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CASE STUDY OF TECHNOLOGY TRANSFER TO A FIJI RURAL VILLAGE USING AN IMPROVED 'SUSTAINABLE TURNKEY APPROACH'

Leslie Craig Westerlund*[1], Goen Ho*[2], Martin Anda*[2], M. Daniel Wood[3] and Kanayatha Koshy[4]

[1]Technologies and Strategic Management of Sustainable Biosystems, First International Conference, Murdoch University, W.Australia

[2]Environmental Technology Centre, Murdoch University, Murdoch, W.Australia

[3]School of Engineering & Physics. University of the South Pacific, Suva, Fiji. 4 University of the South Pacific, Suva, Fiji

A modified appropriate 'sustainable turnkey approach' (STA) was developed, trialled and used to introduce new cottage papermaking technology to an existing papermaking village in a remote highland part of Fiji, an example of a less developed country. The new research explored making a high technology piece of equipment in Suva, the nearest city to the Wainimakutu Village. The STA has empowered a local engineering business and the engineering department of the local university to be able to understand and transfer the 'hardware' (equipment) and 'software' (skills) of these technologies and actually make the machines. The principle Author helped them to adapt and improve the design, to trial it, to test it, and then network with a village to complete the ideals of using the 'best available technology' that is also sustainable, eco-friendly, appropriate and financially viable. The STA has proved a far superior process. When something goes wrong with the machine it can be adjusted, fixed or modified to work: first in the village; second, with local industry help; third with local university help; and fourth with contacting the inventor for advice and networking with all stakeholders.

Keywords: case study; Fiji; papermaking; sustainable turnkey approach; technology transfer.

INTRODUCTION

In technology transfer (TT) there are several approaches to transfer the hardware (equipment) and software (skills) of new innovative technologies to less developed countries (LDCs). The established industry approach is to transfer small increments of innovation in 'software' or 'hardware'. The next level is argued to be larger levels of innovative technology transfer with more risks and benefits. The modern perspective includes using the 'best available technology' from the start of a project and also pioneering sustainable and ecofriendly principles in the 'life cycle analysis'. Within this range of technology options is importing new high technology advanced equipment from developed countries and with a bit of local training it might work in the village by 'turning the key' and miraculously working.

FIVE PHASES OF SUSTAINABLE TECHNOLOGY TRANSFER

The 'turnkey approach' is part of the third phase of transfer technology to developing countries. This is based on a introduction to a trial of 'five phases of sustainable technology transfer' to LDCs [Westerlund 2008], summarised for this project as:

- The 'first phase' is the selection of the project site. This is first based on the existing papermaking technology hardware and software; then the village infrastructure, culture, skills, needs, wants, management and marketing.
- The 'second phase' is to further examine methods of improving existing hardware and software technology levels of use and understanding; then to actually select and improve examples in TT in small and bigger steps using the research on specialised handmade papermaking technology from Westerlund [2005];
- The 'third phase' is to introduce new or more radical higher levels of hardware and software in TT. This can include a "turnkey approach" for hardware; and "copy it exactly" approach for software.
- The 'fourth phase' is a 'vertical transfer' of technology. This is to empower a village with new skills and tools to value add a raw product into a range of more useful and valuable merchandise. This project aimed to make a value added product range from the base A3 size paper product: to be guillotined into quality standard A4 paper, then printed into useful books, poems and publications;
- The 'fifth phase' is a 'horizontal transfer' of technology. This is to then help empower the village to own, modify and transfer·· the holistic range of new technologies to the next village.

TURNKEY APPROACH

The 'turnkey approach' becomes very important as it could transform a LDC cottage industry into a more competitive production advantage. This is levered further by: using local cheaper labour ; and new free raw material (post industry waste paper) ; and using locally grown village flowers and feature fibres in the paper. This could gain a competitive edge in local, regional and international markets.

