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SECTION I: GREEN ECONOMY AND INNOVATION

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TABLE OF CONTENTS

Taking Appropriate Technology to the Market; Stories of Social Enterprises.

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Abstract
Dissemination and scaling of appropriate technology initiatives in India has had limited success because of poor market analysis and education, a limited focus on local capacity building, and a lack of focus on local business and entrepreneurship models of social innovation solutions (Kammen, 1999:10-15). Development professionals are now looking at social enterprises as vehicles for delivery of sustainable development. A viable and useful technology that will work in a rural setting, has a sustainable financial model, and is environmentally benign gives the Triple Bottom Line.

The act of nurturing and supporting enterprises is called 'business incubation'. Successful alumni of the Indian Institutes of Technology have worked to create ecosystems in India similar to that of Silicon Valley. As an outcome IITM established the pioneering Rural Technology and Business Incubator (RTBI).

This paper shares results of a study[3] of six enterprises incubated within the RTBI. It examines the role of the RTBI in taking technology solutions to rural markets. It is hoped that understanding and replicating this model can help other AT practitioners in developing countries, to reach out to a larger population and specifically create social impact through the incubation of innovative businesses and technology.

Key words: Social Enterprises, Appropriate Technology (AT), Incubation, Market Mechanisms, Triple Bottom Line (TBL), Incubating AT through Social Enterprises

Introduction

The best example of AT that has crossed national and international boundaries and become an integral part of life across the globe is the bicycle. Self-help groups (SHGs) are a more recent phenomenon that has spread throughout the developing world and can boast of a very large-scale impact on rural poor. The unbelievable penetration of the mobile phone across the world has left everyone stunned. The common thread that links these three examples is the way they answer some basic need felt by the users: cost-effective transportation, access to loans for people who have no collateral, and the ability to converse with people in remote areas for

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[3] Thomas, J. (2013)

employment and information fulfillment. Additionally there is a spirit of entrepreneurship that has allowed these products and services to overcome hurdles.

The AT movement has often suffered at achieving growth and/or creating large scale impact, despite clever and ingenious technology solutions created based on locally available materials and skills. The movement had and still has ambivalent feelings to using entrepreneurship as a mode to achieve scale and impact although entrepreneurship is a critical factor for economic growth (Leff, 1979:46-64). Entrepreneurship has often been falsely interpreted as a means for a few people to benefit at the expense of a majority or a means to put people out of work to increase profit. Social enterprises with an emphasis on the TBL are seen to overcome much of that type of criticism (Martin and Osberg, 2007: 28-39). A technology and business incubator provides a TBL-focused social enterprise with support for social innovation (Lalkaka, 2002:167-176).

The RTBI formed within the IITM in Chennai, has its roots in an informal network called the Telecommunications and Computer Networks Group (TeNeT group) that worked to create cost-effective 'disruptive' communication technologies to compete with imported ones (Rangaswamy, 2003: 170-176). The TeNet group incubated many companies started by alumni and other bright young engineers. It provided technical advice through the faculty at the Electrical Engineering (EE) and Computer Science (CS) Departments of IITM. Prof. Ashok Jhunjhunwala (currently Co-Chairman of the RTBI Governing Board) of the EE Department realised that companies wishing to serve rural markets needed many different types of support, and the RTBI was created to address all the needs of such social enterprises (Muthaih et al, 2013: 1-14). RTBI (n.d) proudly claims the following: "7 Years of Operations, 34 Companies Incubated, 5 Companies Graduated, 50 Crore (INR)[4] Net worth Created"

The RTBI has reported on the successes and challenges of initiatives such as a mobile-enabled social hub (Ganesan et al 2013) and a mobile (platform) agricultural advisory system (Muthaih et al, 2013: 1-14). The industry-academic innovation networks, such as the RTBI, that make the IITs in India distinctive follow the MIT (USA) as a model institution. It is important in this context to see the RTBI and industry-academic research incubation in the context of India specifically rather than through invidious comparisons with Silicon Valley per se, as the economic and social constraints here are distinct.

