Chapter 3 – Cases from Project Lighthouse

3.0 Project Lighthouse in northeast Thailand

This chapter details the activities in a number of Project Lighthouse sites in Thailand as they relate to my thesis of Emergent Design. I choose to focus primarily on one site, Nang Rong, for a number of reasons. The foremost reasons are that I spent a considerable amount of time there, thus am most familiar with it, and I have influenced the work there considerably. Regardless of my personal involvement, as will be shown in Chapter 4, the work in Nang Rong is indicative of Project Lighthouse as a whole. In the following chapter, I also include short sections on some of the other Project Lighthouse sites. Rather than describe each site in detail, I choose to highlight only those aspects important to this thesis.

3.1 Nong Baot village, BuriRam province, northeastern Thailand, January 1998[1]

Nong Baot is in the northeast of Thailand, the poorest region of the country. It is approximately one-hundred kilometers from the Cambodian border. The New York Times described it as having "two harsh seasons, flood and drought" [New York Times, "Nang Rong Journal," January, 1997]. The economy is based upon agriculture but, due to the harsh weather, little can be grown. Nong Baot survives on cultivating one rice crop per season. There are some small vegetable plots used primarily for subsistence as there is not enough water to grow enough crops to sell. Lately, some groups of villagers have tried to cultivate fish farms by creating small reservoirs during rainy season. This, too, provides food for them only for a brief time, as the water is gone within a few months.

Nong Baot is an area that suffers from logistical problems that stifled the potential for economic development [Sachs, 1998]. It is tropical and does not have ready access by water to the rest of the world. These factors inhibit the development of industry. The soil is poor and there are no mineral deposits. Thus, it has remained an area of minimal means and wealth.

Education in this area likewise has been minimal. There is little incentive to remain in School. Many people leave school as soon as they are legally eligible, claiming that School has no relevance to their lives. Children need to work in the fields or in other occupations to help their families. Few people go on to attend university.

In this region of Thailand, Project Lighthouse collaborated closely with the Population Development Agency (PDA)[2]. PDA is a non-governmental organization (NGO)

[1] This material was briefly introduced in Chapter 1. That description served to set a context for the overall work. I go into significantly more detail in this chapter although some of the material will already be slightly familiar to the reader. I extend my apologies and request patience.

[2] PDA was formed by Khun Mechai Viravaidya. Its original goal was to work on reducing the extremely high birth rate in Thailand by increasing awareness about family planning encouraging the use of condoms. Khun Mechai became know affectionately as "Mr. Condom" through his quite successful efforts. Khun Mechai demonstrated what a tremendous educator he is in this work. He tells of how he would initially introduce condom use in villages. Thai society is quite polite and reserved, and is quite taboo to talk openly in public gatherings about sex. Khun Mechai would gather the villagers together and hold up a condom and ask if the villagers knew what that was. He said no one would ever answer except there was always an audible gasp. He then asked if they knew what they are for. He received a louder gasp. He then asked if they knew how to use one. An even louder gasp resulted. Finally, he said he would show them. At this point people were shouting at him. He then would blow on up like a balloon and let it loose to fly around the gathering. He then would blow up another and paint a face on it. He would fill another with water and create a water bomb. At this point everyone was greatly relieved, laughing and participating. Without saying another word, or preaching at them, he would leave a large supply of condoms and move on to the next village. He relates that without fail, the birthrate immediately declined in each of these areas. This is true education and highlights the possibilities of what one can accomplish not merely without explicit lecturing but perhaps because he did no lecturing. PDA now focuses on economic and social development of rural areas. Due to their success and the villagers' trust in PDA, we were welcomed warmly and did not

developed by Khun Mechai Viravaidya[3] of Thailand. PDA's first mission was to combat over-population and high birth rates, which in the nineteen seventies was a major problem for the health and well-being of Thailand. After successfully addressing that problem, PDA turned its attention to matters of sustainable rural development, including changing farming methods to environmentally friendly, sustainable ones, and to support development of clean industry in the rural areas. PDA has tried to make rural areas more economically viable in order to help keep the rural families intact – adult wage-earners leave the villages to go to the cities, leaving only the children and elderly.

Before the economic crisis of 1997, many adult villagers would leave the area to work in industry as laborers in and around Bangkok, except during rice planting and harvest time. While this provided some income, the practice was not without costs. Village populations were mainly reduced to children in the care of their grandparents. Family life was ripped apart and the local economy was seriously compromised.

For many of the villagers the life in the city was also not easy. Unscrupulous middlemen exploited the migrant workers. These middlemen would promise work, good wages, and housing in the city. Upon arrival the reality was quite different. The housing, if there was any, was unsanitary and unhealthy. The wages for the job, if there was a job, were inadequate. The slum areas where they lived are rife with violence and drugs. The

need to spend the usual amount of time, often years, building trust in the local area. Our association with PDA and their support and cooperation were strong factors in any success that we achieved in this region.

[3] The Thai word "Khun" has several meanings. I use it throughout this document as it is the polite term of address for both men and women, like Mr. or Ms. I also refer to the Thai participants in manner in which we referred to them during the project, and the other participants form other countries in the way we referred to them.

middlemen charged exorbitant fees for job placement and support and often the villagers would expend great effort only to wind up in debt. The life of the villagers is harsh and fraught with inadequate resources whether they remain in the village or migrate to the city for work.

It is in areas such as Nong Baot where the government hopes to improve education as the path to development. For example, the education reform act recently approved by the Thai parliament extends the period of compulsory education from four to nine years. But this in itself cannot be a solution. The villagers hold school in low esteem. If they believed that school is beneficial, they would remain, rendering the extension of compulsory education superfluous. They drop out not only to work on the farm or to earn money or help support their families. They also leave because they feel school as it is provides no value to them and is an irrelevant waste of time. Moreover, many teachers are quite harsh, inflicting corporal punishment on the students. Obviously, the goal of an educated public is worthwhile. However, whether extending the number of years of poor schooling in a country with few resources for education is as useful as fewer years of higher-quality education is an open and important question.

Of course, the assumption underlying standard educational design is the hope that quality as well as quantity can be improved. The view projected by this thesis is that this definition of the problem expresses an in-the-box mindset. *Policy makers have rarely seriously considered fundamentally different alternatives.* My goal is not to provide an

"alternative solution" in the form of a prescription, but rather to break the mindset that impedes the emergence of truly diverse alternatives.

Before diving into detail, I must however concede one way that education in Thai society has been unusually successful. Thais have an amazingly high literacy rate. Administrators in Non-Formal Education told me that the literacy rate is over ninety-five percent.[4] This fact clearly facilitated so much of our work as we did not have to simultaneously introduce reading and writing along with the computational ideas. How the methods described here might fare in a less literate context will be discussed in the concluding chapter.

3.2 Initial Work in Nang Rong

I began our work in the area by conducting an introductory Microworlds-Logo immersion workshop to develop technological fluency. A major goal was to have the attendees quickly build projects and create programs, often very different from anything we might have imagined in advance. At their best, these workshops permit quite dramatically surprising expressions of the thinking and interests of the participants, illustrating an integral part of the Logo philosophy "low threshold, high ceiling" [Papert, 1980]. The slogan means there should be as low as possible a barrier on entry to doing real things but as few limits as possible to what can be done. In this way the learner does not spend inordinate amounts of time preparing before being able to do something meaningful. One is building projects that feel "real" right away.

[4] Personal communication.

Thus, our goal in introducing computational technology is very far from the more common one of teaching rudimentary computer usage, under the misnomer of literacy, thereby devaluing the term. Papert has noted that a person whose knowledge of literature was comparable in extent to the goals of computer literacy would be considered thoroughly illiterate [Papert, 1997]. While the cultural capital attached to computational technology often provides a boost to the initial phase of learning even the rudiments of Windows[TM] and Office Automation "Productivity Software," without fail the students soon hit a plateau and progress halts. The learners become bored, as there is nowhere further to go and no way to leverage such rudimentary knowledge into a greater gain. The initial empowering effect, in the end, has a deadening effect not merely on learning the technology, but also on the students' senses of themselves as competent learners and performers.

3.3 A First Workshop

Our first workshop at the PDA CBird Center in Nong Baot, BuriRam province, had a mix of participants. Some were local villagers. Others were teachers from the local district of the national Ministry of Education Non-Formal Education (NFE) department. A few were local economic-development workers from PDA. The remaining participants were some professors and students from the teachers college of the province.

