Design Interventions for Stimulating Bamboo Commercialization

Dutch Design meets Bamboo as a Replicable Model

Pablo van der Lugt

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Proefschrift

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voor Bart

Table of Contents

PART III: CONCLUSIONS

Preface

What brings a building engineer to pursue a PhD about the commercialization of bamboo in consumer durables? For the answer to that question we have to go back to 2001, when I was in Costa Rica for an internship at the National Bamboo Project, and was first introduced to the good mechanical properties, low costs, broad applicability and especially the very high biomass production of giant bamboo stems. I was struck by the enormous potential of bamboo as sustainable raw material and at the same time wondered why bamboo was still perceived as "the poor man's timber" in Latin America, and why its use was not common in the West. It was this question which intrigued me and set me on an ongoing journey of discovery and trial & error in search of answers, which through my MSc thesis (2002) and bamboo related world trip (2003), led me to pursue this PhD research starting in October 2004 and ending exactly four years later.

Before you, in the form of this PhD thesis, lies the accumulated knowledge during this seven year-long journey, which helps to explain the background of the paradox between bamboo's potential as a fast growing renewable resource and the inability to grasp this potential, visible through the small market share of bamboo in products in the West.
During this journey for knowledge I was confronted with many changes of direction caused by new findings along the way (for an elaborate retrospective description of the seven year journey the reader is referred to the epilogue). Nevertheless, it was this pragmatic, action oriented, problem solving approach which actually provided most insights, enabling me to understand the drivers behind the aforementioned paradox, and providing the concrete tools in the form of a design intervention to actually help solve part of the obstacles causing the low market share of bamboo in products in Western Europe. Therefore, although challenging, I perceive this PhD research as a highly rewarding endeavor, which has not only contributed to new material commercialization theory in general, but unlike most academic research, has also actually made a difference in the empirical world.

As also becomes clear from the retrospective description of my PhD process in the epilogue, there are many people that have provided me with academic, financial, mental, political, organizational and other kinds of support during this PhD journey, whom I owe a lot of thanks.

First of all, I want to thank my promoter Han Brezet, who believed in me from the start, who facilitated a position as PhD researcher at Design for Sustainability (DfS), provided the optimism and encouragement to continue halfway through, and proved to be a wonderful coach at the end when writing my thesis. Han, to me, besides being my promoter you are my friend. Furthermore, I would like to thank Marcel Crul, who as daily supervisor during the first part of my research, has acted as a pragmatic, efficient and pleasant sparring partner.

Besides Han, there are a couple of people in particular that have enabled me to start my PhD research. Thank you, Hans de Jonge and Andy van den Dobbelsteen, for inspiring me and financially enabling me (Hans) to start my PhD. Thank you, Mick Eekhout, for providing me a working space and supervising me

during the start of my research. Thank you, Fred Foundation, for providing me the seed money to start my research in 2004.

I am thankful to the many colleagues at the Faculty of Industrial Design Engineering (IDE) that have supported me academically during my PhD process, and in particular Joost Vogtländer for his intensive help and discussions with respect to the environmental assessments. I would also specifically like to thank Prabhu Kandachar, Henri Christiaans, Sacha Silvester, Ilse van Kesteren, Wim Poelman, Hans Dirken, Ruth Mugge, Jan Schoormans and my brother Remko van der Lugt for their academic support. Furthermore, although my attendance rate in "the aquarium" was not spectacular, I have been grateful to be part of the DfS family. Thank you (alphabetically) Ana, Daphne, Duygu, Hanna, Hitoshi, JC, Mariska, Renee, Paulson, Priscilla, Satish, Sioe-Yao, Susan, Uri and many others. At this place I would also like to thank the various students (many of which are already graduated) who have helped me in different ways during my research. Thank you (alphabetically) Mika de Bruijn, Pieter de Goede, Martijn van Loon, Eleni Soerjo, Arjan van der Vegte and Petra Veen. I would also like to thank the ladies of the Design Engineering secretariat (Astrid, Hanneke and Marijke).

I owe a lot of thanks to many persons involved in the project "Dutch Design meets Bamboo" (DDMB). Marco, it has been such a pleasure to work, discuss and brainstorm with you; I am very proud that we were able to actually materialize our "mental baby" in the form of the Bamboo Labs. José en Hanneke, thank you for taking the risk to adopt and organize the project and for the fun cooperation along the way. Arjan, thank you for multi disciplinary support during the project, and the memorable journey we had in China together. Furthermore, I would like to sincerely thank all designers that participated in DDMB for their inspirational contributions in the form of products & ideas, and their patience and cooperative attitude during the many interviews and questionnaires I forced upon them. Finally, I would like to thank the many sponsors of DDMB.