Practitioners of AT who take the entrepreneurship route to achieve scale and impact need to understand the role an incubator can play in their endeavours. Working with an incubator will help them make informed decisions. In the study on which this paper is based, a survey undertaken in the incubated companies examined their perception of how RTBI services, the IITM ecosystem and external ecosystems were utilised during the ideation, implementation and growth phases of the individual companies. The results were expected to find out whether the incubator was a contributor to the current state of the enterprise. Eight companies were studied but here owing to space constraints we address six of them. These insights are extracted from a project[5] supported by the International Development Research Centre (IDRC), through Villgro Innovations Foundation and executed by the CSIE in 2013.

[4] INR= Indian Rupees and 1 crore = 10 million

[5] A more detailed exposition of the methodology, typology and history of incubators and more details of the RTBI and its history are available in the original study, which can be found at Thomas, J. (2013)

Intellizon

Kushant Uppal, the CEO of Intellizon Energy, is a graduate of IITM. After a stint in the USA, he decided to work on building products and solutions that would provide productivity gains for people living in the rural areas worldwide with a focus on lighting and power.
His first product was a solar lantern called "zon light solar". A well-designed and affordable product, it had a solar panel integrated into its body and had two power settings for the LED lamps that also served as low power indicators. While this product was being introduced into the market, his business plan had to undergo a radical shift because the supply chain and delivery mechanism required to get the product into rural markets was too daunting.

Intellizon shifted focus to projects as opposed to products. It implemented off-grid lighting solutions in commercial and residential properties in urban and semi-urban markets. The stand-alone solar panel and LED lighting solution worked out less capital intensive (than conventional wired, grid powered lighting) and running costs were practically negligible as payment for grid electricity was not involved. Kushant stated that he chose to work with IITM and the RTBI because he felt that they would provide the kind of support he had seen in Silicon Valley. Having the backing of the IITM ecosystem gave him the confidence to overcome the technology challenges he faced

Invention labs

Ajit Narayanan completed an integrated bachelor's and master's course from the EE Department of IITM. He first worked for a company in the USA and subsequently returned to India. He and three batch mates from IITM joined together to start Invention Labs. The other founders left, and Ajit continued to work for the company. He took the crucial decision to move from premises outside the campus and take up incubation space from the RTBI inside the IITM Research Park (IITMRP).

Partly inspired by the work of IITM faculty, Ajit took up primary work on Assistive Technology for the disabled. Invention Labs and Ajit became famous for building the first artificial speech device in India. It is a cost-effective version of the speech synthesis device used and made famous by Stephen Hawking. Ajit was recognised for the work on Assistive Technology by MIT Technology Review and named one of the top 35 innovators across the globe in 2011, when he was less than 35 years old. The Assistive Technology named Avaz costs around $800, compared with $5,000 to $10,000 for a single-language device (like the one used by Prof. Stephen Hawking).

The device sells primarily in India. In foreign markets such as the USA, Denmark and Australia, it is an application (for mobiles) that costs $100. In the future a new product line called free speech will see Invention Labs getting into language manipulation–based products. These products may well have translation functionality in multiple languages.
Invention Labs benefitted from the IITM ecosystem in the form of interns from the CS Department. Ajit values the mentorship provided by the faculty of IITM and the alumni. He was quick to recognise the brand value of the IITM ecosystem, especially during discussions with government and other institutions in the disability sector. Access to debt finance arranged by IITM/RTBI has been of great use for operations. Ajit struggled to create a market for the products as in his words there are no "Mother Teresa markets".

ROPE Enterprise Private Limited

ROPE manufactures contemporary handmade designs of bags, furnishings and accessories with renewable plantain fibres at scalable distributed production centres in rural areas. The main customers are domestic and international retail chains, overseas import houses/distributors and India-based export houses of home and lifestyle products.

ROPE directly employs 130 people and indirectly supports another 600 in the manufacturing process. By 2018, ROPE has a target of impacting 9000 families and recording a turnover of close to 500 million rupees. In the long run, ROPE wants to build an integrated manufacturing campus in a rural area to aggregate new design and designers, to provide warehousing for raw material and finished products and quality control and packaging facilities.
N N Sreejith, the founder and CEO, wants to make ROPE a profitable company that will be a trusted supplier to retail chains within and outside India. He has benefitted greatly from the mentorship provided by IITM faculty and from advisers amongst the external investors. His opinion was that an incubator must recognise that each venture has its own growth as a primary agenda. The incubator should provide the venture individual attention with an institutionalised mechanism/process for that growth.

