to look at their neighbours, their community and where they lived. For example, one musician said he never expected to receive such recognition in his performance and creativity from local friends and other musicians even though they knew each other quite well - before this show he never had such chance to explore the other side of performance (storytelling and making props) and to show these to his neighbours, and “Now they know me better and it feels great”. A local participant also reported that she passed the village drum tower (the stage) everyday but “never thought it can be such a different place as after decorating by LEDs and electronics in night. I am proud that I live here [the village]”.

Three interactive props were co-designed and built using Arduino to

control and trigger recorded sounds in the performance, and to light up a range of LEDs in response to performers’ movements at key parts of the performance. An additional three interactive pieces were created for the interactive exhibition following serendipitous interaction with locals during the Qi2He process. Two pieces were co-designed with local elders to respond to local health concerns - an interactive piece to encourage children to play sport as there was a lack of local sporting facilities despite sports such as football and basketball forming part of all local children’s physical education, and an interactive alcohol game to highlight the health issues around excessive alcohol consumption. The third piece was a new digital musical instrument co-created with local musicians using bamboo making skills learnt in-situ. The final performance is illustrated in Fig. 16 and was attended by more than 300 local people from nearby villages, migrant workers who had returned home especially for this event, and a few domestic visitors. From an audience survey conducted by sampling 30 people, the overall impression of the event was rated as “very good”, and in interviews most audience members liked this form of public performance. A local young returned migrant worker stated that this drama was more like other shows he watched in urban area and was more vivid and attractive compared to traditional Dong dramas, which use only simple props and sets, and slow singing. Indeed, he said that this new production of a Dong traditional story had awakened his interest in his own ethnic culture which he had felt distant from, especially when working in urban factories.

4.2. Post-hoc analysis

Following reflection on our co-design activities in the first case study we realized that we needed ways to better structure the analysis of our

co-design practice. To address this issue we developed a notation for post-hoc analysis of patterns of engagement between participants (Bryan-Kinns et al., 2018) which forms the basis of the Cross-Cultural Engagement (CCE) notation introduced in Bryan-Kinns and Wang (2018) and detailed in this section to capture the flow of interaction between groups of participants engaged in cross-cultural design activities from observation and interview data.

4.2.1. Cross-cultural engagement (CCE) notation for analysis

In CCE we focus on identifying the flow of interaction between groups of people involved in co-design activities. We consciously prioritize readily observable phenomena such as handing over a piece of design work for someone else to work on, or asking for feedback, over hidden phenomena such as an individual’s thought processes or feelings in order to characterize flows of interaction between people without relying on inferring meaning or intention. On one hand this allows us to identify instigators of collaborations and patterns of flow in the collaboration which is useful for understanding how the collaboration unfolded. On the other hand, it does not shed any insight into the thoughts, feelings, or cultural and aesthetic sensibilities of participants. So, CCE provides a way to understand the *shape* of the collaboration, but not the *meaning* of the collaboration.

Data sources for CCE analysis include observations, interviews, and field notes, all of which are transcribed and then chunked into discernable design activities where two or more people are engaged in co-design work together. In the notation a co-design activity is enclosed in curly brackets with the initiating group listed first (if there was one), followed by which groups were involved in the co-design and what the engagement relationship(s) were between them. For example: {domestic: domestic ⇌ local} indicates a co-design activity initiated by domestic participants with local participants, whereas {domestic ⇌ local} represents co-design in which domestic and local groups engaged with each other with no clear initiator of the collaboration. Table 3 describes the kinds of engagement relationships in our notation using examples from this case study to illustrate the use of the relationships.

4.2.2. CCE in use

In this case study the researchers kept extensive field notes on our observations of collaboration and design activities, and interviewed participants throughout the co-design process. We then used our CCE notation to analyze the data and identified a total of 39 co-design activities (14 which had no clear instigators, and 25 activities which had clear instigators). Where there were no clear instigators the engagement

usually involved outsiders and locals equally e.g. {local ⇌ outsider} or {foreigner ⇌ domestic ⇌ local}, illustrating how our approach had bridged rural and urban through design. On the other hand, we found that locals were most likely to instigate collaboration. For example, the choice of music for the drama was initiated by the local musicians, co-created by the local musicians, and undertaken with feedback from outsiders {local : local ⇌ local ← outsider}.

We found that the patterns of extended co-design activities were mostly instigated by locals which illustrates the strong leadership role that locals took in the co-design process. For example, we observed that locals provided frequent self-initiated feedback to outsiders during the rehearsals on how they should move and gesture for the local audience, which in turn led to co-design of the script between local, and outsider participants {local : outsider ← local} ⇌ {local ⇌ outsider}. In interviews we found that a local participant had expressed concern to the outsiders that early drafts of the script were too much like a Western musical, and did not fit well with local cultural norms and expectations. This led to the local participant finding a video of a traditional performance for the outsiders to watch together with them in order to improve their understanding of traditional performance {local : outsider ← local} ⇌ {local : local → outsider}. And, we observed many cases in which local feedback led to co-design together. For example, during the prop making stage we observed locals providing serendipitous feedback on the design of the handcuff props which then led to locals and outsiders working together on these prop items {local : outsider ← local} ⇌ {local : local ⇌ outsider}. From our perspective the Qi2He method and the focus on drama and local stories scaffolded a co-design space which bridged rural and urban, and, moreover, as indicated by our CCE analysis, provided a bridge which was more often driven by local participants rather than outside participants.