It was in the discussion after this workshop (previously summarized in Chapter 1, Section 4) that the village leader expressed the need to gain more control over their lives and the

belief that certain uses of the technology could help them. They described much of their problems as economic, caused by the harsh climate where there was either too much or too little water. They wanted access to expert knowledge, but most importantly they wanted to be in control of gaining the access and the decision about what to do with the knowledge. They felt that the local authorities did not involve them in the thought-process and decision-making whenever the villagers asked for assistance. This left the villagers feeling dependent and without the hope for their own progress. To make matters worse, due to the appearance of new problems with the cattle and the water, the villagers believed the advice and proposed remedies to be harmful rather than helpful.

They believed that the technology could provide them the access and the control. They wanted to end this cycle of dependency and lack of control by gaining access to information and gaining control of the situation. Even though I had to introduce the workshop by demonstrating what a computer is including how to turn one off and on, through the symbolic value of the computer they viewed competency with the technology as a plausible path to this control.

As the week progresses, we begin to develop good working and personal relationships. Despite language difficulties, through the valiant efforts of our translators, they began to know me as a person and I them. Through this relationship, they came to understand why I would come to their village. I began to understand their individual interests and personalities. I tried to be as open as possible about our motivation for working there.

I told them that our effort was part of a broader national effort to improve the educational system. I explained that my colleagues and I would introduce computer technology for learning and attempt to initiate new methods for learning environments that the technology potentially facilitated. We wanted to focus on local issues as the basis for study. We would work together on these projects. The primary goal, however, was not for us to teach any particular curriculum, but for them to appropriate the technology and apply it on whatever they deemed most important. I believed that rather than pre-determining what exactly was important for them to learn, how they should learn, and to build from one step to the next, the important, powerful ideas would emerge from their working on real projects. The powerful ideas are powerful because they help people to understand the knowledge domains. These would appear through working on real projects and thus would have context and facilitate connections.

I told them our choices of tools were based upon our experiences and that we believed these tools were best to help build a fluency quickly. However, the language would still be applicable on harder problems. We also promised that they would have access to other tools and languages and we would jointly decide directions initially. We also told them it was our intention to "work ourselves out of a job," by helping them and the teachers and local community workers learn and understand our role so that they could take it over as soon as possible.

It is important to note that the philosophy expressed above is not merely practiced but is also an object of discussion and reflection. Making the rationale and choices explicit and

discussing them, helps recast reasoning, decision making, and control into a cooperative effort. This project does not belong to us, where we have total control and the process is hidden from the villagers. We are not, however, mere passive observers without input either. We have a role – in our manner of working we take it as our obligation to offer a set of experiences – and a viewpoint, while any actions and decisions are taken as collaboratively as possible. This is true for the overall project and is true in the interaction with individual learners in the course of their projects. In this way the endeavor forms a more coherent whole.

In Nong Baot we were able to achieve rapid acceptance because of our connection with PDA. PDA had been working in this area for more than fifteen years and the villagers had come to trust them. They extended an initial trust to us based upon PDA's presentation of us and our role. It was easy for the villagers to see that our methodology was similar in approach to that which PDA successfully used. That is, we introduced new technologies and methodologies for their appropriation, under their control, and applied to what they desired. They could understand that our goal was to help them develop technological fluency to enable them to use powerful computational tools in the same way that textual literacy provides a powerful set of tools, for their own purposes. Their familiarity with PDA's approach and their knowledge of the potential long-term benefits enabled them to understand quickly how to work with us.

In short, the villagers were able to experience what we did in the spirit of "cultural leverage." As a result, the participants were soon building their own projects, first in

Microworlds Logo, then adding robotics with Lego-Logo. What at first was a foreign and potentially intimidating technology, now is a source of fun and pride in product. The villagers worked in multi-generational groups, from young children to the elders in their seventies and eighties. The teenagers and children did more of the programming, being more open to new technologies. The adults contributed their wisdom, maturity, and experience. They made all of the decisions jointly. They were doing programming and engineering, working on projects of their own design.

I introduced several types of initial activities in Microworlds Logo. Since the participants did not know English, we used a beta copy of the Thai language version.[5] Doing so raised an issue that comes up often in discussions about computer use in developing countries. A common idea is to "do it in English so that the students can learn the language and you can achieve two purposes at once." But this goal goes against our philosophy of "cultural rootedness," where the native culture is a powerful source of learning. The web of connections from the deeply rooted and intuitive sense of one's native language extends a rich set of meanings to things we approach with our language. In Logo, many commands and conventions are based upon this web of understanding. Ideas of *forward*, *back*, *right*, *set*, *shape*, *color*, and so on, are not merely formal commands but inherit from their meanings to English speakers. Treating them only as technical commands debases them and loses the rich web of connections.

[5] We did not know it before we began the localization effort with LCSI, the vendor, but this was the first programming language translated into Thai.

Moreover, programming not in one's native language makes learning the programming much more difficult. The error messages, help text, examples, and support materials are important for understanding learning to program. If one cannot make use of these materials, the task is much more difficult. Thus, I felt that the positive features of "learning English as well" were minimal and perhaps not positive at all. The negatives were strong. Still, as it was our goal in the design of the overall project that our Thai partners not merely follow our directives but construct and develop their own understanding and make decisions accordingly, we decided to leave it open to each site to use whichever version of the software they wanted. How the paths differed based upon the choice would be an interesting research question.[6]

In working with the villagers, I did not want to spend much time with preliminaries thereby delaying the moment when people could begin to perform meaningful work. All too often people helping beginners take long amounts of time showing every little step of using the computer. Even when well-intentioned by not wanting to overwhelm people with something daunting, this too often has the effect of losing people's interest because the relevance of the tool becomes obscured in details of use. It begins to feel like another meaningless school task where the potential joys and utility are deferred too far into the future for people to maintain the faith to continue. We knew from discussions that many in this workshop had left school after only a few years because they did not feel it added

[6] Xxx and yyy in Israel related their results in working with a Hebrew langauge version of Logo. The results were dramatic across the board in terms of types of students. The students who programmed in the Hebrew version performed much better, wrote more and more sophisticated code, accomplished many more projects, and even had better mathematics and science results. They are now in the process of writing these results and they should be published soon. They related this during the EuroLogo conferernce in Sofia, Bulgaria in August, 1999.

anything to their lives. We did not want to lose them as well by taking days to show arcane aspects like files, directories, DOS commands, etc.

Microworlds is designed according to the Logo principle so as to allow a learner to construct something real and satisfying as soon as possible. Creating animations or pretty designs with turtle geometry might not be directly useful but was sufficiently captivating to enable people to begin and continue to work. That Logo is, to at least some degree, personally expressive helped to engage the learners, as each one could make something of their own choosing, reflecting their own aesthetics. However, the pervasiveness in their school experience of following instructions presented an obstacle. It was necessary to continually remind the learners that when we gave examples they were not meant to be "commands" for everyone to follow by rote.

People did manage to build their own programs during the first day. There was considerable joy and satisfaction among the participants over having created their own projects, primarily aesthetically pleasing designs from geometric commands and the use of colors. Especially salient was the feeling of mastery over a high-technology device, the computer. This was particularly empowering and liberating in that many aspects of school and modern life left many of these people feeling powerless and alienated. That they could program and control this device gave a feeling of accomplishment. With this spirit they moved on to attempting to use the technology under their control for projects to their benefit. Moreover, accomplishing this quickly, without months of prerequisites, was critical so that they were not further alienated.

I began with two types of Logo activities, turtle geometry and creating simple animations. My goal was to introduce the language in a manner comparable to the *in vivo* learning of a natural language. Children learn new words by using them in meaningful situations. A typical way people introduce programming languages is to list the most elementary commands, provide an example, and have the learners memorize the commands. Once they have memorized an initial set, they are given a simple programming task such as organizing a list of elements, or placing a message on the screen, or performing a simple calculation and outputting the answer. The underlying paradigm again is of contained building blocks, introduced out of context of use or only within the context of the curriculum designer. The learners are expected to collect the building blocks, which they can subsequently apply when they finally are allowed to program on their own.

Rather than listing commands for people to memorize, I demonstrate how to make things happen within the Microworlds environment. I know that the participants do not have any familiarity either with the environment or with programming, so I cannot expect them to know what is possible. Thus, I have to show some things. However, I try to make this familiar, interactive, and enjoyable.

I introduce turtle geometry. Through this they will see how to program and manipulate objects in the environment. I have concurrent goals for the teachers. I want them to learn the language but also to think about their learning while we do this. Since our objective

of technological fluency is not just to have someone learn any particular programming language, but rather to learn how to think and express themselves using computational ideas, reflecting on how this is possible is paramount. However, it cannot work well in the abstract and needs to be embedded in some concrete activity. This is the role for the programming language.