Desicrew

Saloni Malhotra founded Desicrew, a pioneering company that took business process outsourcing (BPO) to rural areas. It won many awards, a non-exhaustive list of which is available on the wikipage (Saloni Malhotra, 2013) and at Desicrew (2014). As quoted on the wikipage (Saloni Malhotra, 2013) she says "When we looked around, we saw that a lot of BPOs hire people from rural areas and realized that people have to migrate to work here. So, we decided to take the jobs to them".

The company has operations in two States and employs close to 250 people in BPO centres in rural areas. Its unique selling proposition is to export knowledge service out of rural India. Major clients are in the banking, financial services and insurance space and the information technology–enabled services sector aside from the telecommunications and government sectors. It is looking to grow and employ 2000 people in rural areas, operate out of eight to 10 States and reach a turnover of 250 million rupees by 2016

J K Manivannan is the current CEO of Desicrew. He brought with him the experience of running BPOs in rural Andhra Pradesh. He gave his views on Desicrew and its interactions with the IITM ecosystem. Desicrew benefitted from having at least 10 interns from IITM and about five from other educational Institutions. In the early days, it received mentorship support from the faculty of IITM, from the EE and CS Departments. Manivannan is now concentrating on growing the business and has made less use of the IITM ecosystem. His recollection of being incubated inside the RTBI includes the lack of shared support services and proper guidance on service tax issues. However, he is confident that both the RTBI and IITM can be counted on for support in times of need, whether financial or technical.

Arogyam Organics Private Limited (AOPL)

Arumugasamy, the managing director of AOPL, has spent most of his professional life engaged in agriculture- related businesses. His stint at the Centre for Indian Knowledge Systems (CIKS, an NGO that promotes all aspects of traditional agricultural practices) thrust him into this

entrepreneurial role. CIKS decided to create a private limited company to take up marketing of organic produce and thus came AOPL. The initial goal was to provide farmers with inputs like certified organic seeds, fertilizers and plant protection materials. AOPL would then pick up the harvested products directly from farmers to sell to the end consumer through its own retail outlets and through franchisees. It was able to leverage the farmers associated with CIKS in the beginning as they had undergone training in organic agricultural practice and the certification processes. The business model found support from the RTBI and Villgro Innovations Foundation; however, AOPL ran into unexpected cash flow problems when dealing directly with farmers and had to reinvent its business model. It closed its retail outlets and stopped creating franchisees. It currently has only five employees and their reach to farmers is indirect, through eight certified processors. The processors are able to deal directly with farmers and serve as aggregators.

In order to stabilise the business, AOPL concentrated on non-perishables and traditional varieties. It deals with two brands. 'Bhojanam' products (such as cereals, pulses, spices, millets, condiments, rock salt) are certified end to end, while 'Parambaryam' are traditional varieties grown organically but not certified.

Products are moving in urban markets through other retailers present in Tier 1, 2 and 3 districts in Tamil Nadu. Once the operations stabilise AOPL will expand to all four southern States and go back to direct sourcing from farmers to increase profits. There is a business plan to raise investment that envisages achieving sales of 750 million rupees by 2016.

AOPL has had minimal level of interaction with the RTBI and IITM, largely because of its agriculture focus. The RTBI has a technology focus, and AOPL needed business inputs and help with contacts and investment. Arumugasamy acknowledges help from RTBI staff and an intern from the Villgro Innovations Foundation fellowship programme (Villgro, 2012) on reworking the business model. He did not take up incubation space as he felt it would be a drain on scarce resources. Last financial year saw the business turn the corner, and Arumugasamy is concentrating on attracting investment for the next phase of growth.

Uniphore Software Systems Private Limited

Umesh Sachdev and Ravi Saraogi graduated from Jaypee University of Information Technology, Solan, Himachal Pradesh, and started their entrepreneurial journey working on mobile theft security. During this period, they took part in competitions and won prizes and recognition. Their interest and work turned to speech recognition and related technologies and they started Uniphore.

Mobile phones address the issues faced by Internet services providers in rural India such as: a) Entry cost of PC/laptop is high, b) Power availability, c) Internet connectivity, d) Content predominantly in English, e) Vernacular content is urban centric, f) Inability to have village-level content on the Internet, g) Software corruption is frequent, h) Hardware support is not at hand, and i) Keyboard interface is challenging for many users.

