

SUSTAINABLE VALUE CHAINS FOR BAMBOO WORKING COMMUNITIES

Integrating the tenets of sustainability through the Rhizome Approach

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Abstract

There is a growing demand globally for products which impact sustainability positively. Bamboo fulfills these criteria, since it is a highly renewable timber replacement material which does not cause deforestation. It simultaneously has the potential to create livelihood opportunities for both the urban and rural poor.

The eco-friendly potential and image of bamboo has led to various designed sustainable products, which are made from industrially processed bamboo. Though this approach frees the product from common negative connotations associated with bamboo products, such as 'low cost', 'rustic' etc., actualizing these designs requires industrial production facilities. Consequently, bamboo producer communities are pushed lower in the value chains of these products. From being final stage producers, their role becomes limited to growing the raw material, and at the most primary processing of bamboo inputs.

This focuses on the role of design as an enabler to achieve holistic sustainability in the bamboo value chain in general, and in the instance of the Kotwalia community in particular.

Most contemporary bamboo designs focus primarily on bamboo's potential for eco-design and for commercial viability, and in consequence contribute to the unsustainability of social and cultural factors.

The paper also presents the Rhizome approach, developed through the process of action research with bamboo working communities. The approach is designed to facilitate the design of products which take into consideration the social and cultural tenets of sustainability, alongside the ecological and economic tenets.

Keywords

sustainability, bamboo, design, craft, livelihood

1. Introduction

This paper reports on research that investigates the implications of design interventions on value chains, and their related impact upon sustainability. The research aimed to integrate the social, economic, ecological and cultural tenets of sustainability into a flexible framework: this in turn would provide different points of departure for traditional bamboo working communities, using their indigenous knowledge in the development of innovative products and systems targeting contemporary markets.

While the word 'sustainability' stems from *tenere* i.e. the capacity to endure, and is therefore very wide ranging; it is commonly known through the Brundtland Commission's 1987 definition of 'sustainable development' i.e. 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. The concept of sustainable development has since been criticised as being an oxymoron: the possibility of exponential growth given finite natural resources seems unviable. Nevertheless, a universally accepted understanding and definition of sustainability is yet to be arrived at despite the vast body of scholarship on the nascent science of sustainability.

Various concepts, definitions and frameworks of sustainability were studied to arrive at the construal of sustainability that would form the integral framework and reference point for this research. Sustainability is being recognized as a multifaceted and complex concept which is shaped by the interconnectedness of all the integrated systems in our world (Komiya and Takeuchi, 2006; Shedroff, 2009). A change in any factor/system sets in motion a domino effect by way of complex 'linkages' or interdependencies, and 'externalities' or side effects (Rostow, 1960). According to Komiya and Takeuchi (2006), the current crisis of sustainability can be analyzed in terms of the breakdown of all these interconnected world systems and the linkages between them.

Although sustainability has always rested on a balance of these interconnected systems, our understanding of the emerging discipline and science of sustainability; and recognition of specific tenets that influence it has expanded from the ecological context during industrialization, to include the social and economical tenets of the Triple Bottom line (Elkington, 1997), and the cultural tenet of the Four pillars model (Hawkes, 2001) post industrialization. In the future, more tenets will need to be identified, and important 'sub tenets' will need to be isolated from existing 'umbrella tenets', from the overall network of connections between systems and entities that influence sustainability.

The relationship between 'the complex and interwoven patterns of synergy and conflict' (Thorpe, 2007) between the different tenets, offers a compound picture with many potential directions. Many different models of sustainability indicating the relationship, validity and priority of the identified tenets have been proposed. However, this research argues that a singular model defining the relationship, validity and priority of these tenets of sustainability will not hold for every situation, since the ecological, social, economical and cultural contexts of problems and their solutions are diverse. Komiyama and Takeuchi (2006) suggest that flexibility in structuring the scholarship and knowledge base of sustainability according to different situations may itself be a driving force for greater diversity; given that the homogenization of the models of sustainability and the approaches they offer will threaten the diversity of both the earth's regions and cultures, much as economic globalization does now. It will therefore always be the prerogative of people, as individuals or as collectives, such as communities or nations; to make ethical, intelligent and sensitive, subjective choices that positively impact sustainability (Thorpe, 2007).

This research defines sustainability as 'A continual process of actualizing "the possibility that humans and other life will flourish on the Earth forever" (Ehrenfeld, 2008) through a conscious maintaining of the balance between ecological, cultural, social and economic conditions.' Such a dynamic and evolving field of inquiry that provides visions and scenario analysis (Swart et al, 2004) will allow for new and different reference points which can then be actualized through well designed products and systems.