I begin with moving the turtle with FORWARD and RIGHT commands. I use PD to put the pen down so that the movement of the turtle leaves a trace so they can see better what is happening. Initially, even though FORWARD and RIGHT have abbreviations that work (FD and RT, respectively), I spell the commands out completely so people can understand their meaning and the command itself is not so cryptic. Soon, I switch to using the abbreviations.

I move the turtle forward and show how it rotates in the same spot with the RIGHT command. I then suggest we make a square and ask how much we should turn. In this situation, people typically suggest ninety as the right amount. If they do not suggest ninety, I take whatever suggestion they give. In these situations, although they may not describe it this way, people can quickly see that the turtle has not made a right angle and will not make a square. I show how to undo a command and move the turtle back to its previous location. If this situation occurs, I always make certain to make explicit that making a *mistake* is not bad and usually leads to a better understanding later. On the computer we can typically rectify what went wrong so there is very little cost. The bigger cost is in being afraid to make a mistake and therefore not trying things. I encourage them

to try, see if it is what they want or not, and try something different if it is not. I want make this spirit of experimentation, of trying, hacking, guessing, reflecting, explicit and alive in our learning culture.

This is just the opposite of typical Thai School culture. People are not encouraged to guess. Indeed, for the most part they are not encouraged to participate. Having the wrong answer leads to the shame of "losing face." It is better to keep quiet than participate. This situation, of course, is not conducive to a good learning environment. Nor is it conducive to helping people develop the skills desired in the new education plan. Changing this attitude is a key goal of Project Lighthouse.

3.4 Nong Baot, February-July, 1998

Both the Suksapattana Foundation staff and the MIT group felt that the work in collaboration with PDA was important. This site enabled us to work in a non-school, community-center-based site. Although we would have preferred to be in the villages themselves, working from the CBird center had advantages also. There were already on-going activities there. PDA had developed a strong relationship with and trust among the villagers. There was technical, logistical, and staff support for the computer room. The electricity and phone lines were stable.

However, unlike locating in the villages, rather than being an integrated aspect to village life, coming to the computer room was an extra effort. Indeed, it often detracted from

village life and was difficult in rainy, planting, or harvest seasons. Still, this was better than nothing.

Unfortunately, at this point the funding for the foundation was badly hit by the Asian financial crisis. Thus, rather than having Foundation staff that could help develop the project at the Nang Rong site, combined with not having a group of Fellows to mentor, monitor, and guide the project, the Nang Rong site was left primarily to its own devices.

One PDA staff member, Khun Saithong, devoted part of his time to supporting Project Lighthouse. He had been hired to provide technical support. He is very pleasant and likes children, so he volunteered to work with the children who came to the computer center. He had participated in one Logo workshop, but that was the extent of his experience with our methods. Moreover, his computer training was quite rudimentary.[7] He had never really thought about learning or education. He helped out because he liked the project, liked the technology, liked children, and was generally supportive and helpful person. However, the burden placed upon him was clearly too large.

The Foundation did try to send some people from outside the area to support the Nang Rong site. Ae, the driver, came for several periods, working individually with people. Several students and young faculty came from KMUTT to run a Lego/Logo workshop.

[7] The problems with printing when we upgraded the computers highlights the rudimentary nature of his training, and the lack of adventurous spirit that inspired many of our supporters from the private sector to initiate Project Lighthouse in the first place. We upgraded the four computers already at PDA and had a dozen more donated. The new and upgraded computers ran the Thai version of Windows95. When they upgraded the existing computers, the printer attached to them stopped working. Rather than connecting the two events, or trying to diagnose the problem where the cause seems fairly obvious, or even just hacking

Still, while helpful, this type of sporadic, unsustained effort was not sufficient for the people at this site to develop the technological fluency needed to create interesting, meaningful, varied, and complex projects. Saithong himself had only participated in one week-long workshop. Thus, for these seven months the Nang Rong site did not develop much at all.

Still, and quite amazingly, when I arrived at Nang Rong in August, the children ran to the computer room every day after school. In fact, on my first day back we held a meeting in the computer room. I noticed the children arriving at the window, peering in, but not entering the room. They kept returning to the window to look at us. It appeared to me that they were becoming angry. Someone told me that they normally used the computers at this time, but would not enter out of respect while we were meeting. They were bothered because here we were, preventing them from entering, and we were not even using the machines. Once we realized the situation, we held our meeting outside so that they could work.

Rather than play games, they worked on Logo projects. The staff told me, and I witnessed this during my time there, that this was the usual state of affairs. They made many animated stories, added music and images, and also played with creating and programming fanciful and artistic geometric shapes. That this continued for so long is impressive, and a tribute to Saithong's efforts.

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through the debugging process, they decided to stop using the four computers and just use the new ones so

3.5 Nong Baot, August 1998

We enlist the help of the director of the PDA Nang Rong Center, Khun Booncherd, and Khun Gaensri, who manages some of PDA's projects with the villagers. We invite residents from the Ampur (an official term meaning district) to a brainstorming session about what projects we will undertake in the technology center. There are about fourteen villages in each Ampur and we are fortunate that at least two villagers come from each village. We have a session in the morning for one Ampur, and another in the afternoon for the other.

Khun Gaensri addresses the morning group first, explaining our goals, the activities we hope to do, and what we hope to accomplish during this meeting. Khun Booncherd does this for the afternoon group. Khun Bangkok and I add some more detailed information about Project Lighthouse as a whole and what is possible and not possible with the technology. We then divide into small groups for brainstorming and discussion. Each village was one group, and someone from PDA, NFE, or from Project Lighthouse facilitated for the group. We asked them to think about what problems they had in the village, or what they would like to create, or what they would like to improve.

I was a little bit nervous about the participation of the local NFE teachers. In every other part of Thailand, we had conducted technological fluency immersion workshops for the local, participating NFE teachers. They had at least two weeks of introduction to the

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that they could print.

technology and the ideas about learning before they began working with children. In our proposal we had specified that they should have six weeks of workshops and another six weeks of working on their own projects. Despite our insistence on this, which was based upon our previous experience, no Project Lighthouse site in Thailand gave the teachers this much preparation time. The reason behind not providing the development was its cost. Yet, undoubtedly the project suffered from the lack of experience and development of the teachers and facilitators. This is a typical administrative decision that focuses on short term costs, and ignores the long term results.

We had two NFE teachers from Chiang Rai and two from Lampang assisting us in the project. Both the Chiang Rai teachers and one of the Lampang teachers had been involved in Project Lighthouse from its first workshops in Thailand. These teachers rode eighteen hours on the bus not only to help out in BuriRam, but also to learn how to work on such village projects. Rather than run a workshop about what we were going to do, we just planned our activities, did the activities, and then reflected upon and discussed how things went, looked for what the key ideas in the projects were, and then re-planned the subsequent activities.

The need for an emergent design is evidenced by situations in Project Lighthouse where even when people accepted and agreed with the ideas and principles, they often did not know what to do. They had no in practice examples for guidance. Part of this is a problem of running workshops. In workshops one can practice with the technology and discuss the ideas, but it is out of the context of the actual work. We therefore tried only to

use workshops for introduction to the technology and the ideas, but do as much *in situ* as possible.

Most importantly, no matter what one would do in the beginning, people would need time and practice to learn to function differently in a learning environment. Just as we expect learners to need time and practice to construct their own understandings, the teachers and administrators need time to develop their new understanding of learning environments. Just as learners construct their own theories based upon experience, style, and practice, and then further construct, develop, strengthen, or even discard these theories over time, the same would be true of the Project Lighthouse practitioners. We designed and planned as best we could at each step, but we still needed to observe, reflect, and react to the actuality of construction.

Still, I was worried about the burden we were placing upon the NFE teachers from BuriRam. They were all very young and inexperienced. Except for one, they had no experience working with computers. They did not have the benefit of participating in an immersion workshop. Not only did they now have to start working with the technology, they also had to work in an unfamiliar learning environment, and they had to work on real world projects. None of this is easy. I was worried that the pressure was too great and that they might quit. None of them did, and they all became active and very productive participants in Project Lighthouse. Indeed, one of them asked me when I was leaving if it would be okay to continue working with the villagers in this way after I left, or did he

have to return to the traditional way of teaching. I told him that the whole point was for them to continue.