The active leadership role of local participants identified by this CCE analysis is reflected in post-hoc interviews with participants where it was clear that they considered themselves as both actively participating and actively learning from the collaboration. For example, local musicians often preferred to call the outsiders “teacher” and “Nin” (you in honorific). Such honorific forms of address in the local context imply that they took an active attitude to learn new things from the other side. Indeed, several locals mentioned that some methods used by outsiders in the collaboration would “inspire their future work and life” Wang et al. (2016). For example, the final scene of the drama in which the lovers are reunited used back projection onto the stage’s curtain to convey the idea of an afterlife. This was developed during the Concluding stage in which foreign students identified back projection as being useful for the final scene of the drama and worked on this with domestic students. Local musicians stated that they would consider using the staging effects shared in the co-design of the drama, such as back projection, in their future local productions to help create an engaging and enticing spectacle for their audiences. This was captured by the CCE notation {foreign: foreign ⇌ domestic} ⇌ {outsider → local}.

Furthermore, by analyzing the engagement between participants in the co-design process using CCE we identified an important role played by serendipitous feedback for locals to contribute to the co-design process. Such feedback relies on the establishment of mutual trust between participants, and in our opinion, an open making and co-design environment. In this case this often led to sustained periods of cross-cultural co-design. CCE helped us to better reflect on the quality of the co-design process we conducted and to identify the points to improve in our practice.

5. Case study: cultural product innovation

Whilst the interactive drama produced in our second case study engaged local participants throughout the refined Qi2He process and encouraged community engagement, the legacy of the drama was short lived with little concrete long-term output. In our third case study with Hengling village we wanted to explore the application of Qi2He to

Table 3
Cross-cultural engagement notation (adapted from Bryan-Kinns and Wang (2018)).

Rel'n	Description	Example
$a \Leftrightarrow b$	<i>Mutual design engagement:</i> groups <i>a</i> and <i>b</i> undertake co-creation at the same time.	{local ⇌ outsider} Outsiders and locals worked together on the script for the drama— often serendipitously without any clear instigator of the collaboration
$a \rightarrow b$	<i>Sequential design engagement:</i> first group <i>a</i> leads the cross-cultural design activity, then group <i>b</i> leads.	{local : local → domestic} Local participants instigate co-design with domestic participants to give them a copy of a local story which domestic participants then work on
$a \leftarrow b$	<i>Feedback engagement:</i> group <i>a</i> receives feedback from group <i>b</i> .	{local : outsider ← local} Locals spontaneously give feedback to outsiders on particular elements of the script content
$\{a\} \mapsto \{b\}$	<i>Leads to further engagement:</i> activity <i>a</i> leads to activity <i>b</i> .	{local : outsider ← local} ⇌ {local : local → outsider} Locals give feedback on a particular aspect of the script which leads to locals leading revision of that part of the script

undertaking design innovation with potential long term impact, and in some ways coming full circle to the aims of the first case study.

5.1. Co-design process

In contrast to our previous case studies, in this case study we aimed to build spontaneous collaboration with a wide range of locals throughout the stages of our co-design process rather than working directly with local experts. The design goal was to create culturally inspired designs for future products combining an exotic cultural concept (European traditional music boxes) with Dong's traditional crafts and culture as understood by ordinary local people rather than local experts. This design challenge was chosen to explore outsider and local cultural heritages which would be mutually novel and unusual. As in the previous case studies, the researchers, other facilitators and local contacts initiated the discussion and preparation of Qi2He process six months before the outsider teams arrived in the village. Local community leaders and contacts supported the design theme because they said that they would like to see the possibility of creating another new business of Dong keepsakes after the success of the e-commerce sales in the Dong brocade case study.

In the summer of 2016 we spent 14 days in Hengling village and 7 days in Changsha (the biggest city close to Hengling village) with a team of nine outside designers (five domestic, four foreigner) who ranged in experience from design students to professional interaction designers. The outside designers were split into four teams to respond to the design challenge based on their experience and skills. Each team developed one interactive piece illustrated in Fig. 17 and described below which responded to different understandings of the design topic, local experiences and individual creativity. After describing the pieces we introduce the Qi2He co-design activities in this case study.

Team A (two foreign participants with a local farmer and bamboo weaver): '8bit Memento' is a bamboo made keepsake inspired by local children's toys and the eaves of local buildings. Tipping the tube triggers playback of locally recorded sounds from the river and an

embedded LED matrix displays animations of patterns inspired by local brocade weaving.

