

## **Chapter 1 – Scenes from Thailand**

The context of this thesis is Project Lighthouse, a bold intervention to initiate radical change in the educational processes in Thailand. As its name suggests, Project Lighthouse is not a blueprint for education or education reform. Rather, it attempts to highlight actual possibilities for powerful learning environments in Thailand, particularly in settings where traditional education has not succeeded. A primary goal is to *break mindsets* about what education must be by providing concrete examples. The following is a sample of activities from Project Lighthouse over a seventeen-month period. The scenes provide a concrete basis for the discussion that follows.

### ***1.1 Scene: Bangkok, March 1997***

Seymour Papert and I are meeting with leaders of the Suksapattana Foundation. We are designing a proposed intervention intended to provoke a radical reform of the educational system in Thailand. The meeting came about because a group of industry leaders and government officials had come to believe that unless they achieved a total transformation of their educational system Thailand would not merely stagnate economically, but also that they would lose all the gains of the previous decade. More critically, they worried that there was a growing and more intractable divide between rich and poor that would destroy the fabric of Thai society. They further believed that in the absence of an educated, thoughtful, literate populace, it would be impossible to support their nascent democracy and prevent a return to autocratic, and corrupt, military rule.

The Thai leaders believed that the existing school was not a hospitable medium for developing alternative forms of learning. Moreover, they felt that to change it directly would cost too much and take too long. They believed the existing schools to be too rigid, too reliant on rote instruction, and staffed by too many barely educated themselves.

They had set bold and ambitious goals for their educational system. They had developed a new national education plan as an essential part of their national development plan. This education plan, combined with a special commission from the Office of the Prime Minister devoted to education reform (ONEC), specified the new goals. The goals were thoughtful and admirable. They included:

- becoming learner-centered
- developing critical-thinking ability
- fostering innovation and creativity
- developing collaborative spirit and skills
- learning how to learn
- providing familiarity, ability and comfort with working with technology
- developing “happy” learning, that is, a joy for learning

However, none of the plans specified how to achieve such a system. They did not discuss how to operate in this new paradigm or how to make the transformation. Thus, while the goals were lofty, the implementation of both the new system and the method of reforming the current one, were mired in the existing, undesirable paradigm.

The goal behind our endeavor, Project Lighthouse, was to break mindsets by creating technologically rich learning environments that would demonstrate the "out of the box" yet practical possibilities for children in Thailand.

However, it was not clear what to do. Moreover, there was little agreement on or acceptance of our proposal. Some believed that we should focus on gaining the acceptance of the national curriculum developers as the current system moved only through the curriculum. Others believed we from MIT should train the trainers who would then train the teachers who would then work with the students. Others felt we should place computer labs in more schools and train teachers to work there. Finally, there was near unanimous agreement that the existing teacher corps was incapable of working in a new, learner-centered, project-based, technologically rich environment. Virtually everyone told us that the teachers were barely educated themselves and might not be able to learn to use the technology let alone teach with it.

We proposed creating four pilot projects where we could quickly demonstrate significant results in some of the most critical areas of need<sup>1</sup>. These were:

- create an alternative environment within non-formal education
- create rural village learning centers
- teacher training
- projects with at-risk youth such as street children in urban areas and girls at risk for or exiting prostitution

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<sup>1</sup> The thesis will go into considerably more detail regarding the decisions and the rationale behind them. This section is merely to serve as an introduction.

Our idea was to go deeply into particular areas to show concrete examples of dramatic results through employing a different educational methodology and tools. This was as opposed to doing something broadly, but as would be inevitable in early experiments, shallowly. If, as hoped, the pilot projects succeeded, the idea was to further deepen the existing projects, add new ones for new target areas, and to take the best practices and ideas into other educational projects in Thailand. To achieve this, we proposed a new fellowship program to begin concurrently with Project Lighthouse. The Lighthouse Fellows would mentor and monitor the pilot projects, research the activities, publish and discuss the results, and help to bring them into broader practice.

