

Thoughts on Studying Cultural Ergonomics for the Atayal Loom

Yuma Taru¹, John Kreifeldt², Ming-Xean Sun³, and Rungtai Lin¹(✉)

¹ Graduate School of Creative Industry Design,
National Taiwan University of Arts, Ban Ciao City, Taipei 22058, Taiwan
lihan.workshop@gmail.com, rtlin@mail.ntua.edu.tw

² Tufts University, Medford, MA, USA
john.kreifeldt@tufts.edu

³ Institute of Applied Arts, National Chiao Tung University,
Hsinchu 300, Taiwan
buddasfox@gmail.com

Abstract. The purpose of this study is to explore the meaning of cultural objects and to extract their cultural features from Taiwanese aboriginal culture. Atayal is a tribe of Taiwanese aborigines whose culture is disappearing rapidly due to a hundred years of colonization. The weaving box, a cultural object, unique to the Atayal loom, is the subject of this study. Based on the previous studies, this study proposes a cultural ergonomic research model to provide designers with a valuable reference for designing a successful cross-cultural product as well as the interwoven experience of design and culture in the design process. This study attempts to illustrate how by enhancing the original meaning and images of Taiwan aboriginal culture features they may be transformed into modern products by taking advantage of new production technology and so fulfill the needs of the contemporary consumer market.

Keywords: Ergonomics · Cultural ergonomics · Atayal loom · Taiwan aboriginal culture

1 Introduction

Cultural ergonomics extends our understanding of cultural meaning and our ability to utilize such understanding for design and evaluating everyday products (Kaplan 2004). Designers need to develop a better understanding of cultural ergonomics not just to participate in cultural contexts but also to develop interactive experiences for users. Thus, cultural ergonomics is an approach that considers interaction and experience-based variations among cultures in cultural product design (Lin et al. 2016). Hence, cultural products can extend the heritage and traditional values of different cultures to the consumer and increase the sense of spiritual essence in human life (Varutti 2015; Guttentag 2009). Perhaps the best way to extend a unique culture, as for example when we talk about the impressions of different culture garments, crafts, decorations, utensils, furniture, ornaments, packages, etc., is to promote it to users' daily lives through product usage (Lin 2007, 2009). Culture plays an important role in the design field,

and cross-cultural design will be a key design evaluation point in the future. Designing “culture” into products will be a design trend in the global market. Obviously, we need a better understanding of cross-cultural communications not only for the global market, but also for local design. While cross-cultural issues become important for product design in the global economy, the intersection of design and culture becomes a key issue making both local design and the global market worthy of further in-depth study (Lin et al. 2009). The importance of studying culture is shown repeatedly in several studies in all areas of technology design.

Taiwan is a multi-culture fusion of traditional Chinese with significant East Asian influences. Over time, Taiwan gradually developed its own distinct culture, mostly from a variation of Southern China culture (Lin 2007). Evidence shows that the prospect of Taiwan’s local cultures will undoubtedly become crucial cultural elements in future design applications (Lin 2009). Of course, the Taiwanese aboriginals also have distinct and abundant cultures. With their beautiful, primitive, and spiritually motivated visual arts and crafts, Taiwan’s aboriginal cultures should have great potential for enhancing design value, and being recognized in the global market (Hsu et al. 2013).

For example, the Atayal tribe which is composed of several subgroups is one of the best weaving tribes in Taiwan. In their traditional society, Atayal men did the hunting, fighting, farming and house building, while Atayal women were known for the artistry of their handwoven artifacts (Chang et al. 2008). Having suffered from their traditions being nearly extinguished in the past colonial periods, the Atayal tribe members are now trying to retrieve their textile traditions and they have already achieved fruitful innovations rooted in their ancestors’ wisdom (Yoshimura and Wall 2014). For example, the first author has spent years “reverse engineering” many old woven tribal patterns to preserve the knowledge of how to weave them, a knowledge that was formerly passed from mother to daughter. She also runs and is trying to improve a school for the children of a poor village in the hills above Miaoli, has built a cultural center called lihang workshop and promotes interest in their culture (<https://www.facebook.com/lihangworkshop>).