Uniphore invested in local language speech recognition and speech-based value-added services. The local language technology replaced input from the mobile keyboard, and end users could talk their way through an Interactive Voice Response System (IVRS) menu instead of punching in numbers or text. This facility makes the mobile far more useful to an illiterate or innumerate user.

Uniphore is now serving customers in the banking, microfinance, agriculture, health care, retail, insurance and government sectors. It is active in more than 10 States in India. Recently, it

has been approached by Airbus and Intel and has thus extended its geographical reach to France and the USA. Uniphore is positioning itself to harness the power of voice and data and convert any mobile device into an enterprise delivery platform. It has received funding from Indian Angel Network, Stata Venture Partners' founder Ray Stata, and YourNest Angel Fund. It wants to grow into a one billion rupee company with 200 employees and have its services reach 100 million people by 2016.

Uniphore has made use of interns and fellows from the IITM ecosystem and other educational institutions. The company has benefited from the mentorship and knowledge of the IITM faculty and from Villgro Innovations Foundation, National Research Development Corporation (NRDC) and other individuals. Fieldwork through research projects in collaboration with the IITM CS Department also helped Uniphore develop a reference database for local language. Umesh said that technology support from IITM was good. He felt that the RTBI could help Uniphore in connecting to the next stage of investors and that the RTBI brand needed strengthening.

Results

Here we present the summary of results based on the survey and interviews with the CEOs. The companies use the IITM ecosystem services heavily during the ideation phase and then lower their dependence. By the growth phase, they have built up many skills internally and are less reliant overall on external agencies and the IITM ecosystem. Free discussions with the IITM faculty received the highest ranking from the companies incubated during all the three phases, whereas entrepreneurial and leadership development received the lowest. All the support services provided by the RTBI/IITM ecosystem were availed of during the ideation phase. Incubated companies relied more on external agencies than the IITM ecosystem for legal services and leadership/entrepreneurial development. The RTBI/IITM ecosystem contributed more services to the incubated companies than external agencies did. The incubated companies made good use of the RTBI's exploratory initiatives in market research to enter both urban and rural markets at the lowest cost. The CEO's agreed that the companies benefitted from the presence of good external investors on the board of directors. The majority of the companies received external investment and were looking to gather more. Those that did not were not looking to raise investments. All the companies were selling to urban markets and three were in rural markets as well.

Interviews with RTBI personnel revealed the key points they felt needed improvement: were ability to identify the individual needs of the incubated company and to provide them with i) high-quality mentors, ii) access to finance and iii) providing other common support services like administration, finances, human resources and logistics like travel and purchase. Half the companies in the study perceived the RTBI as being within the IITM ecosystem. The remaining half saw the RTBI and the IITM as having an intersecting ecosystem.

Conclusions

The development of affordable and scalable technology innovations in developing countries like India requires a support infrastructure that can provide the 'space' for development. Research partnerships between industry and academic institutions are essential in this respect (Hall et al, 2001:783-797). Business incubators are playing this role globally, and the RTBI is a particular example of this which additionally focuses on affordability and social

impact. Without a sustainable economic model, initiatives with social impact in the AT space, such as those described in this paper, will often fail, e.g., OLPC (Kraemer et al, 2009:66-73). Another clear requirement for success globally is understanding the local context and engaging local stakeholders and actors ((Littlejohns et al 2003: 860-863). Business incubators such as those in this paper leverage local innovation and entrepreneurship, building on local knowledge and capacity rather than on 'imported' expertise. The examples cited above also show degrees of dependency on the academic environment with no 'one size fits all' model.

The survey of these companies confirmed that they have leveraged the IITM ecosystem for their success. In interviews, the CEOs have confirmed that they engaged with students, faculty, and other campus resources for the betterment of their enterprises. The RTBI has been able to provide the incubated companies complete access to IITM's capabilities as an institution of higher learning. From the data and interviews, it is clear this relationship has been exploited by the incubated companies to good effect for technical solutions, mentorship, financial access and market penetration. All this has happened despite the stark differences in perception of the RTBI-IITM relationship by the incubated companies. One can conclude that the companies are not concerned as much about the relationship as how best it in can be utilised for their betterment.

To address the issues raised by the companies, an incubation cell has been created at IITM. This cell will provide all support services for all the incubated companies in IITM, including the ones in the RTBI (IITM has three other incubators). An IIT Madras Entrepreneurship Forum has also been created. This forum consists of alumni and other professionals who will offer high-quality mentorship to all the enterprises in the IITM ecosystem.