The intent of this paper is to investigate how design can consciously strategically aim to integrate the economic, social and ecological tenets of sustainability: this in turn will positively impact the gain of traditional bamboo working communities in the bamboo value chain. The paper examines this through the case of the Kotwalia community, who are a tribe of traditional bamboo workers in India whose livelihoods, community nucleus, and craft are currently unsustainable due to the effects of globalization.

Ironically, the material which they craft, through the only productive skill they have – bamboo - dovetails into the growing demand for sustainable products, systems and lifestyle options. Bamboo is a highly renewable timber replacement material which restores degraded lands, prevents soil erosion and helps mitigate water pollution. The tremendous interest in bamboo as a sustainable material has led to versatile and innovative contemporary applications, ranging from the Asus Bamboo Eco book computer and the I Pod Bamboo Shuffle case, to bamboo textile products ranging from bed linen to lingerie, to bamboo houses, furniture and lifestyle accessories, to bamboo crash helmets, medical products and cosmetics. Workshops such as ‘Bamboo Boards and Beyond’ at the National Institute of Design, India, and ‘Dutch Design Meets Bamboo’ (van der Lugt, 2007) have successfully explored bamboo’s potential for innovative applications through a ‘technology push’ (van der Lugt, 2007) approach, where bamboo was used in an industrially processed form. While the resulting products, concepts and explorations, like the several applications described earlier, have contributed to the appreciation of bamboo as a commercially viable, ecologically sustainable material; they do not address the other aspects of sustainability as effectively. This is because actualizing products produced through industrial, technology intensive protocols push traditional bamboo-working communities lower in the value addition chain: from being involved in all the processes from growing to final assembly, their role becomes limited to growing, managing, harvesting, transporting and at the most primary processing of bamboo.

Interestingly, bamboo has a tremendous potential to positively impact the social and cultural aspects of sustainability given that it is easily available to poor communities in Asia, Africa and Latin America in their natural environment, often, even in their homesteads. Bamboo’s linear fibres allow it to be easily processed using simple tools including by marginalized groups such as women. Bamboo based enterprises require lower capital, raw-material and machinery investments than other micro, small and medium enterprises. Crafting bamboo is part of traditional non-industrialized economic, ecological, social and cultural systems.

Designs that allow traditional bamboo-working communities greater participation in the value chain can address the issue of sustainability in a holistic manner, while simultaneously actualizing bamboo’s potential to allow for economically viable, culturally sensitive, socially equitable, and eco-friendly production.

2. The Kotwalia community: traditional and current scenario

The Kotwalias are an indigenous bamboo working tribe from the Narmada basin in the state of Gujarat in India. They are believed to have evolved from ‘Narmada Man’, the earliest

Homo erectus identified in South East Asia, who lived in the region around half a million years ago.

This community is amongst India's 75 primitive tribal groups (PTGs) that are characterized by small and diminishing size, isolation, pre-agricultural technology and low literacy. A typical Kotwalia settlement consists of 50-60 households on the fringes of forests, along the banks of rivers or on the outskirts of villages. Their main source of livelihood has been crafting bamboo gathered from the forests into baskets, which they then traded for grain from neighboring agrarian communities (Reubens, 2010b).

Historically, tribes have considered the forest (and natural resources in general) as common property, and since the Kotwalias traditionally did not farm, they were usually landless. In the 1860's, the British began taking control of the forests and common pasture, armed with the Indian Forest Act of 1865. The Kotwalias were no longer allowed access to the forests to gather bamboo, their primary input material. Even in post colonial times, this community, along with many other forest dependent communities, struggle for access to grazing lands, as well as minor forest produce needed for their sustenance and their craft (Sharma, 2007; Balooni 2007; Reubens, 2010a). A recent government policy allows for 800 bamboo poles per Kotwalia household annually, but most are not literate enough to follow through with the paperwork required to avail this quota.

A survey of 450 families, conducted in 2009, as part of this action research found that lost access to bamboo resources, the availability of substitute products and evolution of local economies have caused a decline in the number of Kotwalias crafting bamboo. Also dwindling is the traditional product range: intricate fish traps, basketry based containers ranging from huge granaries to small food baskets, livestock related products such as muzzles for cattle, and ritualistic representations of their different deities through bamboo structures (Reubens, 2010c).

Globalization is causing a change in the world view of the rural segment which reflects a preference for technology over tradition (Chaudhary, 2010). With the influx of new and more efficient substitute standardized products made from materials like plastic and metal, there are fewer takers for bamboo products. The community is forced to sell their produce at lower prices since they are unable to compete with the prices of mass produced substitutes (Jaitley, 1997; Smith and Kochhar, 2004). Their only recourse is to increase their volume of production, due to which they resort to crafting poor quality cheap bamboo products (Reubens, 2002) which only reinforces the perception that bamboo products are inferior to their substitutes.