The 'turnkey approach' may not· be initially considered relevant to LDCs because a village does not have the money or expertise to buy sophisticated equipment to be just delivered to them - and - expect it to seriously work in the harsh environment of LDCs. Likewise the village has no technology skills to re-design, and engineer the range of technologies - so there is a level of co-dependence to make the new technology relevant to them, fixable by them, with training to use it safely, and phone support for maintenance advice or breakdown services. Stewart [1987] argues that the "turnkey plant are typically built by engineering firms with no proprietary technology rather than by the innovative firm" that compromises the quality and integrity of the holistic system. He goes on to be disillusioned with the whole incentive system for technology diffusion or transfer and suggests "efforts to promote technology transfer are either useless or counterproductive." A useful case study of the 'turnkey approach' is the Cypriot 'advanced manufacturing technology' researched by Efstathiades et al.,[2000]. They argue that it is preferable to develop the technology and expertise in one city, make units, then export the finished product to either developed countries, intermediate DCs or LDCs.

There are also many challenges to the 'turnkey approach' so a compromise would be to get the inventor on-side, to re-design the plans of new technology for a LDC, and make it with industry in the nearest city to the project. This would empower TT at the grass roots levels and allow the machines to be made and serviced in a developing country. However, who is going to give away good new up-to-date or 'best available technology' to a LDC? Who will pay for it? Who will teach them? Who will profit? Who will answer their phone calls for help when it breaks down? Who will translate complicated science and engineering to a village unskilled person using the equipment with limited training? Which village would appreciate it? Which traditional hand-made papermaking village will truly appreciate the opportunity:

BACKGROUND ON A (MODIFIED) TRADITIONAL P APERMAKING CRAFT IN FIJI

The traditional papermaking involves the following steps: (1) collecting plant fibres and glue from the village gardens; (2)soaking, pounding and boiling into softer, small fibres; (3) further pre-treatment in a 'Hollander beater' / grinder (500g/20litres); (4) diluting the fibres into 99% water solution in a vat; (5) scooping with a sieve-like mould and deckle to collect a thin layer of pulp; (6) flat couching onto a cotton couching cloth; (7) pressing a batch of fifty in a screw press; (8) peeling each off and pasting onto a hot metal surface for drying; and (9) when dry, the rougher textured paper is sorted and graded for wrapping paper.

BACKGROUND ON NEW TECHNOLOGY

The new technology involves a range of new equipment to make the process quicker, easier, and cheaper. It derives a superior quality paper smooth surface texture. The new technology would have the following features locally: (1) 95% free post industry waste paper could be used with local village grown fibres and pretty flowers as 5% features within the paper; (2) new 200 litre hydropulper that chops 3kg of paper into 150 litres of pulp; (3) new aluminium moulds and deckles that do not rust or warp; (4) new transfer roll-over couching curve; (5) new guided stacking system of couching clothes; (6) new pressing system with a 20 tonne hydraulic press; and (7) traditional loft drying avoids fires and resultant OHS smoke issues.

The new hydropulping machine allowed the new source of free waste paper to be quickly, cheaply, easily used and compliments the existing Hollander technology that slowly grinds fibres for use. This process is further explained in Westerlund [2005,2007,2008] and available on the www home page.

From research of the greater Pacific region as an example for regional LDCs, Wainimakutu Village, Fiji was chosen as the best place to launch the project, Kassim [1992], Liebregts [1998], Liebregts and Townsend [1998]. They were already making a decorative hand made A3 wrapping paper and had the interest and incentive to diversify their cottage (business) enterprise. The traditional protocols were followed and the project had the Headman and Chief's blessing. This part of the greater project, which was to investigate better ways of transfering low and high technology equipment - hardware and software - to remote villages in a less developing country.

METHOD

The project involved designing a hydropulper machine (LHP) to chop up paper into pulp, engineering and building, financing and then giving away the new technology hardware (equipment) and software (training) to an existing village-based papermaking project in Fiji. The propriety 'intellectual property' to the new smooth papermaking process and equipment is with the Author* [Westerlund 2007]. This 'creative commons' approach to technology transfer was freely offered to help the village acquire the best available technology and training [Bunt 2007]. This can give credit to the person(s) technology and transfer it with their blessing. This acknowledgement is empowering for all concerned. If the next group wish to further consult with the original inventor/designer than that can be done in a fair and equitable way.