3.6 Getting Down to Work

The majority of the project ideas that the villagers raised in discussion were about water or agriculture:

- create a reservoir to enable more farming
- create a decision support system to improve rice cultivation
- improve the layout of farmland for raising vegetables and rice
- find ways to obtain more drinking water
- create fish farms in reservoirs
- find new types of crops to grow
- find new uses for existing crops

At the end of the session, we re-grouped and discussed some of the more salient and common project ideas. One village did not have enough drinking water for the whole year. They had to ship in bottles of water for the final three months before the rainy season. Khun Bangkok led a session at the board, working out how much they might save if they did not have to truck in water. He asked them how much each bottle cost, how many bottles they needed per period, and how many they would need overall. He then worked through the calculations for the total cost.

At this point a villager stood up and interrupted. He said that he was just a simple villager and could not do such calculations and mathematics. He said he knew he spent twenty-seven thousand Thai Baht (then worth about six hundred U.S. dollars) on water for drinking and farming and that if he could reduce that cost to twenty thousand Baht (a savings of about one hundred fifty-five dollars), he would be very happy.

Of course, while he disparaged his mathematical ability, he had accurately calculated his yearly costs and knew how much savings would make an effective change in his family's lifestyle. We knew this because as we continued working with him we saw his bookkeeping and saw his mathematical ability. Yet, it was clear he had not yet developed a certain type of mathematical fluency. He was uncomfortable manipulating quantities in the way we had done on the board. His mathematical ability was accurate to the level he required to function in the way that he was comfortable. He was not mathematically inept as he claimed (although some of this could be typical Thai modesty), yet, he was not fully fluent with mathematics as a system or as a means of abstract expression.

More importantly, and we saw this repeatedly, the villagers often referred to themselves as "simple" or "not capable." Somehow, they had come to not value their own talents and expertise. Their category of "smart" and "capable" in things that require smarts did not include themselves.

It was this attitude as much as anything that we hoped to change in this project. However, we believed that we could not change attitudes in the abstract or by argument. The

change had to come from within the person. Moreover, this change could not come about unless the person accomplished things in areas that are experienced as difficult or requiring significant expertise. In other words, we believed that disempowering views of self would change through support and encouragement, but only if it is given in the context of accomplishing difficult tasks themselves.

Access to water was the major concern throughout all the villages of the Ampur. The people of Nong Baot wanted to construct a dam to create a reservoir. The idea was that the dam would retain water at the end of the rainy season that they could then use for agriculture. In each of the past two years, the project failed as the reservoir did not contain the water as it ran out.

They had not previously calculated the potential. When we engaged in this brainstorming with them, together we calculated that the villagers would more than double their yearly income if they could harvest a second vegetable crop. Again, Khun Bangkok led the way through the calculations. He had a very gentle, though also boisterous, way of leading the discussion. He made certain not to perform any step on his own, nor to continue before everyone said they were clear about what was the meaning of the step just taken.

We asked for the acreage (or number of *rai*, using the Thai measure, where one rai equals about four hundred square meters). He then asked what they would like to plant in this area if they could plant another crop after the rice harvest. There were several suggestions, but, as a group, they decided that growing cucumbers and cabbage would be

best. When asked their reasons behind this choice, they responded that the price was good. There did not seem to be much consideration of what might happen to the prices of these vegetables if they added to the supply. Indeed, this appeared to be a common trend. Decisions were rather immediate, without looking at the next steps that might occur based upon the initial decisions.

The villagers, seemingly without exception, knew by heart their acreage, the prices of crops, the cost of fertilizer, and their total costs and total revenues per growing season. As other work in other countries has demonstrated, they had the mathematics that they needed to work [Nunes and Bryant, 1996, Nunes, Schlieman, and Carraher,1993]. But the math did not seem to extend beyond the immediate needs. They were not familiar with working on hypothetical scenarios to calculate the relative benefits for decision making. The math needed to do this was not different from what they did to know their yearly situation.

One rather surprising point emerged in this discussion. The national government allocates a certain amount for the village to spend for the year's projects. The new constitution alters tambol governance (tambol, sounding like tam-bun in English, is a designation for village although what constitutes a village differs to the government and to the villagers). Currently there is the local headman and a village council (known by its acronym, OBT, pronounced aw-baw-taw) that should continue, although their selection process and national role changes.

The amazing point is that there did not seem to be any consideration of the results from projects other than having something concrete, in particular roads (although also things like telephone lines or dams), to show at the end. However, the budgeting process seemed overwhelmingly political in its determination of relative allocations. What project would receive money was a function of who it would help. Whether it would provide a greater benefit than some other project was never considered. Benefit was never considered in any project as a factor for making decisions. Cost-benefit analysis may have its shortcomings, but ignoring benefit completely also is not a good method for rational, equitable, and effective decision making.

There was also an emphasis on what people called *hardware*. That is, tangible objects made it appear that the government was providing real results to its constituents. However, this meant that many potentially important projects that would contribute to the social good, such as education, providing clean water, and so on, were ignored. There also were problems with corruption. We learned later that the headman of the village that trucked in water for three months of the year received a percentage of the payment from the company that provided the water. Thus, he had little incentive to solve this problem. Bringing transparency to the issues involved, making explicit the costs and benefits from alternatives, and providing open group discussion about problems, plans, alternatives, and then deciding collectively with as much data as possible, as we were doing in Project Lighthouse, potentially helps reduce such corruption.[8]

[8] Although, in the spirit of full disclosure, coincidentally the morning of the village meetings, I read in a Thai newspaper an article with the headline, "Body of Researcher Found in River." The river was in the province in which we were currently working. This made me less comfortable about attacking this problem first. The cause of the murder, apparently, was that the night before in a bar, the researcher had insulted

These considerations highlight the multiple, simultaneous aspects upon which we had to make decisions. Ours is a learning project, but we believed they would learn better when working on projects of real importance. We could not know in advance what their choices might be. Thus, here was another example of why we could not have provided the five-year curriculum for our project in advance. The projects would vary from time to time, place to place, and person to person. Our principles and mode of working, however, remain constant. We wanted the projects to be their choice, but also to be tractable, to not be too difficult initially so that they reasonable could solve them, to have connections to important bodies of knowledge, and so on.

The principle we applied here was to surface real projects collectively upon which to work. A fundamental component is that this had to be the villagers' choice. We knew they could not make such choices without our input because they did not yet know the affordances and constraints of the technology. They could not yet have knowledge about what was and was not feasible to attempt. Our role was to assist them in this, all the while making our choices as explicit as possible as it was also our aim to have them become self-sufficient in this role.

None of us assisting in the project truly knew beforehand how to solve any of the problems they chose to address. Rather than being a negative, we thought this was positive as we would all learn together. Another essential principle within Project

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some military officers. It did not seem to be connected to his research. Still, the potential for violence was an undercurrent as the project was potentially disrupting and altering the existing power relations.

Lighthouse, and indeed is also expressed in the goals for the future of Thai education, is to learn how to learn. With an ever-changing world changing at an increasingly rapid pace, no one knows what the future holds or what skills and knowledge will be useful. Thus, for everyone, learning to learn is crucial. Nowhere in typical School is this addressed, nor do typical students get the opportunity to see their teachers and leaders learn. In these projects we would all learn together. How we would go about learning serves as a strong, concrete exemplar for the learners.

Both the villagers and the rural teachers developed the project together. We formed groups so that an NFE teacher somewhat experienced with both Logo and the approach to learning in Project Lighthouse would team with an NFE teacher from BuriRam since they had no experience. Together, they would work with the villagers on the project of the villager's choosing.

One quite wonderful and unusual aspect to this was the mixture of people working together on the projects. We not only had a mixture of teachers, NGO staff, and villagers, we also had a mixture of residents from different villages. We also had a mixture across generations. Wide ranges of villages, from grandparents to the young children who played with Logo after school, collaborated on building the projects. Often, the elders would not do so much on the computer, leaving that to the young adults, teenagers, and children. Still, they remained involved in the project, guiding the direction and helping to make decisions. Here again was a demonstration of a social-constructionist approach [Shaw, 1995]. We did not lecture them about the benefits of collaboration across

generations or among villages that often have less than harmonious relations. Rather, they came together to construct projects of value to all. The social benefits were subtly present, but real.

I chose to take a supporting, mentoring role. I decided not to just do the project myself, believing that the only sustainable benefit would be for them to develop the package of skills themselves. To me, this was a critical design point, where the choice of action is not exactly clear.

We had calculated that building a dam to create a reservoir would at least double the per-family income in the village. This is considerable. The dam project had failed each of the prior two years. Thus, it was not as if this was proceeding properly on its own. Clearly, there is a short-term advantage to building the dam. If either I, or any other outsider, designed it, contracted for it, and supervised its completion, a significant increase in resources to the villagers could occur.