Today, most Kotwalias migrate seasonally in search of wages, because they don't have any economic or productive skills other than bamboo working, nor land to farm. Most Kotwalias work as sugarcane labor. An average family of 4 earns less than \$400 USD annually (Mehta, 2009; Reubens 2010c).

The traditional value chain and the current unsustainable 'technology push' value chain are reflected in Table 1.

Table 1: Traditional and 'technology push' bamboo value chain

Activity Analysis	Output	Traditional value chain actor	Current value chain actor
Growing, Management and Harvesting of Bamboo	Bamboo	- Kotwalia community with forest as common property	- Forest Department Central Paper Mill - Private Farmers - Homestead Bamboo Owners - Village Panchayat
Transportation to site of production	Bamboo available at production site	- Kotwalia community	- Private transporters
Design	Design to be produced	- Kotwalia community through open design source of craft tradition - User	- Design Consultants - Social Design Firms - Design Institutions
Primary processing of bamboo	Components and input materials	- Kotwalia community	- Kotwalia community
Secondary and tertiary processing of components	Machining, assembly, and finishing	- Kotwalia community	- SMEs - Industrial production units
Transportation to site of marketing	Product supplied to seller	- Kotwalia community	- Private transporters
Marketing	Product sold by seller to consumer/user	- Kotwalia community	- Middle men - Wholesalers - Retailers

2. 'Technology- push' value chains

As discussed above, the thrust area for the development of designed bamboo products is bamboo processed through new industrial technologies: technologies which exploit and bring to fore previously unknown possibilities of bamboo as a material. This is despite the fact that these new industrial materials and technologies do not leverage bamboo's potential to address sustainability in a holistic manner.

Many of the barriers to sustainable innovation in product and service development identified by Maxwell et al (2003) are relevant to the bamboo sector. These are outlined below:

1. Lack of approaching sustainability holistically by simultaneously addressing the social, economic and cultural tenets alongside the ecological tenet

2. Inability to mainstream sustainability concerns in the business system, thereby not facilitating the sharing of sustainability related experiences and concerns across the business itself
3. Lack of integrating sustainability criteria, (social, economic, ecological, and cultural) at a strategic corporate level alongside traditional criteria such as market, quality, technology etc. and thereby also in the design brief
4. Focus on 'cleaning-up' product end-of-life environmental impacts rather than addressing sustainability holistically at the concept generation or design stage
5. Lack of focus on achieving sustainability across product supply and value chains from the Original Equipment Manufacturer upwards and downwards

Design decisions and specifications have a significant impact on sustainability due to their economic, environmental, social (White et al, 2008) and cultural spin-offs. More than 70% of the costs incurred over the product life cycle (Waage, 2005), and value chain including product development, material production and processing, fabrication, distribution, use, and end-of-life handling (Waage, 2005; White et al, 2008) are determined by design decisions. Many product life cycle impacts that need to 'cleaned up' could be eliminated or minimized by envisaging and addressing them at the conception and design stage (Maxwell et al, 2003). This back-casting and visualization exercise is possible because design is a 'problem-solving activity lodged between art and science (Greenhalgh, 1997)', which has at its core the design process, based on research, analysis and synthesis. These tools allow designers to create diverse and distant scenarios - including sustainability related scenarios- and innovate accordingly.

Despite being equipped with these tools, industrial designers favor a technology intensive, or 'technology push' path with bamboo product design. This section explores why new industrial processes and technologies, which exploit and bring to fore previously unknown possibilities with bamboo as a material, are the thrust area for the development of designed bamboo products even though they do not exploit bamboo's potential for sustainability holistically.

2. 1 Constraints of 'traditional' production systems

The culm or stem is the part of bamboo most used for production, irrespective of whether the product is handicraft, handcrafted, or industrial. The characteristics and morphological features of the culm, such as diameter, wall thickness, internodal length, shrinkage, warping, discoloration, (Reubens, 2009) are factors that limit the designer and manufacturing process

(Larasati, 1999 *in* van der Lugt, 2007). There are fewer (industrial) designers working with non-industrial materials like bamboo (van der Lugt, 2007) as compared to industrial materials like wood, steel etc. industrial designers are more comfortable working with bamboo when it is processed into familiar wood and reconstituted wood-like derivatives, such as different kinds of boards, panels etc.