The weaving art of the Atayal in Taiwan has developed rapidly over the past decade. Women’s weavings have performed outstandingly in various textiles exhibitions through combining traditional textiles with modern weaving techniques. For example, Yuli Taki is also trying to preserve cultural patterns by commercializing use of them (Lin and Kreifeldt 2014). The Truku used to be one of the several subgroups of the Atayal peoples but are now officially recognized as an independent group. (The aboriginal groups seem to be fractioning at a great rate.) However, while Truku weaving has much in common with other Atayal peoples, Truku textiles are distinguished by their light weight, thinness, quiet color and patterns mostly of single lozenges (<https://www.facebook.com/yuli.taki/>). Among some Atayal peoples such as the Malikuowan, these seemingly simple lozenge shapes are called “eyes” and stand for the blessings of countless ancestors. With those blessings the people could enter the land of happiness and join their ancestors forever.

Such spirituality characterizes much tribal design giving it an immediacy which even outsiders can feel deeply and respond to without knowing much, if anything, about the culture of the peoples who produced it. Such feeling can transcend cultural

differences. An outsider may say that certain primitive art “speaks” to him which is more than just an expression.

By using a cultural ergonomic approach, the *gungu*, literally “weaving box” in the Atayal aboriginal language, was chosen as the cultural object for discussion in this study. A framework will be proposed for examining the way designers communicate across cultures as well as the interwoven experience of ergonomic design and culture meaning in the design process. Using the framework, this study attempts to illustrate how, by enhancing the original meaning and images of Taiwan aboriginal culture features, and taking advantage of new production technology, they may be transformed into modern products and so fulfill the needs of the contemporary consumer market (Lin 2007, 2009).

2 Cultural Object of Atayal Loom

Although the date of the first loom or even what it looked like is unknown. As a weaving tool in one form or another it dates back at least to the ancient Egyptians and Greeks (Roth 1913, 1918). Three main types of loom were used in the ancient world: the horizontal ground loom, the vertical loom with upper and lower beams around which the warp threads are wound, and the vertical loom with warp weights. The warp is the stationary threads across which the weft threads are woven in and out. The horizontal ground loom is the older of the looms of Ancient Egypt (Crowfoot 1937; Faxon 1932).

The Atayal woven crafts played a large role in the tribe’s social customs and organization. These crafts were woven on a type of loom called a “backstrap” loom which is the subject of this study. “Backstrap” refers to the strap behind the weaver’s back as in Fig. 1 and Table 1. The Atayal loom is one of the original types of simple movable backstrap-type looms (Broudy 1979). The earliest example (201 B.C.–8 A.D.) of a backstrap loom in eastern Asia is found at a site in Shizhaishan, Yunnan Province (Broudy 1979). It was similar in principle to the Atayal loom in being “foot braced”. That is, the weaver controlled the tension of the warp threads by pushing with her feet against a brace. The foot brace could be a simple bar but in the Atayal loom it is the culturally important “box” By changing the arrangement of the warping bench and one’s way of weaving, simple even weaves to Atayal’s own characteristic complex patterns can be woven.

Traditional Atayal looms were composed of many parts, with one of the most important being the Weaving Box, made of tough woods like beech and Formosan *Michelia*. The weaving box was not only an important part, but could also be used for storage when weaving wasn’t taking place (Broudy 1979). In the days long ago when head hunting was practiced, the hollow box could be struck to make a loud drum sound as a signal to the village that a warrior had returned with a head. For a clear understanding of the Atayal loom, the features of all parts of the Atayal loom must be understood. Diagrams of their parts are therefore included in Fig. 1 and Table 1.

The threads in Fig. 1 are called the “warp”. Weaving consists of lacing a “weft” thread over and under selected warp threads as it goes from one side of the warp to the other and then reverses direction and repeats lacing and so on until finished. The “art”