I also owe my gratitude to the dozens of persons I interviewed, or intellectually sparred with, over the past years, some of whom I would like to thank in particular. Thank you, René Zaal for your valuable and extensive contributions to my research and for facilitating my visit to China. Thank you, Jules Janssen, for having been my loyal and constructive bamboo mentor throughout my seven year journey. Thank you, Arienne Henkemans and Gerben Stegeman, for your selfless help especially in the start of my research project. Thank you, Coosje Hoogendoorn, for the inspiring discussions and realistic mindset. Thank you, Charley Younge and Pim de Blaey, for the pleasant collaboration in the beginning of my research. Thank you, Ana Cecilia Chavez and Ligia Ramirez for introducing me to bamboo….

Furthermore, I received much help during the final preparation of my thesis in the form of this book. First of all, I would like to express my gratitude to Guido van Rijn, my old English teacher and father of paranimph Paul, for proofreading and correcting my thesis. Secondly, I would like to thank Jacques Schievink and Duygu Keskin for helping me with the layout of this thesis. Finally I thank the members of my committee for the valuable suggestions they provided to improve this thesis.

At this point I would also like to thank my friends for bearing my complaints about PhD research for four years, and in particular my paranimphs Paul & Robert. Thank you, Groeneveld family, for your interest and support throughout my PhD process.

Last but not least I want to thank my fantastic family - Mank, Manu, Mara, Remko & Becky, Sam, Sarah and Ben - for always being there for me when needed, and supporting me in every possible way throughout my PhD journey. You know it has not always been easy, but your positive support has made me pull through. The same applies to you Klink; thank you for always supporting me. I am incredibly grateful to have you in my life and look forward to our future, a future in which soon you will also have your PhD, I am sure.
Finally, I want to thank my father, Bart van der Lugt, for his love, fatherhood and friendship. You always urged me to finish my PhD knowing that like for you, it will be a stepping stone toward higher goals in the future. And although I deeply regret that you will not be able to attend my defence physically, on another level I know you will be with me that day.

Bart, I dedicate this PhD thesis to you.

Pablo van der Lugt
July 16, 2008

Summary

In chapter 1 the problem analysis and main research question of this PhD research is introduced.
The importance of materials in society throughout the history of man becomes evident in the classifications provided by archaeologists for various chronological eras: the Stone Age, the Bronze Age, and the Iron Age. Each age refers to the dominant material technologies being deployed at that time, revealing the impact of materials on societal development and technological progress.
Materials also have a considerable impact on the environmental sustainability of the products in which they are used, visible through the three, interrelated, main global environmental problems: depletion of resources, deterioration of ecosystems and deterioration of human health. Due to increasing population and consumption patterns worldwide, more raw materials are consumed than can be produced globally, making especially resource depletion an urgent problem; many raw materials based on abiotic resources are expected to be exhausted within this century. Although the use of materials based on renewable resources such as timber seems a promising alternative, because of the high felling rates of available forests worldwide, especially slow growing (tropical) hardwood is under a lot of pressure and with continued unsustainable extraction can be considered a finite resource as well. Due to its good properties, bamboo - a fast growing renewable resource - could have the potential to help meet the increasing demand for raw materials, and hardwood in particular. Nevertheless, in Western Europe bamboo is still a largely unknown material with a small market share, which is caused by several obstacles found along the bamboo Production-to-Consumption System (PCS).
Due to their strategic position in the value chain, and their ability to translate a new material in a concrete value added marketable product, designers may act as champions for a material in high end consumer durable markets, such as in the interior decoration sector (i.e. furniture, interior finishing and accessories). In this action research is investigated how the commercialization of bamboo in the interior decoration sector may be stimulated through the active integration of designers as potential material champions through the main question: *To what extent can design interventions successfully stimulate commercialization of bamboo in products in the interior decoration sector in Western Europe?*