Nevertheless, the bulk of bamboo products are still produced in traditional set-ups, using simple techniques like splitting, slivering, bending by heat, flattening, interlacing and working the whole culm. This is because the bamboo-working tradition has almost always been prevalent in cultures which have had access to the raw material, and became part of the socio-economic-cultural-ecological fabric where it was done by certain communities or specific social groups as a trade and passed down from generation to generation (Reubens, 2009).

Though a wide range of product categories, from houses, to containers to ritualistic objects can be produced from bamboo using these few basic techniques, when it comes to contemporary mass markets, these products find it difficult to compete in terms of quality, standardization, and quantity. The accuracy required from a 'designed' product catering to a mass-market, is much higher than that accepted from a 'crafted' product, catering to what is often a customized local market. It is difficult to achieve this accuracy and the related economy of scale in traditional bamboo-craft based set-ups.

The reconstitution of the bamboo culm through industrial 'technology-push' approaches address some of the main weaknesses to the commercialization of bamboo culms over the production chain such as insufficient drying, inadequate preservation, damage by insects, cracking, joinery, and inconsistent finish (Flanagan, 2004 and CORPEI 2005 *in* van der Lugt, 2007). However, these approaches can turn ecologically sustainable bamboo into an ecologically unsustainable 'monstrous hybrid' (C2C framework *in* Shedroff, 2009): the bonding of reconstituted bamboo in a resinous matrix makes it difficult to recycle since both materials need to be separated before their disposal can be addressed separately. 'Low-tech' approaches like turning solid bamboo on lathes to achieve required standardization, and pre-forming the growing culm through use of moulds (Reubens, 2009) maintains the idea of a mono-material, while simultaneously addressing production limitations, and allowing poor producers greater participation in the value chain and thereby its financial and social gains.

2. 2 Associations with 'bamboo'

Bamboo stem based products in general have a poor image in the West and are perceived by EU consumers as being low quality and non durable (Larasati, 1999; Held, 2004; CORPEI, 2005 *in* van der Lugt, 2007). A survey of 50 Dutch interviewees at an IKEA store revealed that the respondents associated bamboo with the terms 'Asia, panda, cheap, natural and rustic' (de Bruijn, 2006 *in* van der Lugt, 2007). The negative perceptions about bamboo's quality stems from whole bamboo products being used in outdoor spaces like patios and gardens in the West. The culms shrink, crack and decay due to the difference in the temperature and humidity and the exposure to the elements (Reubens, 2009). This can be prevented through treatment techniques, but more importantly by creating awareness about bamboo's properties, limitations, usage options, etc. among the designers, constructors, fabricators and users.

Bamboo's association with Asia likely comes from the extensive representation of bamboo in Asian arts and crafts, and also the history of colonization. Distancing the material from the associated means of production and context i.e. craft in the East, through technology intensive approaches circumvents this image, and is one of the reasons why designers and product innovation teams choose to work with processing technologies which are more industrial in nature.

2. 3 Lack of awareness about non-industrial production systems

The action research on which this paper reports indicates that a lack of awareness of non-traditional, non-industrial production to consumption systems and value-chains is another major barrier to sustainable innovation in product and service development in general, and in the bamboo sector specifically. The word 'industrial designer' implies a strong connect to the process of industrialization: an industrial designer by definition is therefore a designer trained to work along the industrial principles of division of labor and assembly line production (Rees, 1997). While traditional industry set-ups are familiar to designers, alternate set-ups, such as sustainable 'development' oriented set-ups, where rural bamboo producers form the enterprise; are largely unfamiliar to designers in terms of structure and working. Designers therefore apply design methodologies and processes, which are rooted in industrialization, to rural enterprises and producer communities (Reubens, 2010a).

Rees argues that the work of industrial designers is defined by the production process and that 'designers design for the industry, rather than for the consumers of the products of the industry. It is a way of thinking about the world which, by implication, denies the social, cultural and economic significance of consumption' (Rees, 1997).

The resulting designs often do not succeed, or realize their potential for social or cultural reasons (such as the dynamics of a caste system, or material culture parallels by the producers), organizational reasons (lack access of proper organizational structure) or logistical reasons (bad infrastructure and communication, health of workers, transport etc.). These same factors that are so crucial to the success of a product in an alternate, and often BOP production set-up, are taken for granted in an industrial set-up (Reubens, 2010a).