There were two major objections to our proposal. First, commentators argued that our proposal did not fit the prototype five-year plan, which spells out all activities over that time period. How could people know what to do if we did not provide such a plan? People wondered if perhaps either we were not serious or did not know what we were doing. Second, people told us that the quality of the teacher corps was so low that they would be incapable of carrying out an ambitious endeavor such as ours.

However, we argued that it would be counter-productive, if not impossible, to develop any specific plan. It was not merely that we were not familiar enough with Thailand to know what would be the right things to do. More profoundly, what was needed was a philosophy of design based upon recognizing that nobody could know beforehand what would resonate, how people would appropriate new learning technologies and

methodologies, what learners would choose as projects, how villagers would react to the intervention, and so on.

At the meetings we tried to show that there is a fundamental contradiction between having learning environments that function through connecting to, building upon, developing, and deepening the interests of the learners, and planning everything centrally in a top-down manner where all activities are pre-determined for all learners and all locations. What is needed is a philosophy of design for educational innovation as different from traditional ideas of reform as the content of the new innovation would be from traditional educational content.

Our Thai hosts agreed to let us proceed. This thesis describes how some very general initial ideas developed concretely in practice. It explores the theoretical framework for such a philosophy of design in the context of ideas from the management of business and of research as well as ideas about education.

The phrase “Emergent Design” in the title of this thesis puts a spotlight on the need (which has not been recognized by education policymakers) to study the conceptual space where the purposeful stance implied by the word design mates with the openness implied by the word emergent. This mating underlies modern approaches to organizational practice. It also underlies modern approaches to organizational practice. My work in Thailand and the thesis itself bring together my own experience in these two areas.

The emphasis on *emergence* as the guiding principle does not imply that this is an anything goes environment reacting to the whims of the participant teachers and learners. We brought a very disciplined set of principles, methodologies, tools, activities, models, and exemplars for learning environments. However, to deliver a pre-set curriculum with pre-chosen problems, explanations, and sequence of events would be not only antithetical to the underlying learning philosophy but also it would be incapable of taking advantage of the very benefits that the technology affords.

Designing for this dialectical tension requires something vastly different than previous design methodologies. In this case one is designing where human use and appropriation is the critical element and is unpredictable. Thus, the design must enable a wide range of possibilities, must be able to adapt to the situation, must be appropriable, and must deal with dynamic change. This thesis will describe this project and begin to delineate such an emergent design methodology.

***1.2 Scene: Non-Formal Education Department, Education Ministry, Bangkok, March, 1997***

Seymour Papert and I are conducting a short, introductory workshop. The goal is to introduce the ideas about learning and the technologies we will employ in Project Lighthouse. The audience is composed of people from the education ministry, formal and non-formal education sites, university professors, and a few business people.

A high-level member of the education ministry is supposed to inaugurate the workshop. Unfortunately, he is late. People tell us he is arguing in front of parliament for the restoration of the education budget, which is being severely cut. We are unsure when to begin, as our hosts are reminding us of the importance of protocol, and, since he is the highest-ranking attendee, must be the first one to speak. This sets the workshop off on an uncertain footing.

After more than an hour delay, the deputy director arrives and convenes the proceedings. After some introductions, Seymour begins an introduction to the project, the idea of Constructionism, and then begins to demonstrate Logo. Not wanting to make everyone listen to a long lecture, we invite the participants to begin programming small projects based upon what they have seen and heard so far.

Everyone is hesitant. No one dives into a project. No one is even exploring the possibilities in the environment. Seymour and I go to as many people as we can to get them started, but since there are so many of them and so few of us, we can only manage to get a few started. People tell us they want explicit instructions and clear tasks to attempt.