Team B (one foreign and one domestic participant with local carpenters and construction workers): 'Doye Boxes' is a set of wooden cubes which are covered with fabric displaying patterns inspired by local brocade designs. When rotated the boxes play a selection of music recorded locally and illuminate to show the brocade inspired designs.

Team C (two domestic participants with a group of local elderly ladies): 'Dong Tunes' is a windchime-like decoration covered by yarn-knitting based on a local traditional design of good luck decorations. When the object is turned, twisted, and rotated it plays songs and stories recorded from local elders during the making of the traditional 'lucky flowers'.

Team D (one foreign and two domestic participants with a small group of middle-aged left-behind housewives): 'Dong Shine' is a portable gesture-controlled hanging lantern which plays locally recorded music when gestures are performed underneath it. The shape is created from a locally found bamboo strip-woven creel (wicker basket) and the patterns on the outside reflect local stories displayed on traditional rice-paper lanterns.

起 (Qi) Introducing/ starting (3 Days prior to arrival) Preparation of tools for making including preparing digital tools and initial communication between outsiders (foreign and domestic). This pre-arrival stage introduced outsiders to the digital tools to be used, established the groups of designers, and introduced the co-design goals. It was undertaken in Changsha and the primary cross-cultural engagement was between foreigners and domestic participants in building design teams.

承 (Cheng) Following/ inheriting (4 Days in the local area) Cultural exposure to the local context involving four days of visiting locals in their places of work and rest and collecting ethnic patterns and ideas from, for example the local bazaar, craftspeople's homes, a local museum, and a local carpenter's workshop (Fig. 18). Locals were interviewed about their everyday life, handicrafts, making skills, and their ideas about the design challenge. In this stage participants undertook early design ideation and concept development serendipitously with local participants. For example, Team C discovered a local elderly



Fig. 17. Future product designs created in Hengling Village. Clockwise from top left: Dong Shine (Team D); Dong Tunes (Team C); 8-bit memento (Team A); Doye Boxes (Team B).



Fig. 18. Cultural 'hang out' in local.

ladies knitting club who had an interest in developing new products with their crafts for the emergent tourist market. When Team C first visited the club, they reported that some relatives of the older ladies in the club expressed a strong interest in them and asked “would you please help us pick which patterns in the basket look good for urban people like you?” which Team C then used to drive their design rationale. In this way the in-situ engagement between outsider designers and locals informed their design rationale and shed light on local motivations for future product designs— not as products for local consumption, but as souvenirs for outsider purchase and consumption.

We found that a small part of the local population, who were also casual makers, were driven by their hobby of making to get involved in collaboration from the承Following stage onwards and enjoyed the chance to develop their design ideas with outsiders. For example, the elderly ladies told Team C that it became one of their most joyful times when they had the chance to talk and work with Team C every afternoon. Indeed, when their first visit ended, the ladies asked Team C to commit their time to come the next day and continue their making before they let them leave. The background of local participants was more diverse than any of us had planned, including a bamboo weaver/farmer with team A, a few carpenters who run a small shop with team B, the elderly lady club with team C and a few middle-aged housewives from a dancing group with team D.

转 (Zhuǎn) Changing/ transferring (5 Days in the local area and rural makerspace) The majority of the cross-cultural co-design activities involved low-fi prototyping with local resources and interactive materials in and out of the Hengling makerspace (e.g. Team D in Fig. 19). In this stage we saw the most cross-cultural engagement bridging local and outsiders in co-design. From our perspective it was the hands-on nature of the low-fi making and design iteration that facilitated these ad-hoc cross-cultural engagements. For example, Team C moved their product making from the Hengling makerspace to the local community elders' club where they worked with local elderly women's afternoon craft sessions (Fig. 20). This provided the opportunity for locals to engage in the making and design activities, to offer advice on design from a local perspective, and to bring in local materials for use in the making (Wu

et al., 2017). Similarly, when Team B moved to the carpentry workshop to undertake their fabrication, their work received design critique from not just the carpenters such as how to drill the hole array in the wooden box for a better sound output, but also from the carpenters' local clients who had different backgrounds.

合 (Hé) Concluding/ combining (5 Days in the local area and rural makerspace, 4 Days outside the rural area and in the urban design studio) In our concluding stage we improved the robustness of the product ideas in Hengling village makerspace (Fig. 21) to fully working interactive prototypes, and then polished the interaction details in Changsha city. We then exhibited the pieces in both Changsha (China) and London (UK) to get public and potential customers' feedback. Our motivation for moving from Hengling to Changsha was twofold: i) several outsiders had become fatigued with the realities of rural life; and ii) we required higher quality design, rapid prototyping, and electronics tools than were available to use in the village at that time. However, the first 5 days in Hengling were critical for delivering fully working demos with local participants and evaluating them with the local community. For example, Team D refined the gestural interaction of their hanging lantern following local feedback to be controlled by waving of the hand near to the lantern which was more considered more intuitive to the local population. Evaluating with locals in this stage also helped participants examine the value of their design work in the local context. For example, local people said that they felt quite proud when they saw that their local Doye dance inspired the interactive designs of team B, and that their children were then interested to play with it who might otherwise spend all their time on their smartphone. This revealed unexpected product value for team B.