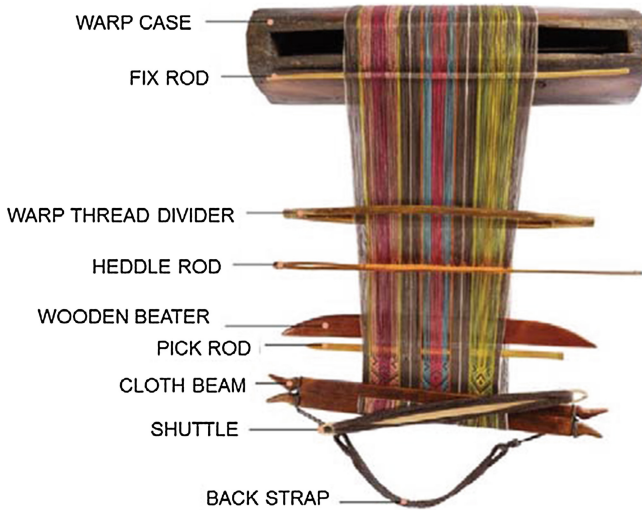


Fig. 1. Atayal Backstrap Loom (Color figure online)

consists of choosing the colors for the warp threads and the complexity of the lacing of the weft thread (which also may change colors) as it goes over some warp threads and under others. It is the particular lacing plan in combination with the coloring of the warp threads which makes the pattern. Practically infinite combinations of colors and lacings (i.e., patterns) exist. Creativity comes in designing aesthetically pleasing combinations. In tribal days before writing and modern means of recording such information existed, these highly complex combinations had to be committed to memory and passed as instructions from mother to daughter - prodigious feats of memory. Sadly, once that mother to daughter chain was broken, as by outside disruptions, this information was lost. It takes modern “reverse engineering”, special coded weaving annotation, and great dedication, to reconstruct these instructions from careful examination of existing examples and record them permanently for posterity. Lest it be thought that weaving is somehow inferior to the other arts because it can be described in this mechanical sounding fashion, it is also true that making piano or organ music can be described (as Bach did) as just pressing the right keys down at the right time and the music makes itself.

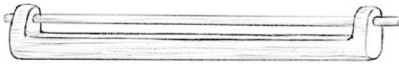
The weaves used by the Atayal and patterns produced with them are technically interesting and aesthetically pleasing (Lin and Kreifeldt 2014). In the past, each tribe could be distinguished by the unique types and patterns of its weavings. Recently, with the rapidly changing social trends and progress in technology, tribes or individual studios weaving textiles hope to see this field embracing both tradition and originality in order to create different possibilities for future development (Yoshimura and Wall 2014). Furthermore, the new Atayal weavers work closely with tourism marketing channels to balance the production and marketing of textiles. Therefore, the future of weaving art is full of hope and potential. The Atayal loom is apparently unique and deserves in-depth study (Nettleship 1970).

Table 1. All parts of the Atayal Backstrap loom

Warp Case



Fix Rod



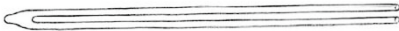
Type 1 Warp Thread Divider



Type 2 Warp Thread Divider



Type 1 Heddle Rod



Type 2 Heddle Rod

There are “large” and “small” sizes for warp cases, which could have the length of 90cm or 60cm, depending on the need of a weaver or the custom of a tribe. Usually it is sized to meet special physical needs of the weaver. The wooden materials usually are selected from trees that possess properties of sturdiness and firmness such as camphor tree, beech tree, Formosan Michelia tree and so on.

The Fix Rod is made of straighter and longer Yushania bamboo internode. The diameter of a fix rod should be 0.6cm to 1.3cm and the required length of a rod is usually based on the width of the demanded fabric, thus several different fix rods with different sizes should be prepared in advance.

The length of a warp thread divider is determined by the width of the piece of weaving fabric, which could be 50cm or 35cm wide. Wood or Yushania bamboo is the selected material for making it. There are 2 different types of warp thread dividers. The first type is widely used in most of the Atayal people's areas, whilst the second type of warp thread divider is especially used in the catchment area of Ta'an river and also it's used especially for pick-up pattern weaving techniques.

The length of a heddle bar is around 35cm long, determined by different fabric widths. Wood or Yushania bamboo material is selected for making heddle rods. There're two types of them. The first type is made of thin and long Yushania bamboo and will get wound around with warp-tying yardage. The second type is a hairpin-shaped rod, which is made of twig wood and is widely used in the catchment area of Ta'an River. Both prongs of the hairpin-shaped rod are drilled with small eyes for fine threads to string through and get ready for sealing this part after warp threads are fixed into the oblong slot. The sealing ~~can~~ secures the warp threads from sliding off while weaving.