Mercifully, we break for lunch after about an hour of lab time. Seymour remarks to me that this is perhaps the worst workshop he has ever done. I think that by now he might have done thousands of them, so that is a pretty strong statement. We wonder if what

people told us about the inappropriate fit between an open, learner-centered approach and Thai culture could be accurate and too difficult to overcome. We all go to lunch.

I decided to return to the lab early to think through what we might be able to do. When I arrive, one person is working on a computer, building a project. He is not a workshop participant. Rather, he is the driver for one of the staff from the Suksapattana Foundation.

He had been sitting to the side all morning, observing the workshop. By watching the demonstrations and going from computer to computer to look at what each person had put together, he took what he felt were the most engaging aspects of their projects and combined them into his own. This is even more amazing given that he did not understand English and thus could not have understood anything that had been said since the workshop was not translated. He created an animation with birds flying to trees filled with apples. Through a translator he asked me how he could program it so that the birds would go from apple to apple, eating them, so that the birds would grow and the apples would disappear. Although simple, this is fairly impressive for the first day.

The spirit that the driver demonstrated was what we were hoping to see from the other participants. He had an idea of something he wanted to express. He explored ways to do it. He took in what was possible and let his imagination carry him from there. We related the story and demonstrated his project when the others returned. This helped liberate the rest of them from their anxieties, clarify what we were expecting, and cleared the path for a very exciting and enjoyable workshop.

The driver went on to take an active teaching role within Project Lighthouse for some time. He now teaches at a private computer school, although he also devotes significant amounts of time to many other projects. In subsequent interviews he told me that as a child he spent a tremendous amount of time in a neighborhood motorcycle shop. He went because they had a racing bike and he hoped to ride it some day. While there, he would watch the repairs and listen to the interactions between customers and the owner of the shop. He eventually did get to ride the racing cycle, but, ironically, on the first try he had an accident and hurt his knee.

### ***1.3 Scene: outside Chiang Rai, northern Thailand, March, 1997***

On my first visit to Thailand my hosts took me to a Non-Formal Education (NFE) site in a Buddhist temple. I saw a computer class held at the NFE temple school. A child was being taught DOS commands. The logic behind such an introduction to computers, following the typical school curriculum grammar of sequential building blocks of knowledge, is that it provides the requisite basis for later, more difficult learning. However, the useful learning never comes! And in the meantime, the formalistic nature of the beginning work confuses and frustrates the novice.

His teacher assigned four commands for him to learn and practice. The first was *dir*, to get a listing of files in his directory. The second was *copy*, to copy a file from one location to another. The third was *format*, to format his A drive (fortunately it was not the C drive). I do not remember the fourth but it was made irrelevant by the re-formatting of his disk.

This confounding situation led the student to stop me with a plaintive "what was the problem here? It worked before but now it no longer works. I am following my teacher's instructions but this is not working properly." On the first iteration of practicing his commands by rote, everything was fine. Subsequently, however, none of the commands were giving the specified results. His directory was now empty. He could not copy his file. I explained to him that the result of using the `format` command is that it re-formats the entire disk, meaning it wipes what was on it clean and sets it for the computer's operating system. Thus, there were no more files in his directory to list or to copy. Despite several attempts at various ways of explaining it, including re-creating the example on the computer and showing how *dir*, *copy* and *format* work with a newly created set of files, I am not sure he understood my explanations. One reason for this is that my explanations meant that what his teacher had said, done, and assigned no longer made sense, which would be quite disorienting. Another possibility is that no matter what the explanations and examples, learning commands this way is too decontextualized to make sense. One is merely learning by rote what someone else says is important without any conception of why or how it might be used.