In chapter 2 the intervention proposed is further developed. Through interviews with key stakeholders in the material industry it was found that especially for small material producers, the organization of multi disciplinary design workshops, in which also other relevant value chain nodes such as material suppliers, processors, application manufacturers and retail outlets are involved, may be the most suitable strategy to actively involve designers.
The design intervention (project: "Dutch Design meets Bamboo") is divided in the core intervention (the design workshops named "Bamboo Labs," executed in Winter 2006-2007), with designers as the target group, and the extended intervention (diffusion of the results of the workshops starting in April 2007) with relevant value chain nodes downstream (at the consumption side of the PCS) as the target group. This research mainly focuses on the core intervention which targets three main obstacles found in the bamboo PCS: lack of bamboo related knowledge of designers, lack of bamboo related value chain networks around designers and lack of bamboo related design capacity, i.e. designers working with the material. The extended intervention has a broader scope and also tries to positively influence the following additional obstacles found in the bamboo PCS: lack of knowledge of additional value chain

nodes (processors, application manufacturers, retail outlets and the general public), the poor image & lack of trendiness, and the lack of value chain networks for bamboo. The overall objective of both the core- and the extended intervention is to stimulate the commercialization rate of bamboo in products, i.e. sales in final consumer markets. In the core intervention during five workshops (Bamboo Labs), 21 invited Dutch designers were challenged to develop a bamboo product with high potential for the Western European market, based on five bamboo materials: stem, Plybamboo, composite, Strand Woven Bamboo (SWB) and mats. During the Bamboo Labs the designers were supported by the Material Support System, consisting of various kinds of information material as well as interaction with experts. In the extended intervention the results of the intervention in the form of product prototypes were diffused through an exposition, publication of a bilingual book, and several activities organized around the exposition (design fair, seminar, and several lectures).

In chapter 3 the research design is introduced. Based on the elements of the intervention, and incorporating typical action research criteria, the research model was developed and operationalized into four research questions evaluating and analyzing:

1. The impact of the intervention;
2. The product prototypes developed during the intervention;
3. The bamboo materials used during the intervention;
4. The causes of the success/failure of the intervention, based on which suggestions for improvement are made.

Furthermore, the methodology used in the research is introduced in chapter 3, revealing that for data collection and analysis both qualitative and quantitative research methods were deployed.

In chapters 4 and 5 the various prototypes are evaluated.
In chapter 4 the prototypes are evaluated on their market potential and innovative character through expert appraisal. Half (11 out of 22) of the developed prototypes were evaluated by the expert panel as having a high to very high market potential, which also becomes apparent in the high number of prototypes (eight pieces) that will certainly be developed further toward commercialization. With respect to their innovative character around half of the developed prototypes were evaluated as having a high to very high level of product innovation (12 out of 22) and process innovation (10 out of 22).

In chapter 5 the environmental sustainability of the prototypes is evaluated through a thorough analysis of the bamboo materials they are made from, in terms of Eco-costs (LCA based method) at the "debit" side and annual yield at the "credit" side of the environmental sustainability balance. It was found that in terms of eco-costs bamboo materials used in Western Europe score worse than locally grown wood but in general better than wood grown in other continents (e.g. tropical hardwood) and materials made from abiotic resources (e.g. steel and plastics). In terms of annual yield (m3/ha semi finished materials) giant bamboo species such as Guadua, in general have a higher annual yield than wood (including fast growing softwood species such as Eucalyptus), a higher applicability of the yield in various applications and a higher potential for reforesting degraded land.
Although due to the higher eco-costs it is recommended to use bamboo mostly in bamboo producing countries such as India & China where demand for raw materials is growing most, in the future bamboo may also be used to help meet the demand in Western countries as well, if locally grown softwoods cannot meet the demand.

In chapter 6 the various bamboo materials used during the Bamboo Labs are evaluated by the designers participating in the intervention, based on their attitude toward the material. The evaluation showed

that most bamboo materials (stem, composite, Strand Woven Bamboo and mats) are still evaluated slightly worse than softwood (Pine), and only Plybamboo can compete in terms of attitude with hardwood (Oak). However, the results did show that an increase in knowledge about the various bamboo materials leads to a significant increase in attitude toward these materials. Furthermore, many designers provided several concrete recommendations for improvement of the bamboo materials, and mentioned that several of the bamboo materials still may be optimized, and upon improvement will be evaluated better in the future.

In chapter 7 the impact of both the core intervention and the extended intervention is evaluated based on several success indicators related to the obstacles in the bamboo PCS targeted by the intervention. The results show that during the core intervention the bamboo related value chain contacts, knowledge and behavioral intention (i.e. the chance of implementation of the material within two years) of the participating designers increased significantly. The material supplier noted a strong increase in value chain contacts and generic knowledge about the various bamboo materials (Bamboo Labs functioning as "think tank") with respect to product- and process innovation. This new knowledge can be used as competitive advantage over competitors in future projects of the material supplier. Furthermore, around one third of the prototypes (eight pieces) will be further developed toward commercialization to be launched on the market in the coming years (2008-2010), while four designers already started up new design projects with bamboo individually.
The diffusion of the results (extended intervention) has led to a lot of exposure, of which a large portion was initiated by several of the participating designers themselves who turned into material champions for bamboo. Through the exposure more than one million people were reached and as a result bamboo was recognized as a trend by several acknowledged design magazines. A sample survey showed that in general the attitude and behavioral intention toward the bamboo materials increased after relevant value chain nodes downstream were exposed to the results of the Bamboo Labs. Although the extended intervention has led to a number of interested value chain contacts (mainly designers, but also some large professional clients/brands) and a couple of new design projects, the real impact of this exposure for the material supplier may only become evident in a later stage.