At present, there is no indication that the RTBI uses documented criteria to assess company performance, and this seems an area that will have future importance. The study established that the linkages between the enterprise and IITM have a positive relationship to the enterprises' performance. Going forward, these linkages may form the basis of metrics for success/company performance. Social impact studies can identify another set of metrics that can attract venture philanthropic investors to the companies incubated in the RTBI.

The RTBI's success in incubating social enterprises is largely due to leveraging the IITM ecosystem. The RTBI has also evolved from its inception to identify and create those processes and systems that work to drive social enterprises to success. AT practitioners should look to form enterprises that can be incubated within an environment that provides support services for achieving scale and growth. This model is especially relevant for developing countries to adopt for greater social impact.

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GREEN GOLD FROM GUYANA

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Abstract

In the mid-20th century thousands of people were poisoned by mercury use, emissions and releases into the environment in Minamata, Japan. On November 10, 2013, Guyana and twenty-six African states signed the international treaty 'Minamata Convention On Mercury' to protect human health and the environment from the adverse effects of mercury.

Mercury is used extensively in Guyana and countries that do artisanal, small and medium scale gold mining for the final separation of gold from its ore body. Guyana has pledged to ban the use of mercury in mining activities by 2020. The major stake holders to shift artisanal, small and medium scale gold miners away from mercury are the Ministry of Natural Resources and the Environment (MNRE), Guyana Geology and Mines Commission (GGMC), Guyana Gold and Diamond Miners Association (GGDMA), Women Miners Association, Bank of Guyana (BOG), artisans, jewelers and migrant workers from neighboring countries. The initial task is to innovate the gravity concentration technologies used already in gold mining effectively and efficiently. GGMC, tasked with regulating the mining industry has embarked on legislative initiatives, policy clarity, mercury free technologies, education to heighten environmental awareness and contact with equipment suppliers to empower the artisanal, small and medium scale miners as they work to achieve the stated objective of mercury-free or green gold mining in the 21st Century.

This paper will give an overview of the work of the GGMC and other stakeholders on policies, appropriate technologies, regulatory enforcement and knowledge management to empower gold miners of Guyana and Africa to produce green gold.

Key Words: Gold Minamata Mercury Green GGMC Guyana Sudan Africa

Introduction

Guyana and twenty six African states signed the Minamata Convention On Mercury on the November 10, 2013. The objective of the Convention is to protect human health and environment from anthropogenic emission and releases of mercury and mercuric compounds into the biosphere – land, atmosphere and water. The Convention internationalized the concept of green gold. Green gold means "gold produced without the use of mercury".

Guyana and the twenty six African states signed the Convention because they were concerned that mercury poisoning contributed to poor health and possible death. Sustained poor health is sustained weakness and this cannot empower Africa and Guyana. Power has to do with health and the health of a population has to do with appropriate science and technology. Venezuela is a recent example of putting health at the top of the national agenda to empower the population and has laws banning the use of mercury in gold mining. (1)

Key health and environment issues that have caused me great concern and emphasized the need for green gold processes are indicated below:

Mercury poisoning

In 1996 and 2000, scientists from the University of Guyana UG and Institute of Applied Science and Technology (IAST) Guyana researched mercury loads in the human environment in two areas of Guyana where gold is being extracted. Hair and urine samples were taken from residents and they were also questioned. "The villagers of Isseneru are primarily farmers although every family is involved in some way or another in gold mining ranging from actively pursuing it or doing panning for gold to pass time while out on the farm. Every family that was surveyed had a container of mercury at home. No one owned a retort". (2) According to the scientists "normal mercury concentration in human hair is considered to be 1ppm while a concentration of 6.4 ppm is considered to be safe". (2) Mercury concentration of 14 ppm in hair is the minimum known to affect adversely our health. In Isseneru between 89% and 96% of the population surveyed had mercury concentration in hair greater than 14 ppm (2). Measures must be taken to mitigate this.

In June 2012, GGMC Environmental Division scientists measured the concentration of mercury from among thirty volunteers in the mining settlement of Mahdia, Guyana using a RA915 Mercury Analyzer. Mahdia is the center of Potaro River gold mining since 1884. Volunteers continuously blew into the analyzer until a stable reading was reached and recorded. "Readings ranged from the high limit of 85 ng/m^3 (nanogram per cubic meter) to the low limit of 15 ng/m^3 per person. The high reading showed cause for concern. Many miners generally burn gold in their homes without the use of protective equipment". (3). Measures must be taken to mitigate this.

