23. Do Users Inhabit Or Build Their Boxer Environment?

Liddy Nevile

Sunrise Research Laboratory, Royal Melbourne Institute of Technology
Latrobe Street, Melbourne, Victoria 3000 Australia

Prologue. Frequently when using a computer, I ask myself, where am I? Sometimes I feel that I am sitting in my chair and reaching out to the computer to achieve some particular effect. Then I feel distant and distinct from the computer and that it is like a carpentry tool; I will use it but it will remain the same after my use. Other times, I find myself feeling more as a colleague described: "It feels like an extension of my arms when I am deeply engaged in writing." On such occasions I notice that I am not just using the computer, but somehow changing it, leaving within the environment something that makes it different the next time I use it.

23.1 Introduction

In this paper, the notion of changing the computer is explored with particular emphasis on the activity that might usefully be considered as either the building, or the inhabiting, of the Boxer environment. An initial distinction between building and inhabiting draws attention to the difference between discovering, adapting to features of an environment, and the process of taking the environment as material with which to create a new environment. In many cases, it is teachers or trainers who gain access to a computational environment of the latter type, and with it they form an environment of the former type. Boxer is not designed for such use, although it can be used this way: There is in many cases a transparent connection between Boxer's design priorities and the epistemological priorities of those who use it.

The sense of interaction with the design of Boxer, and hence the designers of Boxer, suggests the question: Does the design of Boxer seed or lead the user of Boxer? (Resnick, this volume). This is at one level a technical question but the psychological aspect of this question is also in focus. What does the Boxer user feel happening?

Boxer is the product of a decade of disciplined "cyclic design" (diSessa, this volume). Those who develop the Boxer system listen carefully to those who use Boxer and design decisions are made according to a set of criteria that include consistency, efficiency, user-intuition. Despite this, no two users are the same and so there are inevitable problems and shortcomings and mismatches in the released versions. Users find ways to interpret these, to circumvent them, to overcome them and so their Boxer, now containing the added material, is transformed. Users do this work from the primitive base of Boxer or by "borrowing"[1] boxes and techniques from others. This process, involving the mutual dependency of the local computer culture and the released version of Boxer supports a distributed design process and influences the quality of Boxer in the location and culture in which it is being used. Where a user group is able to make Boxer its own, to develop a comfortable relationship with it, the question is how? Do such users fit into the Boxer way of doing things; do they make Boxer fit their way of doing things, or is it more a mixture of both processes? Where the user group does not achieve comfort, and cannot make progress with Boxer, what is the difficulty? What approach might be suggested to help the group?

At Sunrise[2] in Australia there are a number of Boxer users who express warm and hopeful feelings about Boxer. What has happened to give them this impression and what they actually achieve with Boxer is the content of this paper. It is a ten-year chronological journey of hopes and disappointments, aspirations and meagre achievements. It is a journey that has left those closely involved optimistic, self-assured, and eager to give others the thrill of the experiences they seem to imagine they have had. All involved have struggled to express one aspect of Boxer in particular: What it is that attracts such commitment. What is it that makes these users so dedicated despite, at times, an apparent lack of productivity?

Several threads emerge and seem to echo the interests of others working in the same area. In particular, to what extent does it make sense to think of Boxer as having "inherent" qualities and what role is played by those that are "delineated" by the user (Noss, this volume); to what extent does it make sense to think of Boxer as a "sketch" of an environment that is built as the users make it their own? How does working in/with a computational environment like Boxer assist with the question of how a particular environment can *shape* the domain, *mediate*, *scaffold*, or even *artificially enhance* the activity?

23.1.1 Building Versus Inhabiting

The issue of building a new environment versus inhabiting a fixed one comes from work using such terms as exploration and discovery in the context of computer

[1]One does this usually just cutting and pasting but sometimes also modifying.

[2]Sunrise Research Laboratory at Royal Melbourne Institute of Technology

programs for education. It comes from the connection between these pedagogical issues and the epistemological ones related to such positions as those adopted by the "constructivists."

Early computer-based educational materials followed the epistemological models of their times and aimed to fill the learner's empty head with carefully sequenced, always correct, material that was accompanied by rewards and successes to encourage the learner. Later materials included what was considered important at the time; the opportunity for the learner to take an active part in the learning process. This meant that possibilities were built into the computer package so the learner could "discover" them. What was to be discovered was, of course, carefully treated and sequenced so that the learner would not lose confidence or be confused.