On the other hand, there are some deeper issues than just the construction of the dam. The villagers initially wanted the technology to help them gain more control over their lives. They did not like how outside experts had treated them in assisting with other issues. The primary cause for the dislike was that the outsiders did not help the villagers gain knowledge about or control over their situation. Rather, the outsiders made a determination and took action, leaving the villagers disempowered. Moreover, even if an outsider solved this particular problem, where would they be when they faced the next,

and inevitable, problem? They would still be in the subservient position of having to rely on outsiders. This clearly is not in their long-term interest.

I also drew on the example of the World Bank study of the project the bank funded to install water pumps in extremely poor countries [Narayan, 1995]. The benefits of such a project are obvious. Clean water helps reduce disease. Having mechanical pumps would save the local people a considerable amount of time they otherwise would have had to spend walking to a stream and hauling the water. Still, in more than fifty percent of the sites where they installed pumps, within one year the pumps were no longer functional. The technology of water pumps is quite simple and well-understood, yet the failure rate is overwhelming. The World Bank surmised that the primary cause for failure was the lack of local involvement in initial decision making. When the planning, decisions and ownership of the project was held by outsiders, the pumps failed, were unused, were not maintained, or were vandalized. When the local people championed, owned, and helped make decisions about the project, then the project succeeded. This example provides a strong rationale for me and the other outsiders to take a supportive, not an ownership role.

In this case, and in the project as a whole, there is an issue of paternalism. We did not want to be in the position of placing the villagers in a subservient role, where we know better and only feign to let them make decisions. If the above reasoning were only carried out by me, without the involvement of the villagers, then this would still be a case of paternalism, and would still tend to disempower them. This is the case even if I firmly

believed my choice was in their best interests. However, we were working in Thailand, and the invitation of local people, because we had some expertise to which they wanted access. This expertise was in learning and technology. If we kept this expertise to ourselves and enable an *anything goes* atmosphere, then we would be neglectful in a different sense. My decision was to attempt to make every issue as explicit as possible through open discussion. As we were deciding as a group what projects to attempt, I expressed these thoughts about what role I should undertake.

As a group we decided to focus on a limited number of projects initially. We reasoned that we could not attack every problem simultaneously as there were not enough of us. In addition, August is the time to plant rice. The villagers needed to spend the bulk of their time preparing the fields, planting, and cultivating their rice crops, as this was the primary basis for their income for the year. The villagers and the participants from Project Lighthouse began devising ways to collect and maintain fresh water. PDA had already initiated a program with the villagers where they made large ceramic containers, placed metal sheets on their roofs, and directed the flow of rainwater over the metal sheets into the ceramic pots. This would hold the rainwater for later use.

We chose the following projects:

- design ways to create reservoirs to maintain the water to irrigate their fields
- design dams to harness the floodwaters and connect to pumping systems for irrigation
- re-design agricultural field layouts to take advantage of the topography of the terrain to better support multiple crops

- develop decision support systems to guide diagnosis and treatment of problems with pests and fungi in the cultivation of rice
- Design new ways of conserving water and delivering water to the houses more efficiently

As in other Logo projects, the goal of the decision support systems was not only for the benefit of the others, but to help the developers themselves formalize and make robust the knowledge required to accomplish the project. There are four important aspects to each of these projects.

The first is simply the accomplishment. Creating these projects will improve the lives of the people. The second is the knowledge required in order to accomplish the project. They can apply this knowledge on subsequent projects and efforts. This is truly the only sustainable development. The third is the process of deciding what issues to address collaboratively. The process of determining projects for the common good collaboratively puts them in an active agency with their environment and positive relationship with each other. Finally, there is the empowerment and satisfaction from accomplishing difficult real-world tasks. Such accomplishments, more than any verbal encouragement, go furthest towards developing positive self-esteem and role models.

Beginning with the dam project, we went out to inspect the area where the dam would be. They told me we were going to the river. As we were walking through a field, everyone stopped and began looking around and taking pictures with our digital camera. I asked

why we stopped. They told me we were at the river. Since this was the dry season, there was no river, just a flood plain. This highlighted the reality of their situation. It also made it much more difficult to envision how and where to place a dam. The locals told us how and where the water usually flowed. They pointed out to which point it usually stretched, although of course this varies depending upon the strength of that season's rains. We had decided to photograph the area, upload the images on to our computer's back at the CBird center, and begin our design there. We also inspected the locations for the other projects, questioning the villagers about problems, circumstances, past efforts at remediation and improvement, and so on.

As we showed people how to upload the images from the digital camera, we discussed possible paths for the software aspect to the project. We decided to create maps of the area, lay out potential solutions, simulate the different probable results, calculate which would choices be better, and then use that design as a guide to the construction.

Interestingly, neither the villagers nor the teachers knew how to create a map. When we asked which way was north, no one knew. So, we asked which was east, figuring that they would know that by the rising of the sun. Again, no one knew. I later found out this was even more surprising, as the word for east is literally sunrise. When we asked where the sun rose, everyone knew and pointed that way. We all laughed when the fact that sunrise and east were the same words, yet no one knew east but everyone knew where the sun rose. This was yet another example of not having access to a taught, but irrelevant fact, while all knowing the underlying concept.

While the fact that the villagers could not make a map might not be surprising, the teachers could not do so either. More importantly, knowledge of coordinate geometry was not at hand either. The powerful idea of drawing axes, marking units of length along the axes, and determining distances was not in their repertoire of ideas to use in representing the area. They had certainly taken school courses and passed school exams on this type of knowledge, yet in practice they could not do this. The impact of this is critical. It relates to the findings of Lave in other situations where people did not use their school math [Lave, 1988]. People legitimately question how we will determine the learning of students within our reform efforts. Yet, the other side of this question goes unexamined. There are many findings where despite passing school exams on the underlying knowledge, people could not or did not use it in real world situations. I will return to this theme briefly in discussion about the dam project.

Making this concrete, tangible, and manipulable was critical towards successful comprehension. Where the nature of the computational technology truly provided a benefit not possibly gained from other media was by enabling the proposed solutions to be shareable, dynamic, contextual, interactive, and easily alterable. Perhaps most important was that the solutions were a powerful expression of their own ideas.

Together, the teachers and villagers created accurate computer representations of the areas, preserving distances, maintaining relationships and ratios. For clarity, they created various views at different scales, providing views that zoom in and out. They calculated

the relevant distances between important objects. They used this to help determine situating the dam, determining the best methods of irrigation, and combining this with the projects for water flow for the entire village.

At the end of the first day, immediately upon creating the maps, we discovered a costly mistake repeated each of the past two years. They had been building the dam in the wrong place! The original location benefited from natural terrain to create the reservoir. However, it was about two kilometers from the village water pump used for irrigation. Once they constructed their own map of the area, they realized they could not create a reservoir large enough to cover the distance to the pump. Even if the dam had functioned properly, it would not have provided the expected benefit, as it was prohibitively expensive to re-locate the pump and the irrigation hoses.

One cannot underestimate the importance of this. In each of the past two years, they wasted a considerable amount of very scarce resources on a project that was doomed from the start. The villagers had not realized this. Even the experts who had tried to build the dam did not discover this. Yet, the villagers and the NFE teachers, both new to the problem type and the technological tools, learned this on the very first day.

Active collaboration among the residents was one of the essential lessons when the World Bank sponsored the introduction of water pumps into rural areas. The rationale behind their introduction was that the water pumps would not only help health matters, but would also leverage many other gains as people would spend less effort walking,

carrying and hand drawing water. This would free them for other more productive activities. However, although everyone needs and appreciates having clean water, the water pump project did not go smoothly or successfully in every area, and actually failed in a relatively large proportion of them. At some sites people refused to change routines to use the pumps, often because they were poorly located. At some sites they fell into permanent disrepair. At other sites people simply vandalized and cannibalized them for parts. While of course the situations are not exactly parallel, we are able to say that despite working in areas of poverty, there has not been a single incident of theft or willful destruction. Nor have people allowed the equipment to fall into disrepair despite difficult climate and infra-structural conditions.

Early in the morning of the second day working on the projects, the wife of the village leader and a friend came to see Khun Bangkok and me. They brought fried, sweet rice cakes with them for us. They were extremely dense and oily, and not the sort of thing that I, or Khun Bangkok, would normally eat. But since they had gone to the trouble of preparing them especially for us, we thought it might be insulting not to partake. So, we ate and listened to what they had to say.

They were very apologetic and asked for our indulgence. They said that they were just "simple villagers," and were not capable of attempting such ambitious projects as designing a dam. They thanked us for our concern and interest, but they felt this was beyond them.