In any case, learning to use office automation software, even if valuable for the types of applications for which it is designed, does not embody the deep computational ideas, which, as this thesis will demonstrate, can become powerful tools for thinking about real-world situations. My central goal is to show how such ideas can be accessible without many years of preparation, including to villagers with only a rudimentary formal education. Simply being an end-user of office-automation or web-browsing tools does not

provide leverage for learning other domains of interest. Working with computationally powerful ideas from the outset by building projects allows learners to appropriate not only the deeper ideas, but also mundane (and often arcane) operating-system commands.<sup>2</sup>

The split between conventional "School thinking" and cultural learning was shown vividly in the contrast between the computer class at the temple and how the monks themselves teach flower gardening.<sup>3</sup> Beautiful flowers are grown and displayed at all the Buddhist temples in Thailand. They are impressive, colorful, and fragrant. After my visit and the experience with DOS teaching run amok, I inquired about how people learned to cultivate such gorgeous gardens. The monk explained that when initiate monks enter the temple, they work alongside more experienced ones and learn by demonstration, by asking questions, in the best sense of learning by doing. I mischievously asked whether any classroom instruction was involved. The monk looked at me askance, but politely answered no, they felt there was no need. I tried to explain that this was the approach we also preferred for learning computational ideas. That is, that new learners work on projects of their own, are in an environment with others working on similar, but perhaps more complex, projects, can observe and ask others, in essence are immersed in a culture of computing just as the monks are immersed in their culture.

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<sup>2</sup> While terms used such as "project-based" or "learner-centered" and concepts such as an emphasis on design appear in other writings on learning, the formulation within this work is distinguished from those others both by the method of practice and the development of a holistic approach outside of the grammar of school that enables a different practice. The differences are made evident in the descriptions of work in chapters one, three, and four, and discussed in the two concluding chapters.

<sup>3</sup> I am adopting the convention of capitalizing the word "School" when referring to School as an institution containing the prevailing mindset around organization, process, learning, and teaching.

The depth of resistance to these ideas was illustrated by the way the teacher who was translating my remarks into Thai misrepresented the explanation, creating an initial misunderstanding between the monk and me. After listening to my translator, the monk politely responded that they would never do what I suggested. Considering that I had just suggested that we create environments for learning computational ideas in the same manner that the monks learn gardening, I could not understand how he disagreed. So I inquired again about what was said. The teacher told me that she told the monk I had suggested that they teach gardening in a classroom just as we teach computers in a classroom. When I re-explained what I had really intended, the teacher could not believe I meant it. Rather than immediately re-translating, she passionately protested. Surely classrooms were the modern and most effective means of teaching. How could I, from a modern western university, suggest that the monk's method could be better? It took quite a while to get her to tell the monk what I thought. In retrospect, this was a powerful learning moment for my translator, although thoroughly and necessarily unplanned.

This example illustrates the mindset we hoped to change. A culture of doing, i.e., to have people learn not by typical classroom instruction but rather by performing activities in conjunction with others, was such an anathema to the teacher's way of thinking that she could not even translate my words properly (although she was extremely accurate otherwise). The incident is significant because it is not an isolated exception. Examples of successful learning environments that do not rely on classroom and formal instruction abound in Thailand. People are well aware of them. But the grammar of school has captured the mindset when people think about education.

The deeper goal of Project Lighthouse was to change this mindset by providing powerful examples of alternative learning environments. The reasons we could hope to be more effective in this than the presence of examples such as monk flower growing are twofold. First, we were also tackling typical school subjects such as math, science, and history. Second, we intended to make the discussion explicit by researching the projects, reflecting upon the results, and having a broad-based group of influential Thai citizens discuss, publicize, and try to disseminate the ideas. So far, the results of this strategy have been mixed, with some important aspects of progress in learning and learning environments wildly exceeding our expectations and other aspects, also critical, barely moving forward at all. I will discuss these issues in depth later in this work.

***1.4 Scene: Nong Baot village, BuriRam province, northeastern Thailand, January 1998***

I am conducting an introductory Logo immersion workshop to develop technological fluency. Unlike most projects trying to bring technology to remote or impoverished areas, our goal is to have the attendees quickly build projects and create programs.