In industrialized set-ups the designer's role is based underlying principle of division of labor, but in non-industrial set-ups a more systemic overview is necessary. Unless designers are oriented to integrated scenarios or provided with a framework or guidelines regarding how non-industrial set-ups function, they will not understand clearly why the product is not successful, or cannot be manufactured. Consequently, they will veer towards the familiar conventional industrialized set-up or 'technology push' approach, which is comprehensible and thus manageable by them – and which at best addresses the ecological tenet of sustainability, especially as this is becoming unavoidable given the current policy and regulatory environment. Incidentally, designs utilizing renewable materials like bamboo are ideally positioned to leverage the holistic sustainability that can add richness to our material culture (Walker, 1998) by offering non-industrial, labor-intensive, localized, community-centric production to consumption, and value-chains.

3. The Rhizome approach

The Rhizome approach is named after the 'Rhizome Framework', which is elaborated on later in this paper. The framework was developed during this action-research process to function as part of a holistic system, where the natural resource management, community mobilization and organization, market analysis, design and development, skill training, capacity building and institution building are part of a comprehensive strategy.

The Rhizome approach aims to address the barriers to sustainable bamboo product development identified earlier. The approach consists of a 7 point system which is represented in Table 2.

3.1. Step 1: The Book

This step addresses the fact that in order to design sustainable products, designers have to be knowledgeable about the concept of sustainability in general; and in this specific domain, the inter linkages between bamboo, sustainability and design. Expertise in this field- similar to most sustainability related fields- lies outside the expertise of traditional designers (White et al, 2008). To bridge this gap, the first author has written a book titled 'Bamboo in

Sustainable Contemporary Design', which encapsulates her experiences while working at the International Network for Bamboo and Rattan (INBAR): She worked at INBAR for seven years, as part of an expert interdisciplinary team in the area of bamboo based development. The book is aimed at designers and the layout is therefore very visual and includes a lot of pictures and diagrams. The first step of the action-research is sharing the book with designers so that they can access pertinent and basic information on sustainability, bamboo and sustainable design in an appealing format.

Table 2: The Rhizome approach

Step	Barrier	Aim	Mechanism
1	Lack of knowledge about sustainability	Inform designers about sustainability, its identified tenets, and the inter linkages between them	Book titled "Bamboo in Sustainable Contemporary Design" which discusses the linkages between bamboo, sustainability and design
2	Lack of holistic oversight of production to consumption and value chain	Sensitize designers to the systemic production to consumption and value- chain picture	Exposure visits to traditional bamboo-working communities, community enterprises, industrial enterprises and the other stakeholders in the PCS chain
3	Lack of including sustainability at a strategic level in the overall approach	Provide direction on the larger goal and its blue-print that the organization is aiming/aspiring for	Sharing and explaining the Rhizome framework for an overall picture towards which all departments will work jointly.
4	Lack of including sustainability criteria alongside traditional criteria in the design brief	Articulate sustainability criteria in the design brief so that it can be addressed early on at the design concept stage	Clear brief to "design a commercially-viable bamboo product, using local production capacities, that leverages indigenous knowledge systems.". Provision of a "sustainability check-list" to clarify the criteria desired in the product.
5	Lack of collaborative design process	Provide inputs from different disciplines so that the design process is collaborative and different concerns are represented and addressed	Constant linkage and interaction with representatives from the PCS and VC including experts in the fields of sustainability, production, marketing, community, finance etc.
6	Lack of tool to measure holistic sustainability against indicators	Increase designers accountability to consciously, and seriously factor sustainability into the design, and to provide an opportunity for evaluation against the same indicators outlined at the concept stage	Using the "sustainability check-list" as the indicators, perform a 360 degree evaluation of the design, which includes self evaluation by the designer, and cross- validation of results by a sustainability expert and a community representative
7	Lack of keeping design team in the end loop of product actualization	Continuing the collaborative design process by keeping design team in the loop until the final product actualization stage, thereby retaining the overall perspective of the product sustainability	Involving design team in all changes required from the perspective of the product actualization, until all issues, including production systems, costing etc. are resolved.

The book includes sections on sustainability, sustainable development, a sustainability timeline, sustainable design and bamboo vis-a-vis sustainable design. It also includes sections on bamboo as a material resource i.e. the morphology of bamboo, bamboo usage and traditions, the natural characteristics of a bamboo culm and their design implications, and species-wise resource planning considerations. Different processing set-ups and the facilitating, enabling and challenging factors pertinent to each set-up are discussed. Production and material information, such as joinery for different applications, methods of restructuring bamboo ranging from traditional to industrial techniques and potential combination materials are also covered.

3.2. Step 2: Exposure visits

This step addresses the fact that designers, like the other actors in the production to consumption chain have lost oversight of the systemic picture. This loss of the systems perspective makes it difficult to approach sustainability in a holistic manner: designers look at addressing immediate issues (such as the fragile ecological situation) rather than looking for holistic, integrated and sustainable solutions.