After the seemingly successful meeting two days ago, combined with the discovery and progress of the previous day, this statement caught us by surprise. We had to decide on the spot what to do. On the one hand, we firmly believed that they had to provide direction about the project. We should not impose our wishes upon them. On the other hand, we believed that this oft-repeated view of themselves as "simple villagers," incapable of serious work was a symptom of many things, including the rural educational system. If our project was to succeed, then we hoped these self-images would change.

We continued our conversation, gently probing for reasons behind it. We told them why we thought it was important. We told them of our confidence in them and why we believed this was within their grasp. We pointed to the incredible progress made so quickly. We believe, and this belief is consistent with past work, that the best path to changing such negative images of self-intelligence is to work on projects that extend beyond what one thinks one can do [Cavallo, 1996a]. Only after successfully accomplishing more than one thought one could does this image change in a significant and solid way. Therefore, we hoped that they would try these difficult projects. We were dealing with a paradoxical situation. Insisting on continuing detracted from their control and initiative. Allowing the project to drop would lose important momentum and delete a potentially empowering project.

We also told them that we believed it would be essential at some point to call in experts in dam construction and water management to assist us. Considering how the project failed with experts previously, we wanted to be at a stage of knowledge and confidence,

so that these experts would consult to us, under our control, as opposed to dictate to us without our being an informed part of the decision making process. Given that at some point we would get experts to verify the practicality of the designs, would they consider allowing the project to proceed? They agreed, although we knew we were possibly losing the balance we desired between their control and our forcing them, no matter how gentle the manipulation might be. So, we continued.

As the design for the dam and reservoir progressed, it became apparent that a reconfiguration of the arable land was inevitable. This raised new issues. The villagers divided the village's farmland into family plots. Each family has a fair share acreage on which to grow their crops. Creating a reservoir would alter the configuration which has been in place for years. If nothing changed, a few families would lose their land for the benefit of others. How would they deal with this situation?

As was becoming customary, there was a discussion. After a period of time and a number of proposals, they settled on a monetary compensation plan for those who would lose their land. They also ensured that those that lost land would still have other land on which to farm. It appeared that everyone was satisfied not only with the plan, but also with the fact that they solved it relatively easily.

What was also changing was a new spirit of cooperation and activism. They were not waiting for and relying on outsiders to solve problems for them. They were taking charge themselves. They also were focusing more on the overall benefit rather than trying to

maximize one's own. This realization itself had a positive feedback effect. However, the changing of values, just as the changing of learning, was occurring not by lecture but rather through working on projects.

Another key element was the integration of various fields into the projects. A School approach is to separate the subjects into discrete units and then further separate the knowledge within the subjects. In this case, the work was on projects, both large and small in scale. To succeed at constructing the projects required that one touch on various fields. There is math of various subtypes, science, engineering, and often language and history. Moreover, there are elements of ethics, rhetoric, and social studies. They are bound together in a coherent whole, where often the various parts support one another. This provides context and relevance for the math and science. It provides value and meaning. The result is that the villagers who left school dissatisfied worked their way through many difficult, unfamiliar fields in order to bring their projects to fruition.

The mathematics of this project is not simple. They applied various branches of mathematics in order to solve the problem. None of the participants had what the grammar of school would consider the knowledge prerequisite to the math they did. Yet, rather than making the project impossible, the so-called prerequisite knowledge was applied in the context of constructing their projects.

There is a lot of mathematical knowledge required to determine how much water was needed to grow for how big an area of particular types of crops. They measured the real

space. As real terrain is not as neatly configured as pencil marks on paper, the measurement and calculations are also not neat. They had to know what was critical to maintain and what they could smooth. They had to create maps based upon their measurements. As they were constructing the maps on the computer, they decided to create various views. They therefore had to maintain proper ratios and relationships among elements. They used coordinate geometry to determine distances and layouts. They used variables and algebra to calculate. They wrote formalisms in their programs to manipulate their objects, maintain accuracy, and create meaning. They used various symbolic representations to make their work consistent and functional. They built mathematical models to run simulations to help determine the best choices. They had to calculate area based upon the real measurements. They had to determine the density of crops within their farmland. They then needed to determine how many plants they could support and the volume water those plants required. They had to figure out how deep a reservoir they needed. They knew that this would not be constant as water evaporates at particular rates depending upon climate. Water also seeps into the earth. Since the ground was not level, they had to determine where and how to level it and where to dig irrigation ditches. Leveling and digging requires renting machinery which costs a substantial amount of money. Determining the site depends upon factoring the costs of the various plans with the benefits of best yields. They needed to calculate the various costs to provide the data upon which to base their determination.

All of this is serious mathematics. Yet, these same people who did not feel competent at math, who left school as soon as possible, whose experiences of math in school were

problematic, worked their way through these problems in Logo. Certainly we were there to help them through this process. But, as noted earlier, for sustainability the main work was theirs, not ours. They really did the design and construction of the simulation project. Moreover, these were just the first projects. Assuming that our project will continue and expand, which it appears it will do, they will continue to work on projects of this nature. Clearly, they will deepen their experiences by having more projects with which to make more and deeper connections. Seeing an idea once and using it is one thing. Seeing it repeatedly, using it in a variety of circumstances, provides its power. Working in this manner, they were developing a fluency with mathematics, and mathematics on the computer rather than just with pencil and paper. They were becoming fluent with the ideas, able to express and communicate their thoughts, and use math and computation as a means to understand and address each other and their environment.

The role of the computer is critical in a number of aspects. The issues are inter-related so it is not possible to untangle them. However, it is clear that while our approach would have been better than their school experiences even without computers, our approach would have suffered without the computers as well.

Computational tools allowed simulation, collaborative joining of various parts of the overall project, graphic representation, individual expression of the ideas, rapid cycles of expression, operation, reflection, and debugging, dynamic manipulation of symbolic expressions, and working on large projects in pieces. One also cannot underestimate the fact that working on computers makes one feel connected to the modern world. Building

on the computer may not be cognitively more difficult than many other things people do every day. Yet, they value the work on the computer in a way they do not sense satisfaction from other activities. People believe that if one can build things with technology, then one must be smart. This claim is disputable, but in some ways its truth value is irrelevant. Simply because people feel that way, it is empowering, and that is good.

Another important aspect is that people *have fun* while they are doing this. There may be times they are frustrated. There are certainly difficult times. However, we try to create an ambience that is light, supportive, and fun. We hope to demonstrate that learning can be one of the most enjoyable experiences in life. And, since the process was both enjoyable and meaningful to their lives, they put in the work and developed an understanding of knowledge domains that School emphasizes. Yet, in the typical School presentation, these villagers did not stick with or enjoy the subjects. This contributed to their lack of belief in their own intelligence. This is what was being reversed within Project Lighthouse.

Our use of the computers also runs counter to most trends in educational practice. We emphasize construction and programming. While we use a variety of tools, our initial focus in the overall project as well as within individual projects is to program. Many educators now feel that programming is too hard, and prefer to emphasize *end-user programming* [Nardi, 1993, Williams and Begg, 1993]. In end-user programming, the tool is specific to a particular class of problems. The learner is the end-user, and changes

parameters in the environment, or, as in the case of Excel, supplies values and can add functions. In any event, the educational design is to minimize the chances of being lost or going wrong by limiting the expressiveness in the environment. This is not due to any bad intent. Rather, it is fueled by a belief in doing as much as possible to not let things go wrong combined with a worry that the quality of teachers is not high enough to successfully carry out work in open, less constrained environments.

Just as we have demonstrated how our approach can be successful when working with students who have not done well at school [Cavallo, 1996a], this approach can also bring out the best in and help develop the expertise of teachers who have not been held in high esteem. It does take a different set of skills and attitudes than does lecture-style classroom teaching. And in order to develop these skills, we must give teachers the time, opportunities, and support necessary. Still, the successes in BuriRam, Lampang, Mae Fah Luang, and Chiang Rai provide and existence proof of the possibilities.

Also important to note are the differences between our approach and the problem solving, the word problems, and the concept of project in typical School. Making calculations based upon measurements, setting up formalisms and equations, using algebra and geometry, making maps, drawing to scale and adjusting scale, and using Cartesian coordinates, and so on, were all foreign concepts, even if they had been covered in school. The vast majority of those working on the projects had left school after only four years. The children who joined us likewise had either quit or were totally alienated by and disenfranchised by their school experience. The math they had learned in school was

not a useful tool. However, everyone managed the underlying mathematics in the context of the problems they had chosen.