Malaria

World Health Organization (WHO) web report on 'Malaria in Africa' states, "The African region accounts for 85% of malaria cases and 90% of malaria deaths worldwide" (4). On a visit to a gold mining camp in Guyana in 2004 I contacted malaria – cold fever, passing blood incessantly and weakness. GGMC now offers to its staff going to mining camps a range of medicines to prevent malaria: Chloroquine, Doxycycline, Malarone, Mefloquine, Primaquine.

Chickungunya

During GGMC's Mining Week celebration in August 2014, I visited the Port Kaituma district to celebrate with miners their special week and on returning to Georgetown discovered that I had contacted a mild form of chickungunya – abrupt joint pains, mild headache and a rash under my arm and on my back. A pharmacist sold me diclofenac75 and panadol 500 for my pains and hydrocortisone acetate ointment for my rash.

Sudan Issues

I visited Khartoum, Sudan in July 2013 at the request of the Ministry of Minerals. The war with Juba, South Sudan forced a change in government policy away from petroleum to gold. On doing so, Ministry of Minerals proposed placer mining to extract gold and earn money for the national treasury. They set up a 'river mining committee'. But, state agencies and regional administrations began objecting to their placer mining proposal for many reasons including mercury pollution. At the opening discussion with my team they used the phrase "abatement and replacement" of mercury in placer mining. The purpose of our visit was to discuss how Guyana addressed the issues of placer mining, including mercury pollution, and to share information.

In Sudan, there are three categories of miners: artisanal, small scale and large scale. Artisanal miners are not allowed to have machines. Artisans are unlicensed and unregulated. Artisans add mercury to silt to form a solid heavy mercury-gold amalgam and remove the remaining silt by gravity because the amalgam is dense. Then they heat-treat the amalgam to separate the two elements. This is the traditional way of gold mining and processing and half a million individual miners in Sudan "will produce 50 tons of gold in 2013, up from 42 tons in 2012". (5) Small scale miners have a mining lease of one square kilometer and are licensed to mine alluvial gold, chromium, mica, gypsum and industrial minerals. Licenses for small scale miners are granted by local government and not central government. Large scale miners begin with a concessional agreement with central government. They have to produce a feasibility study and make a joint venture agreement with government.

In Sudan, placer mining has been proposed for four areas (i) North Sudan near lake Nuba (ii) Abu Hamad on the River Nile (iii) south of Khashn Al Girba on the Abara River (iv) on the Blue Nile before the Roseris Dam (Ed Damazin City). These areas have basic rocks but in the North the geology is sandy and two rivers dissect high clay formations. The anticipated problems from state agencies and stake holders are mercury pollution, water quality, turbidity, electricity generation, the flood period from June to September, fish life, the food chain and methods of dredging the rivers. GGMC and Ministry of Minerals Sudan should collaborate and address these issues.

This paper by a Director of GGMC will now discuss policies, appropriate technologies, regulatory enforcement and knowledge management in the artisanal and small scale production of mercury-free or green gold.

Several New Policies

Poor health in general has affected miners who are the pioneers and explorers of many cultures. Working in remote areas of a country in search of gold demands a health policy for gold miners. These are the miners who keep a flask of mercury in their homes and have no retorts. These are the miners who suffer from mild mercury poisoning. These are the miners who must exchange mercury in their homes for appropriate green technology such as a shaking table. What do they know of density beyond the fact that materials like gold and mercury are "heavy"? What do they know of centrifugal force? These are the miners all over Africa to be introduced to new processing concepts and the health benefits of green gold with demonstration equipment at regional fairs, travelling exhibitions and facility centers.

Second, there must be a clear policy to transform artisanal and small scale miners into investors. Artisanal and small scale gold miners in Guyana work alluvial and river territories such as the old 'ProtoMahdia' river system and Potaro River basin. Alluvial and river mining is at the foundation of culture in many countries of the world. It provides jobs for the explorers and wandering mankind. Explorers (Pork-knockers in Guyana) transform and develop communities and cities and this dynamism is alive in Guyana as in Ekureku, Cuyuni Mining District 4, Guyana. In Guyana's hinterland, about 100,000 to 150,000 persons such as priests, cooks, prostitutes and welders service the 600 artisan miners. Many can be re-jobbed to surface mining of industrial minerals such as bauxite, clay, soapstone and other minerals. Incentives to individual miners in Sudan and Guyana to own equipment must be pursued. They too deserve the benefit of duty free equipment.