There is a mix of participants; villagers, teachers, and a few local economic development workers from the NGO that is hosting us, the Population and Development Agency (PDA). I begin the workshop by showing what a computer is, how you turn one on and off, and how you operate one, as this is the first time that the villagers have ever personally seen one, except for viewing one on television.

In the evening we hold discussions with the villagers to get to know them and their situation. I ask why the villagers say they want us to place computers and internet connections in their village. They tell us that water is very scarce in this region. Worse, there is either too much of it during the two month rainy season or there is none of it during the rest of the year. In fact, one could describe the area as having two seasons each year, flood and drought.

They describe two problems they are having. They feel that the problems are related, but do not know how to determine if it is the case. The first problem is that they have a spoiled reservoir and do not know how the water became unusable.

The second problem was that the cattle developed a swelling around their hindquarters. They did not know what was causing this. They believed it was related to the spoiled water supply but did not know how to make the diagnosis.

When I asked whether they asked for help from local agencies, the village headman<sup>4</sup> told us they used to call in the government agricultural experts but they stopped doing so. When I asked why, he explained to me that they used to do so but gave up for two reasons. The first was that they found it frustrating and demeaning whenever they called in agency help because the people that came never went through the diagnostic thought process with them. Rather, they just told them their conclusion and solution, which was

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<sup>4</sup> That is the literal translation of the Thai word for the person holding this, now elected, office. The word though is traditional and reflects traditional views. It is possible, and is the case in some villages where we work, that the village "headman" is a woman. I maintain the literal translation as it is their term and in actuality carries the connotation and contradiction.

often to put some chemical in the soil. This led to the second problem. They worried that previous chemical treatments had contaminated their water causing the current reservoir and cattle problem.

Thus, they told me they wanted access to the internet so that they could find out for themselves what the problems were and what they could do about it. They wanted access to expert knowledge, but most importantly they wanted to be in control of what to do with the knowledge. Technology could provide them the access and the control.

As the week progresses, we develop a relationship. Everyone is building their own projects, first in Logo, then adding robotics with Lego-Logo. What at first was foreign and somewhat intimidating technology is now a source of fun and pride in product. A mixture of people collaborate on their projects, always working in groups, since we did not have enough machines for everyone. The villagers, in particular, work in multi-generational groups, from young children to the elders in their seventies and eighties. While the youngsters do more of the programming, all decisions are made jointly. They are doing programming and engineering, while working on projects of their own choosing.

### ***1.5 Scene: Nong Baot, August 1998***

When I returned in August, the situation was quite different. This time our discussion moved quickly to how to calculate the potential and the reality of building a dam. In each of the past two years the villagers tried 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 could be use for agriculture in the dry season. In each of the past two years the project failed, since the reservoir did not contain the water. Both the villagers and the rural teachers developed the project together. I took a supporting, mentoring role. I did not take a direct role in the project myself, believing that the only sustainable benefit would be for them to develop the package of skills themselves.

They had not previously calculated the potential benefit from the dam. When we engaged in brainstorming about this topic with them, together we calculated that the villagers would more than double their yearly income if they could harvest a second vegetable crop. We walked through the flood plain and took some digital photographs.

Then, a remarkable thing happened! Using the computer led naturally to mapping the terrain. To my surprise this was a totally new experience not merely for the villagers but also for the teachers. While the fact that the villagers could not do this might not be surprising, the teachers could not do so either. They had certainly taken school courses and passed school exams on this type of knowledge, yet in practice they could not make a map. Together, the teachers and villagers created accurate computer representations of the areas, preserving distances, maintaining relationships and ratios as they created various views at different scales, and calculated the relevant distances between important objects.

Immediately upon creating the maps, we discovered a 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.

As the design project continued, we observed how the efforts of one of the participants was exceptional. He told me that he had not had any success in school and left as soon as it was legal. He primarily helped his family with the farming. We had only introduced computers to the village within the current year. He spent this time working on programming – not by taking classes, but by programming his own projects.