As the design project continued, we observed how the efforts of some of the villagers were exceptional. In a later interview, one of the villagers, Denchai, told me that he did not do well in school. He did not like it at all either as he felt the punishment was too often and too severe. He did not act up in school so the punishment was not for misbehavior. Rather, the teachers inflicted it for anything not to their liking. Denchai left school as soon as it was legal. Outside of school he played soccer and helped his family with the farming.

Given his behavior in our project, it was hard to imagine Denchai in trouble for anything. As participation in our project was strictly voluntary, Denchai did not need to show up or to work. Yet, he cheerfully came and worked diligently every day. When I asked him why he continued to come and work so hard, he said he felt it was very important to help his village and he saw these projects as crucial in improving life there. He also thought it was personally important to develop expertise in working with computers. Plus, he said it was fun.

What was so striking was that Denchai had quickly become a quite adept computer hacker.[9] Atypical of many of our experiences with more educated people, Denchai, similar to others who participated in Project Lighthouse in other parts of Thailand, dived

[9] That is, in the positive sense of hacking.

in and figured out how to build the projects he wanted. If something did not work, he was not daunted. Rather, he debugged the system and worked until it was satisfactory.

I was particularly awestruck when I observed Denchai adapt code particular to his project. I was developing a small Logo application to draw various types of graphs based upon entry data. The idea was to help support budget decision making for the local tambols. Denchai does not know English. Yet, he would observe the functioning of my program, and, if there was a particular effect that he liked, he wold inspect the code, and adapt it for his own projects.

He would find a command that he did know within the language. Even though I never explicitly taught lessons on syntax, by the structure of the code he could determine what was a function, or an argument, or a variable. He would look through my function definitions to understand how they worked, and what was creating the effect in which he was interested. He would then transpose the work to his own projects, not merely copying code, but applying the underlying concept to enrich his own work. This is excellent no matter what, but considering he could do this without being able to read the English, know the words the mnemonics represented, nor even choose to question me through a translator about what something meant, this ability is remarkable and truly something special!

This was atypical of my experience in Thailand with teachers. At other times I had observed people merely copy my code verbatim without thinking of the overall context or

the differences between what I was doing and what they were doing. This happens when people are unfamiliar with programming and cannot yet tell the difference between background context and the actual programming construct for them to adapt to their own project.

While individuals are working on their projects, it is common for someone to get stuck and ask the workshop facilitator what to do. For example, if someone wants to achieve a particular effect, they will try, not succeed, and then ask how to perform the task. I have a heuristic not to just tell the answer unless I feel the person will become too frustrated and quit. I believe that if I answer the specific question, the person will not engage in the thought process deeply and will merely proceed. I endeavor to step back, engage them in a discussion about the situation, debug it with them collaboratively, and hope that they can see their way towards deriving the answer. My goal is to have the person generalize both the process and the particular answer. If this succeeds, then the next time they will not need the assistance. Often, in order to do this, I set up a structurally parallel situation so that solving the problem in the parallel situation, or seeing the commonality overall, will help the person to determine the general principles.

However, in workshops in Thailand, I later discovered that at times people had copied the parallel situations I had set up only to provide a context for the examples. Perhaps mistakenly, I had not paid proper attention to the context examples, simply providing function without due attention to overall programming concepts, structure, and heuristics, let alone paying attention to aesthetics and elegance. I was mortified when I saw this as

people had copied my code letter for letter rather than concept for concept. As they were beginners, this was hardly their fault and clearly was mine. They had not yet had the opportunity to distinguish between form and substance.

Yet, Denchai, despite not sharing my language or that of the programming environment (at this time we were using the English version of Microworlds), with far less education and even less programming experience, never made this mistake and could figure out the constructs. Later in that same day, I noticed him going through the on-line help vocabulary command by command. He would find the command, look at the code example provided, and then try it in his own project. In this way, he was teaching himself the language.

This clearly is someone with considerable intelligence. How he did not do well in school is clearly not from a lack of ability. When I inquired about his interests and background, he too had worked with engines. After leaving school, he moved to Bangkok to help earn income for his family. After his first job, he then worked in a motorcycle parts shop. He told me that by listening to the diagnostic dialog between the manager and the people come into the shop, he was able to learn how to diagnose problems in the engines. He would practice on his own and other bikes.

Like Ae, Denchai developed the sense that he could figure things out. By learning how to build and repair engines, and by working on the farm with few resources, they developed a *bricoleur's* spirit. That is, they would make what they need with what little they had. If

something did not work, they fixed it. If they did not have the right tool or material, they improvised. They took this spirit and applied it to computational technology.

Through further discussions, we found that many people were aware and proud of the mechanical expertise and innovation among rural Thais. One of the local NFE teachers, in fact one of the few that actually came from a village, also worked a lot with engines and farm machinery. They took me to visit their farms.

From the dirt roads of the villages, everything looks as one might expect. The houses are simple. There are some simple barns, some in disrepair. There are the farm fields. However, I was fortunate enough to have local guides who led me into the barns where I quite astounded by viewing little mechanical wonderlands. The barns were filled with various types of simple, indigenous machinery and systems for working on them.

At the farms everyone who could used a small Kubota diesel engine to power a wide variety of local technological contraptions. Indeed, these Kubotas (where the Thai pronunciation puts the emphasis on the last "a," as in Ku-bo-taa'), are ubiquitous in Thailand. They used the little motors to power rice mills, well-water pumps, irrigation pumps, one-person tractors, field vehicles, and even lightweight trucks. The barns contained little pulley systems for lifting the motor from one device to another. The logic of each machine was open and obvious. Upon a relatively quick glance, one could determine the causality of the mechanical constructs.

Figure 1--rice mill in barn in Nong Baot

Figure 2--kubota motor driving rice mill

The innovation and creativity were remarkable. The utility was tremendous. They had taken objects for other, often quite specific, purposes and combined them in a general-purpose melange particular to their needs, resources, and budgets. The experience and expertise of those who worked with these engines and devices were quite impressive.

The small one-person tractors were particularly impressive. People could not afford large tractors. Rather than having to plow by hand, the Thais developed a one-person tractor that could house the little Kubota, which would power the plow.

Inside some barns were rice mills. The large mills too were powered by the Kubotas. Unlike much modern technology, the functioning of the machine was open and apparent. One could easily see the system and its causal logic. There are several apparent reasons for this. One is that this openness facilitates repair. A second is that this makes it easier to learn this machine's operation and, by extension, the mechanical principles to apply to other machines. This was important because everyone had to be a generalist and could not afford the luxury of specialization since there was not any other way to pay for outsider experts. One had to be a jack of all trades. Third, the machines likewise could not be overly specialized since that would make getting parts prohibitively expensive. Thus, there was some innovative and ingenious engineering hidden away in the village barns.

3.7 September-February, 1998-9

After I left BuriRam, the work continued with difficulty. This was primarily due to the fact that there was no one there to facilitate the effort. Tragically, the woman who was in charge of the NFE office died due to injuries suffered in a motorbike accident. Unlike

many people who work in large bureaucratic organizations, she was very innovative and took considerable initiative. She was truly dedicated to the people of her region, and worked diligently to improve education. After her death, the teachers with whom we were working in the project were transferred to other duties. We thus lost the continuity of effort. No one familiar with the educational methodology or the technology was available to work on this project. The PDA staff had other obligations. Thus, the effort here hit an unfortunate and disappointing roadblock.

Khun Bangkok came often to work in the area. A new NFE supervisor was selected who re-committed personnel to our project. The Suksappatana Foundation hired a few recent KMUTT graduates from the Information Systems (IS) department to work on the project. KMUTT staff came to run a few workshops to help familiarize the new staff with the ideas and technologies. Still, despite these efforts, there was a gap in the projects we began in August, 1998. This setback naturally affected the villagers, who, while they were still cooperative, were not yet self-sufficient to continue unaided. The dam project stalled. Denchai continued to work, but he followed the lead of the others at the site and did not continue the real-world projects. Rather, he helped tutor the younger children on working with Microworlds Logo.

Surprisingly, the KMUTT graduates with degrees in IS had not had the opportunity to really program while they were studying at the university. Although they studied computers, their courses were all lectures. Their homework was with paper and pencil. The only programming required was a short senior project. Both of the graduates working

with us did small projects with Excel. Thus, they never had the opportunity to program. Yet, they were certified for their *knowledge* of Information Systems.