Third, a new water policy is required for artisanal and small scale miners. There can be catchment water to supplement river water. The objective is to put into the homes of artisanal miners clean water required to win gold with appropriate equipment.

Fourth, a weather policy that forecasts precipitation from clouds is also necessary. Instinctively in Guyana, the pork-knocker knows to get out of the swelling river as the rainy season approaches. Therefore environmentalists must have a working knowledge of weather. Placer mining is woven into weather patterns and weather may differ from region to region.

Fifth, a policy to remedy the biosphere of mined out locations should be pursued. Mined old rivers such as protomahdia when remedied become districts of clean air, agriculture or forest. The percent of trace minerals in the soil increases and helps trees to grow after reclamation.

Appropriate Technologies

Since the heralding of the new policy which identified mercury as a pollutant to be removed from the chain of processing from ore to gold, I have visited two companies that have switched from mercury separation to shaking table separation. I visited Metallica Commodities Corporation (MCC) (Guyana) from August 18 to 23, 2013. MCC commissioned a mercury-free gold plant from Appropriate Process Technologies (APT) of Zimbabwe. I visited Correia Mining Company (CMC) on the September 28, 2013. CMC demonstrated their new Xtruder 255 Shaking Table.

Fig 1: Washing of ore into the Scrubber at MCC

Fig 2: Centrifugal Concentrator and Shaking Table at MCC

MCC's gold plant consists of: R G Scrubber with ore feeder, cyclone and header tank attachments, Knelson centrifugal concentrator with concentrate box, Gemeni Shaking Table, a water pond and many connecting hoses and pumps (6). When the plant is working MCC feeds about 15 tons of ore within a 12-hour period into the scrubber. Fig 1 shows the ore being washed into the scrubber. The scrubber disintegrates ore of clay, saprolite, quartz and sands. The minus 3mm ore with coarse and fine gold is sent to the centrifugal concentrator. At the centrifuge, a concentrate is produced that has heavy metals and minerals with densities in the range of 5g/cc to 19.3 g/cc: magnetite, rutile, mercury, gold and others. This dense black concentrate sinks and enters the locked concentration box. The rest of the slurry is recycled. After collecting about 25kg in the concentration box, the concentrate is taken to the Shaking Table. Separation of green gold from gangue takes place at the Shaking Table. Fig. 2 shows the centrifuge and Shaking Table.

CMC demonstrated separation of gold with the Xtruder 255 Shaking table. (7). Fig. 3 shows the CMC Shaking Table. 25kgs of black dense concentrate were brought to the shaking table from a sluice box. The shaking table has an inner high grade line and outer low grade lines. The table was first flushed with water for several minutes. The concentrate was fed through a feeder attached to the table with water continuously running through the feeder. Concentrate was transported by water at a rate of about 6 to 10 gal/hr. The operator adjusted the water spigots to send the yellow gold down the high grade line into the #1 cup which is the middle cup under the table. Middling go to the #2 cup, one on either side of the #1 cup. Waste materials were conveyed to waste buckets under the table. On the shaking table, the yellow gold was clearly distinguished from the rest of the minerals. In the #1 cup it was visible as a yellow powder under water. This gold was as fine as 37 microns or 200 mesh. On decanting the water

the gold was placed in bar crucible with a teaspoon of borax added. Then into a small furnace and smelted to get green gold. Fig. 4 shows the crucible.

Fig 3; Shaking Table with #1, #2 cups and waste buckets at CMC

Fig 4: Crucible and Smelter at CMC

GGMC does Gravity Recovery Gold (GRG) tests as a service to the industry. Larger Small and Medium Scale miners use this service. GGMC has four types of equipment that use

the principle of separation by specific gravity - a jig, spiral concentrator, shaking table and two centrifugal concentrators. They are deployed depending on the type of ore to be tested.