Pick Rod

Pick rods are made of Makino bamboo or wood materials, and usually will be prepared in many different sizes for making fabrics of different widths.



Wooden Beater

A wooden beater is made of sturdy hardwood material. The blade should be thicker at the upper part and get thinned towards the lower edge. It is typically 60cm in length and 5-6cm in width.



Shuttle

A Shuttle is a tool designed to neatly and compactly store the weft thread and carry it across the warp yarn while weaving. Shuttles are thrown or passed back and forth through the shed – an opening made between the threads of the warp - in order to weave in the weft.



A Pair of Cloth Beams

Cloth beams are made of sturdy wood material from the elm tree, camphor tree or Formosan Michelia tree. A tongue and a matching groove are cut into a pair of the cloth beams respectively for fastening the finished fabric tightly between them. The length of each beam is about 50 to 60cm.



Back Strap

The Back Strap is woven out of rottan material or made of ramie through the bow weaving technique. The usual length is 50cm and width is about 50cm. Extra binding strings can be made based on a weaver's need.

3 A Framework for Studying Cultural Ergonomics

Piegorsch (2009) described how an ergonomic bench was designed for indigenous weavers in Guatemala that is a typical example of cultural ergonomics. The ergonomic bench helps weavers enhanced their productivity and improved textile quality, while also preventing cumulative trauma to their health. The bench focused on user-centered ergonomic design and also stimulated self-awareness in traditional weaving. The benefits of cultural ergonomics can be represented as a cycle with five stages: health, productivity, quality, culture and self-esteem (Piegorsch 2009). It is likely to be a never-ending process and can be applied universally, strengthening the connection between the designers and their cultural heritage as shown as the outer circular factors in Fig. 2.

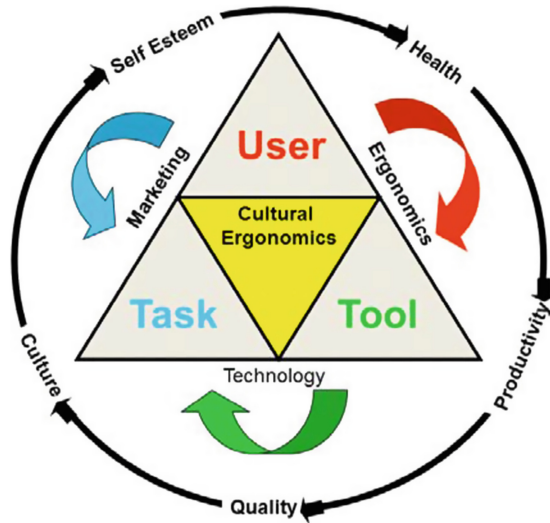


Fig. 2. A framework for studying cultural ergonomics

For the human system design, Kreifeldt and Hill (1974) proposed a user-tool-task system design model that integrates ergonomics into product design for producing aesthetically pleasing and functionally superior products. Based on the user-tool-task model, Lin et al. (2016) proposed a framework for combining cultural features with ergonomic design which facilitates an understanding of cultural ergonomics in product design shown as the inner triangular factors in Fig. 2.

For the cultural ergonomics approach (Kring et al. 2006), the framework consists of two main parts that function to explore the cultural ergonomics issues of the cultural object and to study problems related to human factors. To accomplish the outer circular factors: health, productivity, quality, culture and self-esteem, the inner triangular factors must be considered in practical ergonomic design (Piegorsch 2009). Thus, Fig. 2 details the various influences and interactions in a user-tool system and emphasizes the threefold nature of the design: user, tool (product), and task. Among the user-tool-task, there are the two interfaces of the user-tool manipulation interface (ergonomics) and the tool-task engagement interface (technology); and the various interactions between user needs and design requirements in the practical design process (marketing).

The user-tool-task model is designed to solve the problem of completing a task with a tool; it focuses first on the manipulation interface between the user and the tool and then on the engagement interface between the tool and the task. Finally, for the global market, adding a cultural dimension to ergonomics has become an important issue for exploring interaction and experience in product design (Lin et al. 2016). Along with technological progress, while product design has been transferred from being manufacturing-based to marketing driven to user centered for some time, there is now greater emphasis specifically on user experience, with ergonomics being increasingly considered in interactional design for marketing.