5.2. Post-hoc analysis

As with our second case study, we collected extensive field notes and conducted interviews with all participants throughout the co-design process. Unlike case study one and two, in this case study we wanted to examine how Qi2He could be used to build spontaneous collaboration with local ordinary people rather than local professional communities



Fig. 19. Design conversation of Team D (left) and Team B (right) in and around Hengling village.



Fig. 20. Co-design between Team C and local elderly makers.



Fig. 21. Finalising design work in rural makerspace.

who we had worked with before. In this case study we identified 24 CCE activities, all of which had clear instigators unlike the second case study. Whilst there were a similar number of occurrences of mutual design engagement (\Leftrightarrow) and sequential design engagement (\rightarrow), we identified more instances of feedback (\leftrightarrow) and fewer sequential cross-cultural design relationships (\rightarrow) in this case study than the previous one. The emphasis on evaluation in the 转Changing stage resulted in more instances of feedback (\leftrightarrow), for example, Team C interviewed local people about their low-fi prototypes {domestic : domestic \leftarrow local} and then took their designs to a nearby village where they interviewed three domestic tourists from urban locations {domestic : domestic \leftarrow domestic}. In this way iterative design and feedback acts as a probe into local culture and expectations as found with Team B whose work with local carpenters eventually led to opportunities for design feedback bridging local and domestic participants {outsider : domestic \rightarrow local} \mapsto {local : domestic \leftarrow local}. We also observed how the balance of instigation of collaboration changed over time. For example, team C moved their workplace from the makerspace to the local elders' club and combined their making work with the local elderly ladies' regular afternoon craft sessions (Fig. 20). This resulted in the local ladies bringing materials from their own homes to be used in the making and driving the making process {domestic : domestic \Leftrightarrow local} \mapsto {local : domestic \Leftrightarrow local}. These are important points at which the power balance in the co-design changes which we interpret as an indicator of trust and mutual design engagement in the collaboration. A longer chain of engagement can be seen when the domestic member of Team B elicited feedback from locals on their team's designs, particularly about which local cultural elements should be used. As the domestic participant noted in interview, this led

to locals proactively offering suggestions for decorative cultural elements to Team B. This then led directly to locals instigating design work on the ornamentation and form of the Doye Boxes with Team B {outsider : domestic \leftarrow local} \mapsto {local : domestic \leftarrow local} \mapsto {local : outsider \Leftrightarrow local}.

As well as using CCE to identify patterns of engagement between local and outside participants, we were also able to use our post-hoc analysis to identify patterns of non-engagement and found that this varied across the teams. For example, compared to Team B who worked with carpenters and Team C who worked with elderly ladies, we found that Team A did not show any patterns of sustained co-design with consistent local collaborators. Instead, the CCE analysis highlighted that Team A undertook short co-design activities such as eliciting feedback on their designs {foreigner : foreigner \leftarrow local} or learning bamboo carving skills from a local weaver {foreigner : local \rightarrow foreigner}, but our post-hoc analysis did not identify any sustained co-design. This may have been due to the team not having a domestic participant as a member, therefore making communication with locals problematic, or may have been due to other factors such as the design being less grounded in immediately recognizable local features such as the use of the creel by Team D.

6. Discussion

In this section we reflect on our learnings through the iteration and refinement of our Qi2He framework from three case studies we outlined above.

6.1. RQ1: structuring a cross-cultural co-design process

The aim of our Qi2He approach is to encourage cross-cultural engagement in co-design. Our overall strategy has been to maintain a long-term collaboration with the same village, Hengling, and to bring in new cohorts of outsiders to the local community with different topics. Aligning with the notion of “connected difference” (Mulgan et al., 2007), we observed that the local community benefited from this kind of interaction with group after group of outsiders by learning about different aspects of the outside world which is rapidly encroaching on their rural life, and also by developing a better understanding of the value of their own cultural heritage from a different perspective.

The key features to take from the Qi2He co-design method are that there should be stages of: i) technical skill development and sharing; ii) cultural sharing; iii) co-design innovation and evaluation across cultures using in-situ making; and iv) co-design refinement, production, presentation, and evaluation. From the experience of our case studies, we believe that these stages help to balance the pragmatic challenges of local engagement in cross-cultural co-design and innovation, and at the same time help to bridge between tradition, digital design, and technology.

Below we reflect on the value of our approach and offer suggestions for how researchers could apply similar techniques in their cross-cultural co-design practice.