Step 2 builds on the earlier overall introduction and orientation to sustainability and sustainable design, especially with regards to the bamboo sector, the book provides. The aim is to provide a first-hand exposure to how the various different, yet interlinked, actors of the value chain together contribute to sustainability or unsustainability through the production to consumption process. This is achieved by exposure visits of designers to traditional bamboo-working communities to understand their lives and traditional social, economic, cultural and ecological systems. Designers also interact with stakeholders and actors in a community enterprise set-up, as well as from an often contrasting industrial enterprise set-up, which allows them to directly internalize the potential for realizing sustainability through a paradigm shift in the production set-up, including production volume, livelihood opportunities, preservation of the social and cultural nucleus, and the use of materials (Walker, 1998).

3.3. Step 3: Rhizome Framework

As discussed earlier, a holistic strategy to achieve sustainability and reduce unsustainability is not often part of organizational mandates: the designer therefore lacks both an immediate reference point and the backdrop of the larger organizational scheme.

The 'Rhizome framework' (Fig:1) is one of the main outputs of the larger action-research this paper draws on, which examines ways of providing an overarching strategy for holistically

sustainable production to consumption systems for the bamboo sector, through design. The framework is a proposition towards a model which offers different design directions, to harness local and craft-based production possibilities.

Bamboo-craft is a vital force in communicating and substantiating the culture and tradition of bamboo-working communities. Simultaneously, bamboo's huge commercial potential can be exploited to help contribute to large scale employment of these indigent communities, who do not have much capital, but are rich in indigenous knowledge and have a strong skill and resource base (Ranjan, 1995). Therefore, the Rhizome framework seeks to use indigenous knowledge as a design input during the innovation process. The indigenous knowledge is viewed by the designer in the context of the sustainability, and factored into innovation in collaboration with the craftsman. This collaboration between the two maximises the skill and knowledge each of them brings to the innovation process. The craftsman brings indigenous knowledge and practices that have been validated over the passage of time to be more sustainable than not. Many of the concepts of sustainability have underpinned craft practice (Rees, 1997): the use of local materials, or, expertise and therefore production in a single material, which allows for ease in sourcing, production and repair, and also in eventual disassembly and recycling have parallels in eco-design (Reubens, 2010b). The designer brings value with his access to information and technology on current issues, including sustainability. Both inputs are complementary and supplementary.

The framework deliberately focuses on technologies which are closely linked to craft-production modes, in order to secure the craftsman a higher place in the value chain; and bring in greater sustainability and equitability into the gains along the different stages of the value chain. The technologies are deliberately 'low-tech' as opposed to 'technology-push' approaches in order to allow organic evolution of craft-based production by thousands of craftsmen (Dormer,1997) and producers to a sustainable end in contemporary applications through design (Reubens, 2010b).

The framework is named after bamboo's complex underground rhizome system. Each rhizome either sends up a shoot or sends down a root, and networks itself to other rhizomes to form a stable mesh which prevents soil erosion. A rhizome is not amendable to any structural or generative model: it is a map and not a tracing (Deleuze and Guattari, 1987). Similarly, the framework developed looks at three distinct directions which are independently and interdependently sustainable, and prevent the erosion of social, economic, ecological and cultural capital (Reubens, 2010b).