The idealised: Plan A was to make it in the nearest city, Suva with some village help. Plan B: the business engineers can redesign and build a hydropulping papermaking machine near the city of Suva, Fiji in Jan 2007. Plan C: to network with the engineering section of the University of the South Pacific to make one as a student project in 2007. Plan D: where the original hydropulper (B) was remade as a university student project in 2008 and given to the national training provider. Plan B: was chosen as best and we sought the help of a small manufacturing company. The Plan was discussed with the manager of 'On Time Engineering' and set in place - with a hand shake-and a traditional bowl of 'yogona-grog' to make the LHP at their small engineering company. This also involved redesign it using locally available material and tradesmen [Sharma, 2006].

EVALUATION

The evaluation incluqed field trials in the village and another trial of a questioner. It was based on five points per question per level of competency: Questions like ... Can you fix the motor/electrics ⁄ weld the frame ⁄ sharpen the blade/ engineer the drum/ plumbing/ oil seals/ drive shaft/ bearings/ pulleys ... ? Each person could get up to 25 points per equipment. Then up to 100 points for making four pieces of low technology equipment; 4 pieces of high technology equipment; then making the four stages of smooth papermaking skills. An individual could get 300 points if they participated in learning all facets of the new technology. This was compared against the inventor at 25 points x4 =100/ (equipment); then x3 phases=300/(equipment and skills) total transfer for three phases. This system can keep going on to include a 100 points for each new significant phase of technology transfer. The system has allocated the same points to each phase as all phases are important to any holistic project.

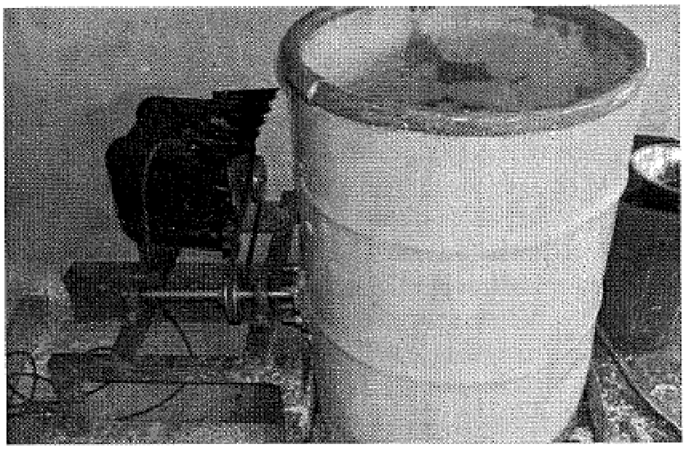
RESULTS

Plan B was successfully implemented and resulted in a book being published on "How to Make a Hydropulper" [Westerlund 2007]. The small engineering company had a suitable workshop, tools and tradespersons to help design and make a hydropulper using locally available parts.

There were many challenges from this first hand experience of TT. At an engineering level there were several design issues to be understood and overcome and the Authors can be contacted to get more details on the case study. One design challenge is if there is a problem in the village then they can at least courier the unit back to Suva and get it serviced and reengineered locally. A photo of the group was taken with it working in the engineering business [Westerlund 2007]. There was only so much the

Author could do with the engineering company before the Author* completed the rest at his Suva home base.

Figure 1. Hydropulper (200 litre) being made by the Author with industry help in one week in Suva.



The final tests were in the village. The important moment came to start the generator and 'christen' the new motor-hydropulper in the remote village ... and ... it 'did not work'! After all the pre-planning and testing, it did not work! The local village portable generator was not powerful enough to start the motor. We had overlooked that issue. The Author was not an electrician and did not fully appreciate using non standard portable 240 volt systems. The pulley had to be literally 'kicked' to make it move and help start the motor.