This lack of real experience is clearly not their fault. There are numerous reasons for this situation. This is not just due to a privileging of the fact-based School grammar over practical engineering experience. There are insufficient resources to provide all students with adequate computer time to work on projects of significant size. More insidious, many of the teachers have had no real experience either. When the economy was good, the majority of the better students would take jobs in private industry, as the pay was significantly better. The next level of students remained to teach. But often they had no opportunity to program and engineer real projects either. This created a vicious circle.

However, while we needed people with programming experience to work with the villagers, there was no one available. Still, the project did not stagnate. Khun Bangkok and his crew used what the tools with which they were familiar and kept the constructionist and technological focus. They thus shifted to work with the local ladies' cooperatives in planning and implementing new business ventures.

This switch of tasks and the reasons behind it are extremely critical, however. When we first discovered and settled upon doing the dam, irrigation, and agricultural projects, there was tremendous excitement and hope. People naturally were extremely excited about the prospect of doubling their income. They held considerable trepidation as they knew this project had failed each of the past two years, that the project was complex, and that they

felt inadequate to tackle such a difficult project as they were "just simple villagers." Still, after the initial reluctance, they were willing and participated diligently on the project.

Nevertheless, people, including those working for Project Lighthouse, discontinued the dam project. Why would this be the case? Why would the villagers stop when the math showed that they could double their income in just one year? Why would the Project Lighthouse staff stop when there was such a promising beginning, when it could have such important and tangible benefits, and when it could truly establish the validity of the overall project?

The easy answer is that the fear and uncertainty was overwhelming to all. The villagers still felt incapable of accomplishing such a difficult project. The Project Lighthouse staff felt too unfamiliar and non-fluent with the technology, the methodology, and with working on such open-ended, large-scale projects. Significantly, this was the case even though they had just graduated with degrees in Information Systems. Still, in all fairness, they had never been required to attempt such projects, or even any open-ended, non-trivial, non-classroom tasks. Thus, what could have been a momentous accomplishment was deferred though fear.

This raised the issue of preparation. In our proposal we emphatically declared that the staff should have a minimum of six weeks of workshops combined with six weeks of working on their own technological projects before beginning work with learners. The idea was to have them have a chance to develop their own skills and technological

fluency. While this still may have been insufficient to successfully finish the dam project, its lack undoubtedly doomed this, and probably any other serious project.

In every project on which we have worked, we have strongly urged the administrators to allow the staff to devote a significant amount of time to preparation. In every case the administrators refused, albeit politely. The rationale was always funding.

This, however, is the epitome of penny-wise, pound-foolish management. While they saved money initially, they lost the benefit of a better skilled workforce. In the case of the dam, less than one year's results would have more than paid for the extra development time. In the case of Project Lighthouse, such a significant result would have justified its existence and appropriation by others. Even still, Project Lighthouse has demonstrated and justified its approach. The dam would have proven the validity beyond any doubt. With sufficient time and resource, where that resource could have been the time of just one experienced and technologically fluent person, the villagers could have designed and managed the construction of the dam. This would have led to a second crop. While we would never allow a textually illiterate teacher to gain such a position, we are not yet accustomed to thinking of the necessity of having technologically fluent, or even mathematically or scientifically fluent, staff.

Fortunately, even thought the staff and the villagers dropped the dam and irrigation projects, they did not quit either. They worked with three cooperatives in Nong Baot. As we did earlier, they began with brainstorming about possible activities. One group,

impressed by the price of mushrooms at the market, decided to cultivate mushrooms. Another investigated alternatives to selling the low-grade rice in bulk. The third looked to vary their crops to grow vegetables.

The group growing mushrooms pooled all of their money, went to a vendor, and purchased all they could of one variety of mushroom. They chose this species because it fetched the best price in the market. They had the men of the village build them a hut to house the plants.

Typical to this area, the men did the necessary carpentry. There again is math involved in the construction. They had to build to the specifications of the women. They wanted a particular size to house their plants. The roof had to be of a certain angular construction. The men pulled this off flawlessly. Yet, upon my questioning later, they did not consider this to mean that they were good at math. They felt themselves inept at math. What they did was not math. It was carpentry.

Their project began beautifully. The first mushrooms came in nicely. They sold them easily for a good price. Soon, their project declined. The mushrooms at the bottom of their racks soon developed a fungus. This spread upwards throughout the whole crop. None of the mushrooms could be salvaged. No new ones grew.

Khun Bangkok arranged for an agricultural expert from Siam Cement Company to consult with the ladies group. The Siam Cement people explained that since they began

the racks from the ground, the fungus was inevitable. They advised them to begin about a half meter above the ground. They also advised them not to grow only one type of mushroom. They would achieve a better cash flow if they grew different varieties, as the different ones would mature at different rates, providing a steady flow of income and not overwhelming them with everything ready for harvest at once. The women took the advice and began again.

Khun Bangkok and the KMUTT graduates, Nan and La, continued to work with the women with Excel. The women had begun other business ventures prior to their involvement in Project Lighthouse. Most ventures failed. But when Khun Bangkok inquired, they did not know how much they had spent on which ventures, and the relative success and failure of the various efforts. They worked with them in Excel, showing how to track expenses, plan budgets, create formulas, try hypotheticals such as varying price to see effect.

When I met with this group, the leader of the group told me that in the past numbers were just floating in the air chaotically. As she told me this, she waved her hands around in a whirling motion. She explained that now with Excel she can pigeonhole the numbers and they have meaning. As she said “pigeonhole,” she jabbed her finger sharply. She told me she felt quite proud of her new, mathematical expertise. She said she was ashamed that she had quit school after four years and was uneducated. She felt this meant she was not intelligent. She was now changing this view of herself, and felt quite confident about the group successfully attempting new ventures.

The rice alternative group had a similar experience. The farmers typically sold all their rice. The different grades fetched different prices. The low-grade rice barely paid anything at all, around five Baht (eleven cents) per kilo. The price was so low people barely paid attention to its sale.

After some quick financial planning with Khun Bangkok, this group decided to make rice cookies and a small rice waffle out of the low-grade rice. Khun Bangkok worked with the women until late at night as they spent the day working. After about four hours of work with Excel, the head woman said her head was hurting from all the thinking, apologized, and asked permission to go to bed.

The next day, the woman appeared very tired. Khun Bangkok worried that he had pressured her too much. The woman said no, it had been one of the best nights of her life. She said that she could not sleep that night, thinking about how she had not accomplished to the level of her potential. She vowed to continue working and learning, for her benefit, for her family, and for her village. She too felt incompetent at math, but now was seeing how she could use it and how she could gain competence.

Interestingly, her daughter and family lived nearby. After these discussions, she decided to open a small shop in the village to provide groceries and household products. She created her own interesting bookkeeping method. Rather than entering the change into her ledger, she omitted it. She did so because she felt the calculations were difficult.

However, her records were not inaccurate because she left the change in the drawer to begin the next day with change for her customers. She thus had a feel for some mathematical properties, as making mistakes with money were literally costly.

3.8 The Current Situation, August, 1999

The Foundation, the villagers, and indeed all participants in Nang Rong periodically reflect on the flow of the project and decide what to modify. For the past few months, Denchai has been away performing his duty to study as a Buddhist monk. He will return shortly. Khun Lynchee, the leader of the mushroom project, is now performing the role of a Project Lighthouse facilitator, helping others learn about Constructionism and how to apply it to projects in the villages. More KMUTT students have joined the effort in this region. They are new to Project Lighthouse, however, and are just beginning to learn the technology and methodology. Some of the more experienced students, like Nan, have re-located to Lampang in order to help the large effort there. Khun Bangkok continues to make numerous trips to the region to monitor the situation and to help.

The existing projects are continuing and new projects are being undertaken. More people are becoming familiar with the approach and with computers. People believe that there is a good understanding of Constructionism, but that the level of fluency with the technology is still quite lower than desired. Helping to develop this fluency is the current focus. While the project in BuriRam has not achieved all that was hoped for or all that was possible, it has achieved enough, both in actual projects and in how people feel about

what they have learned, that people continue to choose to participate. My hope is that they will successfully address the water issue this year.

3.9 Emergent Design in Context

The latent expertise of the people in this part of rural Thailand emerged through the constructionist use of computational media. Working on projects chosen by the participants facilitated not only their interest and participation, but it also facilitated the mobilization of this experience and expertise. Focusing on the development of technological fluency enabled the participants to draw from this knowledge and experience to express themselves in the new projects. By using an Emergent Design approach within the overall project, at each site, and with each learner (design all the way down) enabled this to emerge. It could be reasonably asserted that the new approach of Emergent Design, practiced within a learner-centered, project-oriented, constructionist learning environment facilitated growth and development in ways that prior educational environments had not.