Rhizome Framework

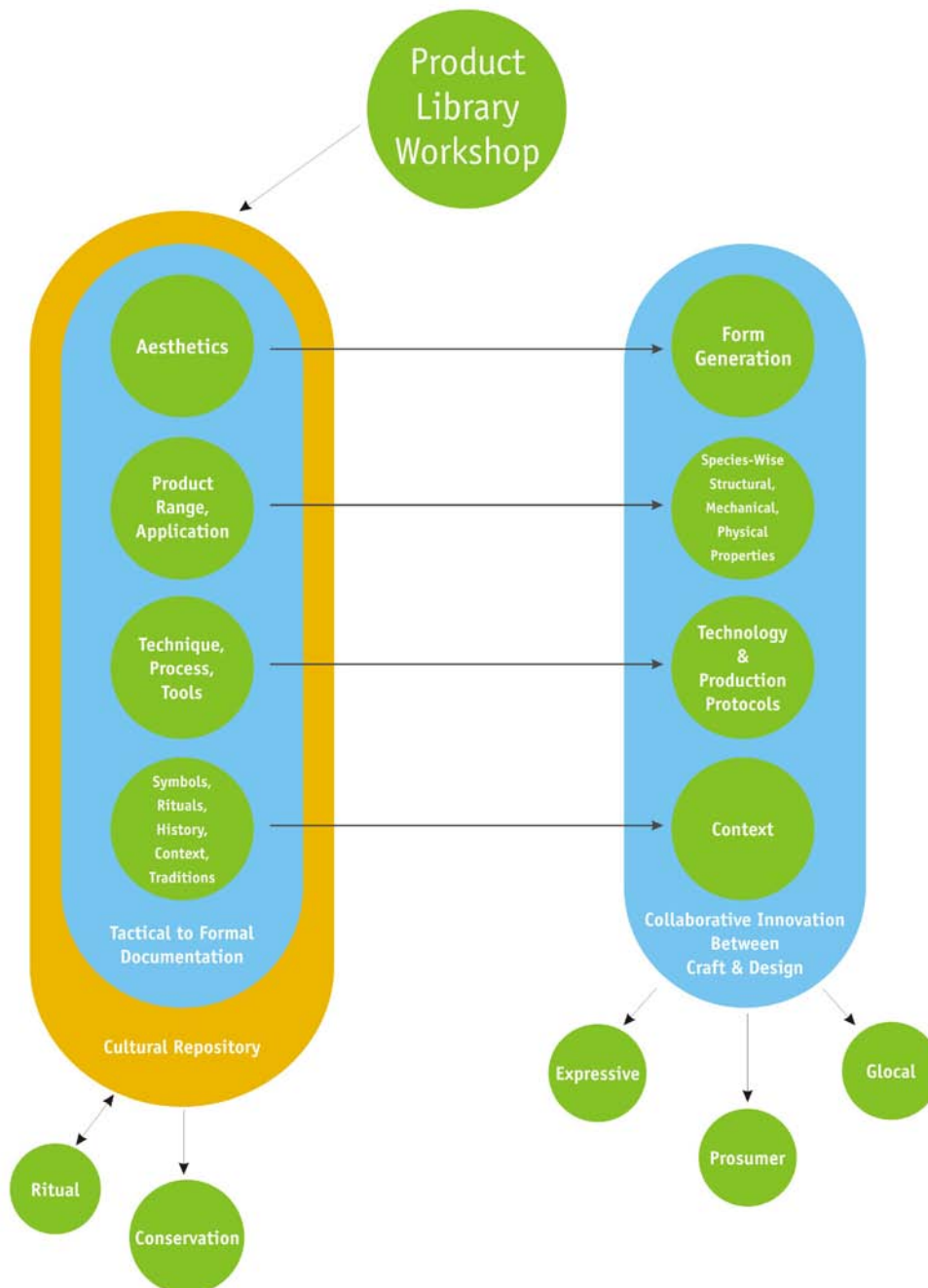


Fig 1: The Rhizome framework

The seemingly disparate tenets of sustainability i.e. the social, economic, ecological and cultural factors, the multitude of producers with varying skill levels, and the complexity of each system scenario in developing countries reinforce that there can be no single model on

which base design for craft production systems. The framework is therefore designed to be flexible enough to encourage and promote diversity by being adaptable to different contexts; while remaining strongly rooted in the interconnections between the social, economical, ecological and cultural tenets of sustainability (Reubens, 2010b).

The framework identifies opportunities for the bamboo producer to be an artist (Expressive) and/or a vernacular production and marketing link of an interdependent sustainable community(Prosumer) and/or a producer and perhaps even small businessman (Greenhalgh, 1997) rooted in producing sustainable products (Glocal): each through proposed directions of evolution for the bamboo craft mode and local production capacity.

Further information on the framework including its working mechanism can be found in the first author's article in the Journal of Craft Research.

3.4. Step 4: The brief and the sustainability checklist

In the absence of a clear brief which clearly articulates the desired sustainability criteria, the onus of incorporating sustainability into the design brief is on the designer: this is difficult, considering that sustainability has not been part of the expertise of traditional design function (White et al, 2008). Step 4 therefore includes providing a clear brief - to design a commercially-viable (economically sustainable), product made from mature, sustainably-harvested bamboo (ecologically sustainable), using local production capacities (socially sustainable), that leverages indigenous knowledge systems (culturally sustainable).

The current mode and proposed changes the brief envisages are illustrated Table 3.

In addition to this, a sustainability checklist has been developed as part of this action research. The checklist supplements the rules of thumb developed in the Design for Sustainability (D4S-DE) Manual (1997), with inputs from Global Reporting Initiative (GRI) Sustainability Reporting Guidelines(2000) and 'The Fourth Pillar of Sustainability' (Hawkes, 2001) to address social and cultural criteria, alongside economic and ecological criteria. This checklist makes the designer aware of the potential and desired criteria that can make a product more holistically sustainable. The checklist also serves as an indicator of sustainability factors achieved, once the product is developed.