6.1.1. Speaking a shared language

A challenge of co-design is how to communicate the design process to all participants cf. Irani et al. (2010). This challenge is compounded when participants speak different languages and have different cultural backgrounds and understandings. In our case studies we used the structure of a locally understood creative practice - a well-known Chinese literature composition method - aligned with Western design thinking processes to structure our Qi2He co-design method. Throughout our three case studies we found that this readily provided a shared structure for co-design between locals, domestic, and foreigners, and allowed participants to develop a shared understanding of both the process and the expectations of each stage. It is important to note that Qi2He provides a shared bridge between epistemologies - the aim is not for foreigners to understand the traditional 起承转合 literature composition method, nor for locals to understand a Participatory Design process such as Spinuzzi (2005), but rather for locals, domestic, and foreigners to understand the shared design process of each step in Qi2He. In this way, the Qi2He approach allowed for both: i) effective engagement with local participants through a shared understanding of the structure of our co-design activities; and ii) sharing of culture through a shared understanding of the objectives of our co-design work.

Our first use of the Qi2He method resulted in outsider participants learning local expertise, understanding cultural elements and building local connections to engage in co-design. This resulted in the development of new design systems designed to bring commercial value and revenue into the rural community using a hybrid of traditional brocade design with computing. Our second case study showed how a refinement of the Qi2He structure could be used to generate engagement between outsider participants and the local community, and to generate societal value in the local community through new ways to treasure and present traditional content. The final case study used the same Qi2He structure to create hybrid traditional-digital design prototypes with the potential to generate new commercial opportunities in the local location and a raising of the profile of the rural community beyond regional and national boundaries. From our observations in the three case studies and the post-hoc analysis, Qi2He shows promise as method which can be applied across design foci and accepted by both local participants and outsiders from different cultural backgrounds.

6.1.2. The design cycle

Bridging cultures through design typically involves stages of

ethnography to inform cultural understanding and requirements gathering, and often in-situ design work e.g. Bidwell et al. (2013); Brereton et al. (2012); Hussain et al. (2012); Oreglia et al. (2011); Reitsma et al. (2014), and Winschiers-Theophilus and Bidwell (2013). Overall, the time commitment from participants is of the order of months and is similar to that of approaches such as Reitsma et al. (2014) though our approach typically involves shorter time spent on in-situ working, and longer time in pre-arrival communication and preparation. Through our three case studies, we realized the value and importance to both design and local engagement of including in-situ evaluation in the co-design process. Completing the design cycle from ideation to evaluation in-situ allows for richer and more nuanced refinement of co-design work. However, completing a full design cycle is ambitious in a short time frame such as two weeks. Our first case study of co-designing a design system is certainly the most in-depth design work of all three case studies but relied on extended design time outside Hengling village. The short time frames we worked with in-situ necessitate thinking of the co-design process as an open design cycle, and structuring the daily work accordingly rather than thinking of the process as a predetermined waterfall model. On reflection, we feel that the third case study suffered from an over-ambitious attempt to undertake a whole design cycle in a short time and yet the co-design engagement with locals, the bridging between rural and urban, was strong. Pre-arrival collaboration and preparation with local contacts served important roles in the success of such short-term processes in local. In the third case study, the early 合 Concluding stage with local evaluation was also found to be critical if the design work has to move to other places.

For readers interesting in applying the Qi2He approach directly in China we suggest planning more interactive activities with locals in the 承Following and 转Changing stages. We also strongly advise readers to involve local leaders in the early stage of activity planning - in the case studies we presented in this paper it took months to prepare before with local leaders before the relatively short in-situ co-design activities.

Thinking about design more broadly as an iterative process involving increasingly convergent design cycles of ideation, refinement, and reflection, our approach would be more useful in the early stages of collaborative ideation when participants need to begin to engage with each other and share their culture to produce initial design ideas across cultures. In this way, our approach is more suited to the very early fuzzy front-end of design cf. Sanders and Stappers (2008). From our experiences outlined in this paper, our approach would be less effective for in-depth ethnographic studies in the requirements and understanding phase of design which do not typically involve extensive hands-on co-design activities. We also believe that our approach would be less effective for later design phases which place greater emphasis on detailed production and refinement for implementation rather idea sharing and co-design exploration.

6.1.3. Making in-situ

In our journey through our case studies, we came to realize the importance of in-situ making for building co-design engagement across cultures. We found that in-situ making provides mutually intelligible physical manifestations of design around which participants can engage in design ideation and reflection in keeping with Reitsma et al. (2014). In capturing local cultural heritages and conventions, the interactive physical objects also provide a bridge between traditions and digital technologies. Furthermore, situating the making in the rural context provides opportunities for serendipitous co-design engagement and inspiration which would not be possible in an urban studio. All three of our case studies involved points at which in-situ design and making led to fresh insight and contribution to the final outcomes.