In chapter 8 the causes of the success of the core intervention are analyzed for the participating designers. First of all, the value of the Material Support System (MSS) for knowledge-, inspiration- and value chain contact development was evaluated, showing that depending on the personal preferences of the designer some components of the MSS were appreciated more than others, although in general the interaction component was evaluated better than the information material component. Secondly, the analysis showed that the success of the intervention in terms of an increase in behavioral intention was caused - as intended - by an increase in knowledge (through) which: 1) the attitude toward the materials increases, 2) bamboo remains more in the back of the head of the designer during material selection (mental material library), 3) bamboo is adopted in the physical material library of the designers, and 4) is perceived as a competitive advantage and time investment which the designers want to pay off. However, the analysis also showed that the increase in value chain nodes - unlike what was intended - had a small influence on the behavioral intention. The analysis revealed that existing value chain quality and a good designer - sector - material match are more important success factors toward an increase in behavioral intention, showing the crucial importance of appropriate designer selection for design interventions.

In chapter 9 the most important conclusions, recommendations and contributions of this thesis are provided. It is concluded that the intervention has been relatively successful in stimulating the

commercialization of bamboo in products in Western Europe, but that the intervention has also had some additional interesting outputs besides an increase in behavioral intention. It can be concluded that the core intervention had a small reach but a high impact in terms of an increase in bamboo related knowledge, value chain contacts and behavioral intention for participating designers (of which some have turned into material champions for bamboo), and a high impact in terms of new value chain contacts, actual projects and gain in generic knowledge about the various bamboo materials for the material supplier. The extended intervention has shown that the diffusion of the results of the workshops can serve as a very strong promotion tool, generating a large amount of exposure and awareness about the potential of bamboo in the form of concrete tangible products, which leads to a small increase in attitude and behavioral intention toward the material for a large number of relevant value chain nodes. For the material supplier this exposure has yielded various value chain contacts interested in the material, some of which have already implemented bamboo in actual projects. Because of the long incubation time commercialization processes may have, the generated exposure may also result in new projects in a later stadium.

Taking into account the additional outputs of the intervention, the intervention may be evaluated as being efficient, since alternatives for the configuration of the design intervention (e.g. design competitions), with the same output requirements, were valued by the participating designers as being less effective. Furthermore, through the new material champions (designers and application manufacturers adopting the material) that have stood up as a result of the intervention, the intervention has become self propelling, showing that a one-time injection in the form of a design intervention at the right time and position in the PCS can have a sustained impact on the commercialization rate of bamboo.

Besides the general conclusions, chapter 9 sketches the theoretical contributions made through this research. The first theoretical contribution of this research lies in the greater understanding gained to what extent, and under which circumstances, designers can play a role in stimulating new material commercialization. As part of this contribution the replicability of the design intervention made in this research for other materials is substantiated. It is expected, based on the findings for the design intervention executed for bamboo, that for (small) material producers, active in the medium to high end consumer durables sector, commercializing a material that is in the development or introduction phase of the new material commercialization process, design interventions can act as an important instrument to develop (generic) knowledge, raise awareness, generate exposure and as a result stimulate the commercialization rate of a new or a lesser known material. Several suggestions are made in the recommendations on how, depending on the requirements of the commissioner, future design interventions can be configured into custom-made solutions to meet each of these outputs in the most efficient way. The second theoretical contribution of this research is in the field of research design methodology for action research based on design interventions, for which the conceptual framework developed in this research may be used as a structuring element for similar action research projects in the future.

Finally, besides the recommendations for stakeholders interested in stimulating new material commercialization in the form of custom-made scenarios, various recommendations are made in chapter 9 for further research amongst others to improve the design intervention framework in the future, including modification for use in the South. Furthermore, several recommendations are provided to the bamboo industry in general with respect to required innovations in the field of sectoral organization as well as future market development, which are suggested to be followed if bamboo is to claim its latent potential as the raw material of the future.

Pablo van der Lugt