The motor was then making some noises after the rough road trip up the mountain. The Author asked if there was an electrician in the village. There were two! The hydropulper motor was soon stripped down and realigned to work better. Several batches of paper were then made to trial the machine under operating conditions. The machine was used for a year until a better machine was redesigned and made. In part summary, a local business was empowered to help make a suitable and functional hydropulper and with local village electrical support it could just work in the harsh village environment.

DISCUSSION

The idealised Plan A, was too difficult to be implemented in the village. The villages did not have the equipment, experience or available skilled tradespersons to start or complete the project.

The next level, Plan B, was successfully implemented with the help of a local engineering business, co-designed with the inventor *I* Author, using locally available parts. This involved some input from the villages to help ensure it could be fixed and serviced in the village or the nearest city (Suva). This project of making a hydropulper was quickly done within two weeks against many challenges. Executive decisions could be discussed and made with the industry Manager and Authors and staff several times during the week. It also became a first hand experience for the other staff who looked on and helped out in different engineering, electrical, welding, lathing, and mechanical skills [Radesh 2007].

The next level of help, Plan C, from the University of the South Pacific was very important to introduce the engineering section to the project and make a better hydropulper. This took a year to make and network as a student project. It was delivered to the village in January 2008 and was happily accepted in the village and now an integral part of their new improved processes. Two students produced a document as part of their research on making a hydropulper at USP [Dayal and Khan 2007]. This will be further discussed in another paper.

The next level, Plan D, is for all Fiji stakeholders to be more in control of the technology while networking with Community Education Training Centre and Murdoch University and for ongoing support of new projects in Fiji and the Pacific Region [Bola 2006, Maka 2007-8]. The hydropulper could be re-engineered and donated to this group for ongoing research and development. This will be further discussed in another paper.

EVALUATION

The hydropulper was successfully made and trialled in the remote papermaking village in 2007. The USP hydropulper was then trialled from January 2008. This shows the importance of getting the inventor to help in the re-design of the equipment and linking with local industry to make it work against many odds.

The results show that for the hydropulper stage of the project; the village contribution from 13 men, seven helped and were allocated 5,5,5,5,10,10,15 points= only 55 points (15%); the industry and university generated 364 points from over 20 tradesmen, staff and students (85%),ofwhich 6 were at 25; 5 at 20 points and the majority below 10 points, (or seven times more transfer potential than the village contribution). This highlights the invaluable contribution of industry partners and the university in making the higher technology equipment in the nearest city to the village.

The combined total for the hydropulper of 419 (55+364) points divided by 25 equals (16.76) over sixteen times effective transfer of the inventors/Authors ideas and skills to various stakeholders in the LDC of Fiji. This should empower the ongoing success of technology transfer over many years. The analysis of the overall results suggest that a factor of 5:1 for low technology equipment and 10:1 for higher technology equipment or skills is sufficient buffer to effectively transfer technology to LDCs.

CONCLUSION

- In conclusion, the modified appropriate 'sustainable turnkey approach' worked to introduce a new sophisticated piece of technology to a village craft papermaking cottage industry in Fiji, a developing country.
- The remote village does not have the expertise, skills and equipment to design and make the more advanced hardware. The best way forward is for the inventor of the technology to empower a local engineering business and local university in the project. The inventor is acknowledged under the 'creative commons' and this process was successfully trialled to work best for a LDC. The process involves redesigning the equipment, using local parts,

engineering local parts, learning new skills, learning the limitations of local machinery to fabricate parts and finally new traditional protocols of doing business.

- A combined collaborative approach involving the scientist /inventor, the papermakers of the village, headman, chiefs, then local engineering business, then local universities, then local government or NGOs training agents, are important to combine all stakeholders to link in with a long term village project.
- The project was evaluated with a survey that reinforced the results that the technology transfer process could be evaluated and objectively judged to be successful. The values of 5:1 and 10:1 could be a new base line for the evaluation of success in transfer of low and high levels of technology transfer to developing countries.
- There were many champions in this 'sustainable turnkey approach' project and at least one is needed at every phase to push-pull the project along.

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