In the first case study, the conceptual design differences between locals and design students were highlighted through hands-on design work in-situ where students' initial designs drew on elements of local brocade design, but were not feasible to implement. In our second case study, extensive serendipitous engagement and co-design occurred

throughout the drama design and making process from physical design of the props to staging and performance technique and identification of new design opportunities from local opportunities such as the design of the interactive sports game. Finally, in our third case study, the in-situ making and evaluation provided opportunities to inform design and refine the design of future products, such as refinement to the gestural interaction of the Dong Shine interactive lamp. Again, nuances such as the locally intuitive form of gesture to be used for the lamp would be unlikely to be identified in an urban design studio. In this way, making in-situ is the catalyst in our Qi2He approach.

However, a balance needs to be struck between the trade-off of what can feasibly be made in-situ in a rural makerspace and what requires more specialised digital resources. For example, the 转Changing stage of first case study involved the development of our brocade design tool in the outside research lab to allow for substantial software development from our findings in the 承Following stage in the village. We balanced this outside activity by involving local participants in ongoing online discussion during the development and returning to the village in the 合Concluding stage to gather feedback. Furthermore, we had discussed and agreed this collaboration structure in advance with locals who felt that it may help to make the design work more successful by involving more advanced resources than were available locally.

6.1.4. Practical preparations

As with Wyche et al. (2010)'s "deliberate interactions", we found that discussing design topics, local practicalities, and recruitment of participants extensively prior to arrival in the rural location was key to facilitating co-design in a constrained timeframe. All three of our cases involved contacting local participants in advance and setting design goals and expectations, with our final two case studies using the Qi2He process as a way to structure plans for in-situ activities. Our first two case studies illustrate the value of engaging local craftspeople in advance in comparison to the third case study in which we relied on serendipitous connection with local makers. Our case studies were fortunate to be supported through the established network and trust which provided routes to undertaking preparatory work far in advance of the visits to Hengling village. Other researchers may not be so fortunate and need to consider how connection with rural community might be facilitated in advance of arriving in rural locations.

6.1.5. The importance of the 转(Zhuǎn) changing/ transferring stage

The third stage of our co-design process, the 转Changing stage, is really about co-designing across cultures and heritage—exploring hybrid design options between locals and outsiders. In our case studies we specifically focused on combining traditional craft and practices with digital technologies in the 转Changing stage. Our first case study lacked a strong 转Changing stage which we feel is reflected in the design system produced which essentially captured and encapsulated local culture within a digital environment (the design system) rather than creating some sort of hybrid traditional-digital cross-over. In the second and third case studies we emphasized the hybridization in the 转Changing stage resulting in cross-over design ideas in both case studies. This emphasis also made a clearer distinction between 转Changing and 合Concluding stages which we have come to consider are aligned to divergent and convergent design thinking stages respectively.

6.1.6. Valuing engagement

A fundamental question of cross-cultural co-design work is what value is created, and for whom. As with other cross-cultural research and design activities the outsider researchers and designers in our case studies benefited from exposure to new cultures and experiences, learning new skills and techniques, and design ideation and realization. In terms of local value, our first case study aimed to generate financial value for rural populations through new products produced and created in the local village. Our second case study aimed to generate local value through engagement with new technologies and exploring ways to

promote local music practice and heritage. Our third case study aimed to generate value through product innovation through potential new categories of saleable goods. However, all three case studies also resulted in intangible cultural value to local populations - design ideas, or community engagement - along with improvements to local entertainment and entrepreneurship. The second and third case studies also exposed locals to rapid prototyping tools and techniques such as 3D printing and Arduino development through the Qi2He process. Whilst the intention was not to teach electronics or programming per se local engagement in the co-design provided hands-on experience of how digital technologies are designed and built. This reflects the transitional nature of much of rural China: as the government increases infrastructure in rural regions, locals move away from subsistence living and diversify into rapidly changing income streams for example through increased tourism and e-commerce. In this state of flux there is value to reimagining and reinterpreting local cultures and Intangible Cultural Heritage in ways that respond to the incoming wave of digital technologies and make them accessible and novel to outsiders whether domestic or foreign and potentially as near-term steps on the journey to Indigenous Futures cf. Lewis (2016). For example, product prototypes developed in the third case study have been exhibited in China, the UK, and the USA, raising awareness of contemporary rural China beyond the internet and traditional museums' articulation.

There is an inherent risk of local fatigue with long-term design engagement (Wang et al., 2016) and a need to manage expectations of the value of collaboration (Smyth and Hidalgo, 2009). We believe that exploring a range of local cultural values and re-imagining and re-interpreting them in their modern life can help to reduce local fatigue by connecting with different groups of local participants over extended periods of time and varying the broader community engagement focus. In our approach we emphasize the importance of cultural exchange and sharing with rural communities in order to manage expectations of participants and establish shared goal cf. Kapuire et al. (2015), which in turn relies on long term engagement to build trust and mutual understanding of expectations. It is worth noting that from a local view these case studies are also viewed as part of a longitudinal engagement with different outsiders and different elements of "our" outside culture.