When in the 1980s, the Logo community at M.I.T. suggested that learners could work beneficially in constructed spaces doing things that had not been anticipated by their teachers, using tools their teachers may not know how to use, and working on problems to which their teachers could not know the answer, the educational world was divided. It was claimed by some in the M.I.T. community that such ideas were developed from Piaget's work, but they were often seen by others to contradict it. The popular interpretations of Piaget's work were used to re-form the possibilities offered by Logo. Instead of accepting that microworlds in the Logo environment could be constructed[3] so that learners would be likely to "fall over" challenges to their existing understandings of the world, and so run into opportunities to change them, and thus learn, many teachers using Logo felt they had to enhance "discovery" situations with worksheets, providing more direction for their students.

This conflict between the acceptance of interaction with an environment as the initiator of learning and the attention to the inclusion of "challenges" for discovery by the learner, has for me characterised much of the work done with Logo in the past fifteen years. So it might be with Boxer.

Recognising that Logo-using students do learn, many have tried to explain this simply by talking about constructivism (Nevile, 1993). What appears to attract many to the notion of constructivism seems to be their association of that word with the writing of a procedure in Logo (or making of a model in LEGO). Such people often connect those processes with the construction of buildings, the "concreteness" of the activity, as they describe it metaphorically. What is difficult to understand is why this concreteness is then assumed to be synonymous with tangible, physical objects.

If building in Boxer is to be limited to the writing of code or data, it is not what is envisaged in this paper. If building in Boxer is the making of a culture, understand-

[3] Indeed, unfortunately so far this is more a theory than a practical reality.

ings and beliefs, ways of thinking and feeling, it is much closer to what is envisaged. If building has to be from the base up, sequential, using primitives and simple building-blocks, it is not what is envisaged, but if it includes slowly making sense of complexity, it is much closer to what is envisaged. If construction includes deconstruction and re-construction, it makes more sense. A user or community of users building their Boxer world in this sense, uses the materials available to them that include the design features of Boxer. The released Boxer is an influence, but to what extent is it the determinant of what they will make of Boxer in their context?

But another way to think about users of Boxer is as immigrant inhabitants of a defined space. In this case, users are "diggers" who uncover what is already embedded within Boxer. Such users might produce results not anticipated by the designers of Boxer, but it could be argued that the possibility had to be there, that it was a design feature in as much as it was not prohibited. Perhaps such users are archaeologists in a contemporary setting: Gaining awareness of some aspect of Boxer they can classify, categorise and use so it becomes whatever they make it. The new object is the product of its appropriation and defined by that process, whatever was intended by the designer.

Alan Kay (1976) argued that good programming languages were those with which users could do things never anticipated by designers. If this argument is extended, good programming languages will leave users free to do as they choose. There is a certain attraction about this, but it is balanced by the demand for languages that make it easy for users to achieve their goals. Quantifying to what extent Boxer inhibits users, and to what extent it advances their goals, might be illuminating although it seems impossible. Users of Boxer (at least those in Sunrise) often cannot nominate their goals in simple terms. They do not write a program specification and implement it. Rather, they work on ideas and understandings in the medium of Boxer. Their fuzziness about their goals and achievements is more reminiscent of life achievements than programming acts.

Describing Boxer as somehow extending beyond the physical confines of the computer makes it possible to include the people and literature of Boxer. Increasingly, telecommunications extend the notion of co-user from those sitting together in front of a console, or linked contemporaneously, to those with whom the user can communicate easily. Often others' work is borrowed, giving a sense of their presence or support. Collaboratories are formed where remotely located participants share ideas and support.

"Neat examples" constitute an important form of support from within Boxer. Boxer help is not just explanations and examples; it includes objects for appropriation. Microsoft has added a set of predefined macros and small programs called "wizards" to their help programs. These wizards act as "over-the-shoulder helpers"; they guide the user through a series of difficult steps required to use the macros. Boxer "neat examples" perform a similar role by being available for direct cutting

and pasting into the relevant location. The Microsoft macros need integration into the main situation whereas this is achieved in Boxer by simple spatial location.

23.2 The Sunrise Boxer Journey

Following is a review of some of the Boxer work undertaken by the Sunrise community in the last few years. This work has been driven by the investigative quest for "what is possible given Boxer" rather than some desire to quantify or evaluate Boxer. The journey is presented with a commentary which relates the events and observations of those undertaking the journey to the ideas outlined above.

23.2.1 Beginnings

In 1984, Boxer was featured at a national conference on computers in education in Australia. For some in the audience this was the unveiling of a bit of magic.[4] For one little boy, Boxer was obviously right. He responded to the demonstration by suggesting that the high standard set should be maintained by the provision of a screen which would be horizontal in use, like serious work materials.