Artisans and small scale miners build sluice boxes with wood, riffles and matting. It slopes downhill for slurry flow. Management of the slurry flow by an operator is critical in determining the quantity of gold captured in the matting because the operator's objective is to form a vortex for the dense gold particles to go to the bottom of the vortex. As Randy Clarkson put it, "At the bottom of the vortex centrifugal and gravitational forces combine to drive the gold particles into the matting". (8). The gold (density 19.3 g/cc) is captured together with gangue material such as sandy loam, loam, silt, and clays all of which have densities less than 2.0 g/cc. These vast differences in densities permit physical separation in preference to chemical separation. Currently, the private sector and GGMC are actively participating in the conversion from mercury to green technologies with small scale equipment at central locations or at home.

Regulatory Enforcement

The law in Guyana on use of mercury in gold mining was gazetted in 2005 under 'Use of Poisonous Substances' and is enforced by GGMC. On mercury, there are three parts (i) use and handling of mercury (ii) vaporization of mercury (iii) use of retort for burning of amalgam. There are offences and penalties if artisan and small scale miners breach these regulations. Miners who use mercury in open systems on ores or put mercury on the sluice from which slurry is discharged into the open environment commit an offence and are issued a Cease Work Order (CWO) until a cleanup is done to the satisfaction of the GGMC.

There are other stipulations such as use of retorts, use of respirators, use of rubber gloves, proper storage of mercury, mercury on the pit floor, in addition to mercury on sluice that artisan and small scale miners are charged for. These have penalties such as summary conviction and a fine of G$ 25,000.00. With repeat offenders their equipment is liable to seizure, forfeiture and a CWO of three months can be placed on their operation (9). New laws banning the use of mercury in gold mining are now being drafted by GGMC's lawyers. In the interim, permits to import mercury are being restricted by GGMC's Environmental Division.

Knowledge Management

Knowledge management is a dynamic and deliberate process of selecting, storing, organizing, and communicating information essential to improve performance of a group or company. The issue here is to set up now the knowledge base related to: (i) effects of mercury processing, (ii) specific gravity of gold, (iii) design and use of alternative equipment; and store, reorganize and package it so that miners in Guyana and Africa shift to mining green gold. Packaging must include a wide enough range of materials allowing persons of different abilities, understanding and skill levels to be educated. They will then be able to work with the miners to effect change.

Resistance to tradition and change is typical human behavior. However, in the case of green gold production for Africa, there is need to urgently convince the gold mining communities of the signatories to the Minamata Convention that their processing methods must change within a specified time period because the Convention has six year mission. Giving information to gold miners on the (i) effects of mercury processing, (ii) specific gravity of gold compared to the materials from which it is found and (iii) design, operation and maintenance costs of alternative processing methods to mercury; will itself not necessarily cause an

embracing of the new initiative. What is needed is knowledge management not just passing out of information.

There is then need to 'find and embrace' those persons who want to see change and are willing to mentor others. These motivators in each gold community are critical to the dissemination and communication of the values of change. The motivators also need to outline most effective and efficient means of dissemination and education to the grassroots of the various gold communities. This means that even at the initial stage there must be the radar that tries to locate them so that they can contribute to the reorganizing and packaging. This has a cost.

A 'Mercury-Free Mining Working Group' is at GGMC composed of one or more specialist in health, mineral processing technology, regulatory matters, knowledge management, environmental management, mines management and GGDMA specialists. Added to this is a fund of One Billion Guyana Dollars for miners to access in pursuit of mercury-free technologies. This effort has already had a measurable effect on the mining sector as previously discussed under Appropriate Technologies. Since the government is a signatory to the Minamata Convention the Ministry of Amerindian Affairs, Ministry of Information, Ministry of Home Affairs, and Ministry of Culture are asked to send representatives to the group meetings. These representatives focus on knowledge management. Brainstorming sessions are encouraged in the working group. These sessions identify specific tasks that must be done annually and each task is ranked.

Each African country and Guyana must have a Mercury-Free Mining Working Group with a knowledge management sub-committee. Knowledge management committees must share information electronically. Costs are reduced with electronic collaboration. Ongoing collaboration is desirable between Africa and Guyana.

Conclusions

Guyana is working on several fronts to meet its commitment to the Minamata Convention On Mercury. The gold mining industry is actively engaged in the program of changing the status quo. Guyana and Africa are already collaborators on equipment, health and environment. Guyana looks forward to further expansion and collaboration with Africa in the effort to make green gold the status quo.

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