Table 3: Traditional, current and proposed value chain

Tenet	Traditional: Sustainable	Current: Unsustainable	Proposed: Sustainable
Social	Bamboo working alongside other trades are part of village based tribal socio – economic system of obligation	Lack of viable livelihood is causing distress migration which is affecting the family and community nucleus	Reduces immature green bamboo used in handicrafts by providing production options using mature bamboo
Ecological	Kotwalias extract selectively, using bamboo for low cost, low volume production of basketry based agrarian products	Bamboo channelized for low cost high volume industrial purposes such e.g. input for the paper mills	Prevents distress migration by providing a viable livelihood to marginalized communities thereby protecting the social nucleus
Cultural	Products produced according to craft traditions and include religious deities and other cultural products alongside utilitarian products	Loss of indigenous knowledge and systems because craft practice and products are becoming obsolete	Records indigenous knowledge though the product library component of the Rhizome framework, and offers recontextualized design directions thus facilitating cultural preservation and evolution
Economic	Traditional system of exchange including barter linked to system of social obligation ensure subsistence economic level for all while shared forest allows gathering and hunting during lean periods	High level of rural indebtedness due to breakdown of traditional systems of exchange and ownership of common property natural resources such as the forest	Provides income opportunity directions by leveraging viable contemporary markets

3.3. Step 5: Dialogue and Technical Backstopping

White et al (2008) outline the need to bridge diverse actors within the organization to facilitate transitioning from a pipeline design sequence to an integrative design process. This logic has parallels in the pre-industrial innovation processes, where design, production and marketing were anchored in a single person, or close group, thus allowing for constant dialogue and technical backstopping between the actors.

The Rhizome approach facilitates developing systems, methodologies, platforms and frameworks that allow for communication and collaborative decision making and ‘participatory design’ (Shedroff, 2009) by encouraging and actively facilitating a constant linkage and interaction between the actors, facilitators and enablers of the value chain. Designers are ideally placed to facilitate this process since they are good at intuitively ‘uncovering evidence of emotions, values and meanings, and are particularly adept at communicating often ethereal or esoteric information’ (Shedroff, 2009).

3.6. Step 6: 360 degree evaluation against the sustainability checklist

The sustainability checklist was introduced in step 4 as a tool to help designers be aware of the indicators of the social, economic, ecological and cultural tenets of sustainability. In step 6, the designed product is evaluated against the checklist by the designer. The product is also evaluated using the same checklist by a sustainability expert and a community representative. These three sets of data allow for investigator triangulation (Denzin, 1978) as a method of cross-validating the data from multiple sources to identify regularities and discrepancies between the data sets. The result yields an indicative 'sustainability-quotient' of the product: this can be used as a reference for further development and also figured into the marketing strategy.

3.7. Step7: Final Product actualization

In the traditional pipeline design sequence, the production, costing and marketing revisions often happen between the time product is realized and is marketed. By this time, the product design function is essentially disbanded (White et al, 2008) and changes in the product are often made without the information or agreement of the design team. As a result, nobody has the bird's eye view of the product and the cascading effect of the changes - including vis-à-vis sustainability.

Step 7 therefore involves incorporating the necessary tweaking and changes arising as a result of step 6, and the additional feedback from the actors across the production to consumption chain; in a continued collaborative manner. The design team is therefore in the loop along with the other design collaborators, until the final actualization of the product.

4. Conclusion

This paper has focused on two main aspects. The first was understanding why designers design products that facilitate production of bamboo products along an industrial model, which lowers the participation and thereby the access of poor communities, such as the Kotwalia in the bamboo value chain.

The second aspect is looking at how designs which are developed to be actualized through craft based production protocols – such as the proposed Rhizome Approach and related framework, can facilitate figuring in holistic sustainability through collaborative innovation into the bamboo value chain. Though the paper discusses these aspects in the context of

bamboo craft, this research is relevant to the design of products using renewable materials in labor intensive situations i.e. developing countries in general.

While pilot design projects using the Rhizome Approach have already been trialed over the past three years, a consolidated design workshop with 30 participating designers is scheduled early in 2011. Following the workshop, the products will be evaluated using the sustainability checklist in line with Rhizome approach and a graphic representation of the sustainability quotient of each product will be developed as a product labeling. It is hoped that the innovative and sustainable products developed as a result of this workshop and action-research will contribute to the existing scholarship on formulating a road-map to integrate the tenets of sustainability through design.

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