What was so striking was that he had quickly become quite an adept software hacker.<sup>5</sup> Atypical of many of our experiences with more educated people, he, as well as others in other parts of Thailand, dived 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.

We discovered that he spent considerable time working with engines. By learning how to build and repair engines and by working on the farm with few resources, he developed a

*bricolage* spirit. That is, he would make what they need with what little he had. If something did not work, he fixed it. If he did not have the right tool or material, he improvised. He took this spirit and applied it to computational technology.

As this skill and experience became apparent, he and others took me to visit their farms. At the farms, everyone who could used a small Kubota diesel engine to power a wide variety of local technological contraptions. 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. 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 was quite impressive.

### ***1.6 Thai Combustion-Engine Culture***

Virtually all commentators on Thai education and on the Project Lighthouse proposal believed that the quality of rural teachers was extremely poor and that they would be unable to work successfully in the proposed technologically rich, learner-centered environment. These same commentators bemoan the problems and capabilities of the overwhelming majority of rural students as well. Lack of faith in the intelligence and capability among economically disadvantaged children is an unfortunately universal belief that is all too difficult to dislodge.

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<sup>5</sup> That is, in the positive sense of hacking.

Contrary to these perceptions that rural and impoverished students are not capable learners, rural teachers are not competent technologists, and that Thai culture is not amenable to innovation, collaboration, deep learning, and technical expertise, we discovered that there are deep intellectual roots and significant innovation practiced and learned over at least many decades, and presumably much longer. Indeed, although not written about in academic circles, there is a strong tradition of "peasant technology," particularly using and adapting the internal-combustion engine to satisfy local concerns and constraints.

Perhaps the best example of this innovation is the creation of the long-tailed boat. There are many areas throughout the country where waterways are the principal means of travel. Significantly, this is also the case on the rivers and canals of Bangkok. As people desired to transport more and heavier goods, human-powered boats became more problematic. In the north, one innovator decided to experiment with placing motors onto the boats. After several attempts with various types of inboard and outboard motors, he settled upon using an automobile engine with long drive-shaft so that the propeller was far from the boat. Typical outboard motors did not work well as they churned too much water into the long canoes that everyone used. The many reeds in the rivers also jammed the propellers too often, negating their benefit. The drive-shaft, the long-tail of the name, not only solved the churning problem, but also served as a rudder for steering and enabled the pilot to lift the shaft from the water to avoid entanglement with the reeds. The use of an auto engine leveraged existing knowledge about repairs and benefited from not

requiring parts not manufactured in Thailand and therefore difficult and expensive to obtain. People quickly adopted this technological innovation throughout the country [Phongsupasamit, 1989].

Tuk-tuks are another similarly inspired innovation. Small motorcycle engines are placed onto the pedicabs, again to alleviate human stress and increase speed. Other rural innovators have also adapted engines to create low-cost one-person mechanical plows, irrigation pumps (including one ingenious invention to pump over roadways, since the native soil had the tendency to crumble into irrigation tunnels), and devices to help operate wells in drought-stricken areas.



**Figure 1 -- Long-tail boat**

**Figure 2 - engine on long-tail boat**





**Figure 3 - Kubota-powered 1-person tractor**



**Figure 4--Engine for irrigation pump**



**Figure 5 - Kubota-powered farm vehicle**



**Figure 6 - Mechanic working on motorbike at repair shop**

For the most part, not only did these innovations not occur in universities, research labs, or corporate departments, these circles barely took notice of them. Rather, they were a grassroots effort, based in the interests, needs, and practices of Thai culture. People created and adapted new technologies to alleviate their burdens and to create new opportunities.

These innovations could not have achieved such widespread use if a culture of practice and knowledge had not also developed to spread and support them. In order to use engines widely, a group of people capable of maintaining them had to exist. This group did not do well in school and did not receive its training in school. Rather, almost exclusively they learned to diagnose and repair engines in informal learning cultures. Making this diagnosis and repair more difficult is the fact that among this social stratum in Thailand, there are not a lot of materials, parts, diagnostic equipment, or written manuals. These mechanics have to become *bricoleurs* [Levi-Strauss, 1966, Papert, 1980, Turkle and Papert, 1992], that is, they must adapt materials at hand to satisfy their goals, even if it is not the accepted way to accomplish the goal nor the proper materials for the task.