4 Thoughts on Studying the Weaving Box

The weaving box, a cultural object and part of the Atayal loom, is the subject of this study. Based on the cultural ergonomic approach in Fig. 2, the weaving box could be employed for a systematized and scientific method to study the three aspects of cultural ergonomics. First, ergonomic study of the weaving box across user operational situations needs to be analyzed to study the manipulation interface (ergonomics) between users and the weaving box. Then, based on that analysis, the engagement interface (technology) is studied to identify the relationship between the weaving box and the task. Finally, based on the cultural-feature transformation model, the weaving box is identified with three levels of cultural ergonomics and used to demonstrate how to design cultural products (marketing) (Lin and Kreifeldt 2001).

Considered from the perspective of ergonomics, to develop an ideal loom in the form of the weaving box, the social and operational interfaces of the weaving box both need to be well designed using a user-tool-task approach. Especially, many studies were made to evaluate the prevalence of low back pain among the handloom weavers (Chaman et al. 2015; Durlov et al. 2014; Montamedzade et al. 2014). These studies suggested the need for further research regarding the postural strain of weavers and also emphasized the implementation of ergonomic design into the weaver's loom. For a good example, the ergonomic bench in Piegorsch's research (2009) provides a culturally, environmentally, and economically viable alternative to traditional methods of working with the backstrap loom.

Considered from the perspective of technology, many tools were needed in traditional Atayal weaving as shown in Table 1. Women produced beautiful cloth relying on their professional and aboriginal weaving skills (Wu 1998) but their tools are inconvenient for fetching due to their overweight and numbers, and the tradition of weaving while sitting on the ground. In recent years Atayal people has been seeking creative and alternative ways. A new type of loom called a desktop inkle loom has been devised. Inkle weaving is a type of warp-faced weaving where the shed is created by manually raising or lowering the warp yarns (Patrick 2010), some of which are held in place by fixed heddles on a loom known as an inkle loom (https://en.wikipedia.org/wiki/Inkle_weaving).

Considered from the perspective of marketing, aboriginal cultural products that tourists purchase as souvenirs are often actually imitations of the original products, and sold without authorization from the aboriginal group (Guttentag 2009). Atayal textiles are now handwoven by some aboriginal women in Wulai who weave primarily for the Wulai Atayal Museum. Weaving exhibitions are the main purpose of the Wulai Atayal museum since it opened in 2005. Other than displaying materials, techniques and final works, the museum arranges to have weavers do live demonstrations on weekends to attract tourism. The museum also sells the works by the members in the weaving association and invites them to be the seed teachers to design promotional activities such as do-it-yourself for user experience, and promote traditional weaving through the flourishing tourism (Varutti 2015). Meanwhile, the reintroduction of weaving not only required the Atayal weavers to retrace their weaving history and to reconstruct and

revive lost skills but also opened up a new opportunity to create new motifs with the Atayal loom (Chang et al. 2008; Yoshimura and Wall 2014).

5 Summary

Based on a previous discussion (Lin et al. 2016), this study proposes a cultural ergonomic research model to provide designers with a valuable reference for designing a successful cross-cultural product as shown in Fig. 3. The model consists of four main parts: conceptual model, research method, human system design, and cultural ergonomic approach. The conceptual model focuses on how to extract cultural features from cultural ergonomics and then transfer those features to the design transformation model to design cultural products.