6.2. RQ2: supporting post-hoc reflection

The CCE notation was developed as a way of structuring post-hoc reflection on the engagement between people undertaking co-design activities. The CCE notation can also be used to make broad comparisons across co-design activities. For example, we noted that all co-design activities in the third case study of product innovation had clear instigators whereas one third of the co-design activities in the second case study had no clear instigators. This kind of comparison suggests that the interactive drama case study was more fluid and embedded in local activities, allowing co-design to emerge more serendipitously. Similarly, we noted that most of the co-design activities were instigated by locals in the interactive drama, whereas most co-design activities in the product innovation case were instigated by outsiders. This reflects the focus of the two case studies - the product innovation focused on outsider designers working in-situ to co-design future products, whereas the interactive drama co-design was often led by local musicians. Whilst there were similar amounts of mutual cross-cultural design \leftrightarrow we found more sequential cross-cultural design \rightarrow relationships in the interactive drama than product innovation, and more feedback \leftarrow in the product innovation than the drama. This reflects both the structure of the co-design that emerged (longer patterns of co-design in the drama) and the reliance on local feedback in the product innovation co-design. From this post-hoc CCE analysis, we note that the drama approach encouraged more sustained and local-led co-design, whereas the product innovation favored short co-design engagements with greater emphasis on eliciting feedback from locals. This may be an effect of the sustained commitment and interest from the local musicians, or it may be a result of the

different skills needed when creating a performance or spectacle versus designing future objects.

Using the CCE notation acts as a way to develop a descriptive narrative of cross-cultural activities in order to facilitate analysis. Intuitively we see an increasing equality of participation and engagement in co-design from feedback ← relationships to sequential cross-cultural design → and on to mutual cross-cultural design ⇔ indicating the most equally shared participation. However, given the realities and complexities of co-design across cultures we do not suggest that all co-design activities should strive for mutual cross-cultural design ⇔. Indeed, even eliciting feedback requires dialogue and trust, and, as we demonstrated in our case studies, can lead to increasing equality of participation and engagement in co-design. Our view is that designers should at the very least be striving to structure their design processes to invite feedback which may lead to the emergent development of trust and mutual understanding.

Reflecting on the stages of the Qi2He process in our three case studies we noted that the initial起Introducing stage in which participants learn and share new technical skills had mostly feedback ← relationships with very few examples of other CCE relationships. As the Qi2He process moved into the承Following stage we noted an increase in sequential cross-cultural design → relationships as participants started to build trust and work together in culture sharing. The majority of mutual cross-cultural design ⇔ relationships and co-design activities which lead on to others (↔) were observed in the转Changing and合Concluding stages with sequential cross-cultural design → relationships slightly more frequent in the转Changing stage as trust and working relationships were being strengthened. We illustrate the typical CCE relationships that we noted in our case studies in Table 4 as an illustration of the different kinds of co-design relationships that may emerge at different stages of the Qi2He process. This is not to say that these are the only relationships that may occur at each stage, but rather to indicate the most frequent relationships we noted.

For us, a successful cross-cultural co-design activity has a balanced set of instigators of activities from different cultural backgrounds, and involves extended chains of collaboration where we see several design activities which lead on to other activities (↔). We suggest that these are important metrics as they indicate i) there is balanced and active participation by all, and ii) there is sufficient trust and mutual engagement to sustain extended sequences of co-design together. Needless to say, the quality and subjective, personal, experience of these collaborations is equally important to consider in evaluating our collaborations and processes. The subjective accounts are captured and considered through in-situ and post-hoc interviews to balance the more objective accounts of collaboration provided by CCE.

However, using the CCE notation relies on the researcher distinguishing between different forms of engagement in a co-design process. Our CCE notation is currently under-specified in this respect and relies on researchers' skill and intuition to draw the distinction between, say mutual design engagement and feedback relationships. For example, mutual design engagement ⇔ is fairly straightforward to identify as people can be observed working together on solutions, but it naturally involves feedback ← between the participants. How to distinguish between cycles of feedback and co-design and mutual design engagement is left to the researcher. Similarly, identifying when one activity leads to another ↔ relies on a researcher determining the level of granularity of

the analysis - to determine what constitutes one activity versus a set of smaller co-design activities. For example, the script development in the interactive drama could be seen as mutual design engagement between outsiders and locals {outsider ⇔ local}, or it could be broken down into its constituent activities {local : local → domestic} ↔ {domestic : domestic → foreign} ↔ {local : local ⇔ domestic ⇔ foreigner} (Bryan-Kinns and Wang, 2018) - this is currently at the discretion of the researcher. This calls for a more rigorous definition of the CCE notation to standardize post-hoc reflection in future work.

6.3. Qi2He limitations

Our Qi2He framework is intrinsically tied to the Eastern cultural context and so application outside China and this context would require re-orientation of the approach drawing on the lessons learnt in the previous sections. The key point of our Qi2He framework is to balance short-term engagement with structured co-design activities which bridge between cultures, local and outsider populations, under the framework of a long term collaboration. This is the key point of our approach - the co-design method used must draw on local practices and at the same time align with design thinking structures. This relies on some preliminary connection and trust established between the local community and the outsiders.