What makes this story compelling is that these mechanics, while respected for their mechanical abilities, were not regarded as academically capable. Conventional wisdom stated that this group may be good with their hands but they were not good with their heads. Moreover, the belief in the dichotomy that different people with different skills are required to be good with their heads remains.

However, in the context of Project Lighthouse, the capability of these motorcycle and engine mechanics was immediately evident. Not only did they learn the new computational technology quickly, they were also quite adept at adapting it and applying it to solve local problems. This was the case with designing dams, improving irrigation, and devising alternative methods of cultivation of rice and other crops in BuriRam.

Still, moving from one technology, engines, to another, computing devices, while impressive, would not necessarily be remarkable except that in order to accomplish the tasks with computational technology they had to competently handle some sophisticated mathematics, biology, engineering, physics, and computer science. What is remarkable then is that:

- they accomplished projects requiring competence in these recognized bodies of knowledge
- they accomplished this in extremely short timeframes
- they leveraged their mechanical expertise and "hacking" spirit to build a computational technological fluency
- they then utilized the technological fluency to gain competence in these bodies of knowledge previously inaccessible to them

Moreover, the dam design is but one example from one site. Other sites also had similar results. The point is not that everyone should design a dam, but rather that at each site the learners could work within the same methodology and same set of tools on projects of

interest and import to them. That each site developed uniquely is an important result of this work.

The significant accomplishment in this work is demonstrating a significant gain in accomplishment among a population that had not previously exhibited such competence in educational institutions. This work demonstrates how to build upon and enhance local knowledge. Within the design of this learning environment, the learners:

- work from local knowledge and interests
- bridge to other knowledge domains
- liberate their local knowledge from its specific situated embodiment

The role of the computer in this process is to draw on a set of skills so that they can transfer it onto something different. Through computational tools, learners design and construct and thereby make the forms of knowledge they have more general. Developing technological fluency enables them to break out of the specific context and represent their knowledge in forms they can draw on in many contexts.

### ***1.7 Thesis: The Design of Technologically-Rich Learning Environments and the Reform of Education***

Discovering the engineering expertise and hacking spirit among so many Thais who had previously not succeeded in school is a major benefit from the Emergent-Design approach utilized within this project. Not only had School not build upon this talent and intelligence, it did not even recognize it. The typical school reforms, despite their

intention to promote creativity, problem solving, technological capability, and so on, also are generally incapable of discovering and leveraging such local knowledge. This is due to their top-down, pre-planned, standardized, curricular approach.

There was no way to know beforehand for every site what will resonate and what local concerns and local knowledge exist. What one does know is that there always is something, and, if one uses Emergent Design combined with the principles of learning environments and open, programmable, technological tools, then this something can be built upon and leveraged.

This thesis will spell out concepts in Emergent Design as a methodology for broad institutional change and for learning environments. This work will also detail the accomplishments and the disappointments in Project Lighthouse. I will investigate what it was about their background, what it was about the activities within Project Lighthouse, and what it is about the nature of the technologies within the project that facilitated the results. This further understanding of technological fluency and new learning environments will help guide principles for the development of other technologies for use in these environments.

It bears noting that this is a work in progress. Project Lighthouse is still developing and we continue to study, reflect, and modify the activities and tools. We only have minimal resources in this project. Primarily, there is a lack of people who have had the opportunity to develop expertise in learning and technology. This more than anything limits the possibilities. In the stories below, in some ways the parts are greater than their

sum. The individual stories demonstrate the possibilities of what could be achieved. The thesis examines in detail how this evolved and how this could be further developed.