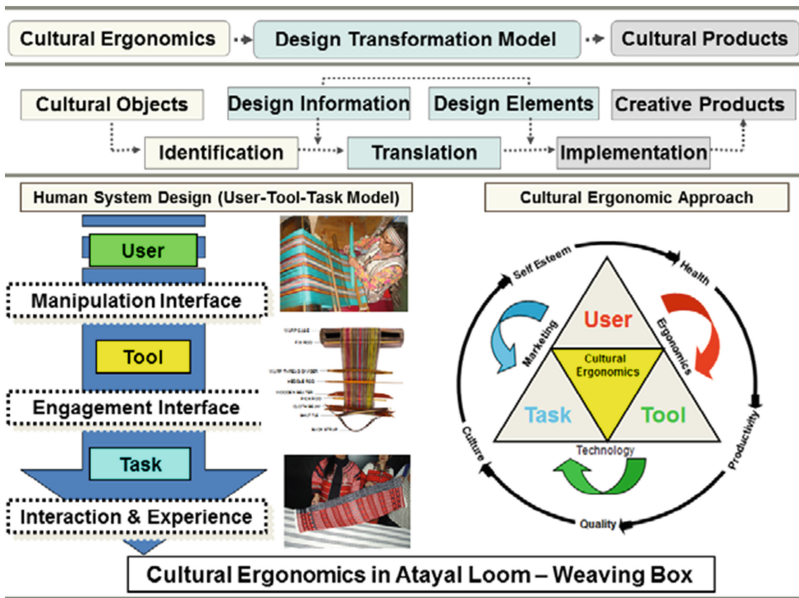


Fig. 3. A cultural ergonomic research model in Atayal loom

The research method consists of four steps: from cultural object to design information, then to design elements, finally to creative products; and three stages: (1) extracting cultural features from original cultural objects (identification), (2) translating these features into design information and design elements (translation), and (3) designing a cultural product (implementation).

The purpose of human system design research focuses on and analyzes the weaving box’s appearance, usability, cultural meaning, operational interface, and the scenario in which it is used. There are social meanings, ergonomic concerns and the functional achievement associated with this cultural object. To develop an ideal loom, both the

cultural and operational interfaces of the “weaning box” need to be well-studied using a user-tool-task approach (Lin and Kreifeldt 2001).

Recently, the reintroduction of weaving has had multiple effects on the Atayal community. Now the Atayal proudly claim their weaving culture as a part of their ethnic identity. The meaning of weaving has changed from the representation of the Atayal women’s gender identity alone to the representation of the Atayal’s collective ethnic identity as a whole (Yoshimura 2007). It has become an ethnic symbol and a tourism product. However, the Atayal tribe, especially the residents of Wulai, are now barely involved directly with tourism business although symbols of their identity are used to promote tourism (Yoshimura 2007; Yoshimura and Wall 2014). As an example of reviving tribal arts, a “carved, blackware pottery jar” recently made by Tammy Garcia of the Santa Clara pueblo tribal people in the US state of New Mexico sold at auction for \$47,500. It expressed feelings of modernity but in the tradition of her people (Johnson et al. 2015).

Having this in mind, we need to consider the following questions before using the research model to explore the weaving box of Atayal loom.

1. For the user and ergonomics: Do we want simply to keep the craft alive? Or provide work for the weavers? Or make an art of it? Or produce a high priced artist? Deciding what will be a successful product has long been a problem. For every 100 “great” ideas, maybe one is commercially successful.
2. For the tool and technology: Crafts such as loom weaving are unique. Is “design” really compatible with cultural tradition which tends to be conservative if it is to retain its uniqueness? Hand work will always be a limited production technique. So its value must be in aesthetics.
3. For the task and marketing (works): Maybe make individual design works which would be prohibitive for machine making. Or create an artist weaving maker demand. Also incorporate cultural motifs and designs. Or create an association which will verify and can enforce a particular product as being of that culture. When there is not enough authentic art to meet the demand and for the price, imitations will be made for the market. The United States has a similar problem of the cultural arts of the American Indians being imitated, misrepresented as authentic and sold. Therefore the US Federal Government has enacted the Indian Arts and Crafts Act. Under this act: “Native American art and craftwork must be marketed truthfully regarding the Native American heritage and Tribal affiliation of the producer.” (www.iacb.doi.gov).

There are many parallels to these questions and problems everywhere that native cultures are disappearing and their arts and crafts along with them. It is strange that as these cultures diminish or vanish altogether, their old traditional art pieces become more and more sought by museums and private collectors and consequently become more and more valuable. Beauty is the soul of the artist expressed in her art. Being based in strong religious beliefs, tribal arts express that soul very strongly. It is a mystery how tribal arts can speak to someone even across cultural oceans if not for soul-to-soul communication. As others begin to see the beauty of the art and are moved by it, they wish to possess it even without understanding or even knowing the culture behind the art. That is the passion of the collector. Such cross cultural attraction with

consequent desire for possession is what designers of products for the international market should hope to have their products evoke.

Continuing studies of what makes tribal arts such as the weavings of the Atayal, or even a “tool” like the weaving box, so attractive cross culturally can definitely aid in designing successful cross cultural products.

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