Hal Abelson talked about Boxer, but it could not be shown operating. The computer suppliers at the time predicted that it would be a decade before it could be shown in Australia. By 1986 however, Boxer was only "almost impossible" to use; Mike Gigante had developed a version for Sunrise that sometimes could be activated on a Silicon Graphics Computer, and we enthusiastically gathered around the screen for odd occasions when it worked. Three students (two fourteen year olds and an undergraduate), "worked" weekly on Boxer, then mostly an exercise in reading error messages in Unix or Lisp.

This early work on Boxer in Australia depended on the technical endeavours of Gigante. His creative understanding of the computer that was used, as well as expertise in Unix, Lisp and Boxer, were essential. Gigante even conducted Boxer workshops. This work was costly and dependent upon sponsorship[5] by parties who could not be promised any material gain for their support. Nevertheless it thrived.

"Doing Boxer" was a popular activity among the dedicated few, but it was not well-defined. There were long-haul plane trips made with the expectation that something could be demonstrated at the destination, but often these were futile. If Boxer worked, it was more as a result of hand-waving than key-pressing. One State Edu-

[4] Many people, seeing Boxer again for the first time a decade later, refer back to that presentation.

[5] Support was generously given by the Telematics Course Development Trust Fund, The ANZ Banking Group, the Victorian Education Foundation, and others.

cation department official even wrote plans that foreshadowed the day when all students would have Boxer in their notebook computers. The distinction between Boxer and virtual Boxer became blurred for a robust but small band of devotees.

23.2.2 Virtual Boxer

Margaret Carnegie is well-known in Australia for her bold support of promising young artists. She has an uncanny ability to detect talent and Australia has benefited enormously from her contributions to its artistic achievements. In 1986, Carnegie, then in her late seventies, heard about Boxer and was convinced it represented a revolution in computing potential.[6] To convince others, she commissioned a young teacher, Basil Eliadis (1987), to create a report of a putative student project undertaken in Boxer.

The project showed how native languages might be associated with kinship structures and particularly how Australia's aboriginal languages were similar in this respect to those of North America. Carnegie chose (virtual) Boxer because of the possibility of expression and execution in one medium. She had several linguistic models to be developed and compared; explanations, conjectures and so on to be written.

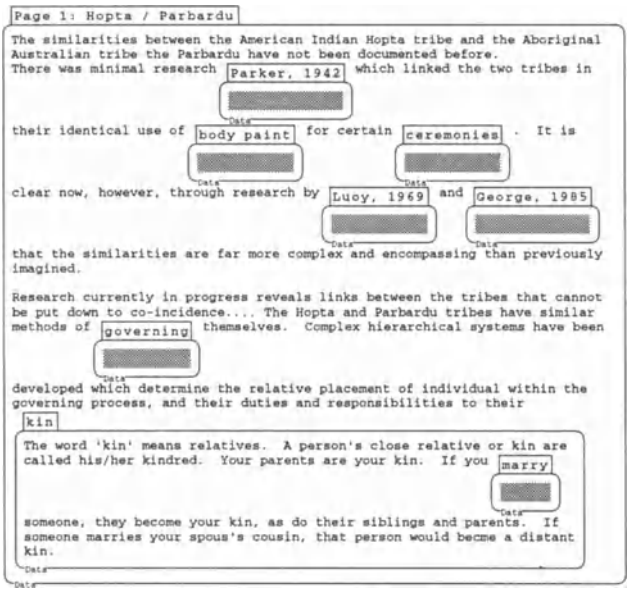

Figure 1. One of Eliadis' illustrations in his prototype student assignment.

[6] In the same conversation she was inspired to learn, in her late seventies, how to use a word-processor and to conduct courses in it for fellow authors.

But a school-type thought-experiment would not convince everyone to use Boxer. What might those in the real world do with Boxer?

In 1987, six prominent senior executives from large multinational companies were invited to lunch and a demonstration of Boxer. They were shown its features but asked to refrain from expressing at that stage, how they might use Boxer. There were questions and discussion about the capacity of and facilities in Boxer and then time for cogitation. Two weeks later the participants returned with their dreams and presented them to the group.

The business men's dreams contained systems that they wanted but currently could not get. One had dreamed of an Executive Information System for managing and planning merges of multinational vertically-integrated companies; another, of an arbitrage system for multiple currencies on multiple markets. The business men agreed that they already had access to an enormous amount of information and computer power but not to an environment in which they could do their work, analyse and synthesise what was presented to them by others with whom they worked.

And so the first comment.