Winschiers-Theophilus et al. (2019) highlighted the challenges of applying the experience from one underdeveloped region with its unique cultural context to another in terms of geographical difference. The Qi2He co-design method draws directly on the traditional Chinese literature composition method起承转合. The universal nature of the Chinese education system is an advantage for us in this situation as all Chinese citizens receive a roughly similar education in early years which includes methods and epistemology such as the Chinese literature composition and thinking method. This consistency of education helps to bridge between local and domestic participants even though different (mutually incomprehensible) dialects are spoken. For rural locations outside China, it would clearly be necessary to align Western-driven design thinking approaches to the specific local epistemology and thinking structures. However, in other countries it may be that local and domestic participants receive different educational training, making the bridge between local and domestic difficult and requiring additional pre-arrival work to identify suitable creative practices to align design thinking processes with.

There was some evidence in our case studies of foreigners co-creating with locals without domestic participation. For example, in our third case study Team A engaged directly in co-creation with locals (see Section 5.2). However, such foreigner-local direct collaboration was limited by substantial language barriers. This suggests that activities within each stage of Qi2He may be feasible without domestic participation, but structuring the whole co-creation process through Qi2He relies on domestic participation to support communication between foreigners and locals where there is no mutually understandable language. In other settings where foreigners and locals can communicate directly it may be that domestic participation is not required to establish the Qi2He process in-situ.

It is also important to acknowledge that China is an example of a country at the tipping point from developing to developed. Whilst at the time of writing China's GDP is ranked second in the world, it remains listed on the International Monetary Fund's list of developing countries (International Monetary Fund, 2018). This provides an interesting and illuminating situation in which to study a society as it transitions to developed status, the plans and strategies that influence this change, and how this may impact on rural life and culture. Needless to say, the unique characteristics of Chinese government mean that the changes in Chinese rural life might not play out in the same way in other developing and developed countries.

Finally, it is important to recognise that Hengling village itself is on the one hand somewhat typical as a remote rural community, and on the

Table 4
Typical CCE Relationships in Qi2He Stages.

Qi2He Stage	Description	CCE Rel'ns
起Introducing	Learning and sharing new skills	←
承Following	Culture sharing	← →
转Changing	Co-creation and mutual inspiration	← → ⇔ ↔
合Concluding	Co-design refinement	← ⇔ ↔

other hand unusual as it has been a site of both New Channel and DESIS social innovation initiatives for over ten years. These long term collaborations no doubt impact local perceptions of external agendas, cultural value, technological transformation, and reception of co-design approaches such as Qi2He.

7. Conclusions

In this paper, we presented our Qi2He cross-cultural co-design framework which is intended to help structure engagement in co-design activities. We illustrated the development and refinement of our approach through its use in three case studies of cross-cultural co-design in a single village in rural China. Each case study had a different design focus and resulted in different products and value for participants, and drove the development and refinement of our Qi2He co-design method. We believe that using existing local approaches to creative practice in combination with design thinking methodologies to structure our Qi2He co-design approach helped to produce a commonly understood framework for co-design. Applying this is, of course, a balancing act where a limited time for co-design activities risks superficial and unbalanced co-design engagement.

There are a number of opportunities for further research building on our work. Firstly, research is needed into how such an approach could be deployed outside China which would require building the co-design method on a different local epistemology. Furthermore, it is not clear how practical our approach is without extensive existing support with the rural community which in our case was provided by the DESIS network and the New Channel program. Without this support, we would have needed to invest much more time in the pre-arrival stage to build sufficient connection for our in-situ activities. We also need to explore how our approach could be refined to better address mismatches of knowledge and skills. Similarly, there are questions on how in-situ making might be readily supported in other rural locations - in particular, what tools, equipment, and facilities are needed for a useful and yet mobile makerspace which can be deployed in rural locations.

Additionally, future work needs to examine how the value to rural communities can be increased, and moreover, how such value can be more explicitly modelled in our post-hoc analysis. Monetary value is not the only concern of rural communities as they undergo transition in the wake of radical infrastructure and societal change with ICTs. Preservation of traditional culture and ways of life are important values to be embraced, as is the value of re-imagining Intangible Cultural Heritage within local communities so that traditional values live on and bridge tradition with contemporary rather than being consigned to museums and archives. Our vision is to further develop the Qi2He method to help us better bridge cultural heritage and digital innovation by bringing cross-cultural groups of participants together in engaging co-design, and to further develop our notation to help us to understand the mechanisms and reasoning behind what happened in these mutually creative fusions.

CRedit authorship contribution statement

Nick Bryan-Kinns: Conceptualization, Methodology, Software, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Supervision, Project administration, Funding acquisition. **Wei Wang:** Conceptualization, Methodology, Software, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Supervision, Project administration, Funding acquisition. **Tie Ji:** Conceptualization, Resources, Supervision, Project administration, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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