The exercise with the business men and others demonstrated the power of a virtual language. In the early days of Boxer, the ideas of Boxer influenced the way Logo was used, and then how education was understood, and in the end even how professional development might be undertaken successfully (the Sunrise model). This interaction between using *and* thinking with *seems to be a persistent theme in the examples described below.*

Typical of the questions that seemed important in those early days were: How will Boxer be used in the 'real' world? and Will Boxer be suitable for working in music in the same way as it is for physics? At the time, these were seen as profound, ontological questions that would have to be tested and that would test enthusiasts' impartiality and discretion. Somehow such questions have become obsolete in the face of the variety of topics that have since been investigated in Boxer. This suggests that Boxer is built by its users as much as by its original designers, satisfying the Alan Kay test.

23.2.3 Cultural Symbiosis

In 1987, a Sunrise Centre was set up at Methodist Ladies' College (MLC[7]) in Melbourne. In this year a section of the school began to work in a fresh way with computers, by *expecting* that all girls should become competent programmers

[7] It is a private school for 2000 girls.

(initially using LogoWriter), and also that they would each have their own computer. In 1988 the programme was extended and a substantial number of girls[8] had notebook computers with them at all times. Some of these girls showed more than usual interest in programming, and it was decided to offer them a medium that would do more than Logo. They were to work on Boxer in a small room alongside the main classroom. A few boxes were created for them that would hopefully introduce the Boxer possibilities. The girls were asked to *explore* these boxes with the help of several adult, novice Boxer users.

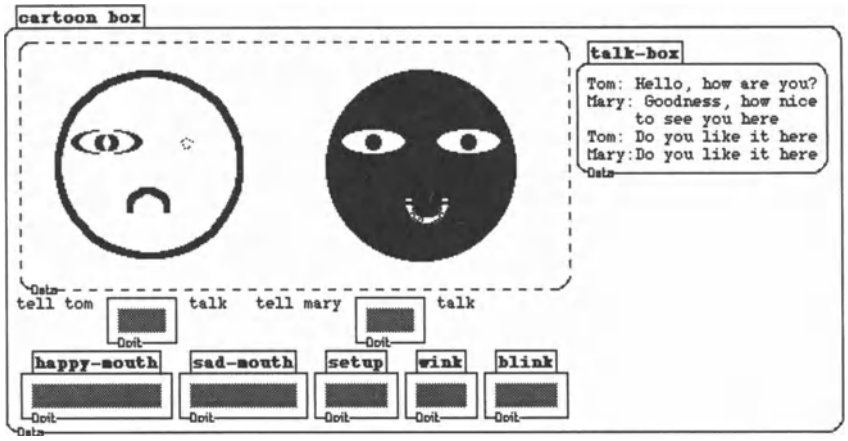

Figure 2. A view of the 'cartoon box' which students were offered as a base for their explorations.

The starter boxes were in one sense successful. They offered fast access to some of the power of Boxer, and the students were quick to appropriate the Boxer turtles (sprites), increase their "intelligence," and to enhance the boxes with interactive text and animation. They adapted the boxes to topics which interested them. But the students' skills and competencies were operating in isolation. They did not have value back in the classroom where others had no experience with Boxer, and their Boxer skills had been developed while the rest of the community was doing something else. As the girls explained later, they had been taught to work with their colleagues in the classroom using notebook computers, so how could they be expected to want to do something else, much less something in isolation from their social world?

[8]There were perhaps 150 in all.

One student however, did remain interested. She appropriated the box offered and happily developed it her way. This student was atypical though; despite the gregarious context, she was confident and comfortable in the sole pursuit of intellectual interests.

A comment.

Exploratory learning does not happen just because there is something to explore. Milbrey McLaughlin (1993) has reported that without both support from above and peer support, teachers cannot change the way they work. I believe the same is true for students and in the MLC case, the classroom teacher was not involved in the use or promotion of Boxer to the students. It was therefore not surprising they did not believe that their Boxer work was a substitute for what was happening in the classroom. The girls felt they had to do the normal classroom work as well, in their own time, so the classroom culture was effectively working against the Boxer culture.

Computer-based explorations can work very well. We had naively expected to be able to manage novice researchers and students exploring together. This was an exotic activity at the time at MLC, and for the researchers involved. In the event, the dominant culture was of notebook computing (not of exploratory learning) and the Boxer students expressed their concern about what they saw as the denial of attendance at regular lessons. We were reminded that exploration is better as just one mode of interaction, not the mode, and that it depends upon the culture in which it is being undertaken, not just the tools being used.

We were disappointed. We had expected to be more successful, but the cultural aspects had been given too little emphasis. Too little attention had been paid to what had made it successful on occasions in the past. One possible explanation for our past success with similar activities was the nature of the feedback the exploring students received. When using Logo in a Logo-rich community, unexpected effects were often interpreted succinctly and constructively for the students so they could gain from having made them. There was too little understanding of Boxer in the group involved for useful interpretations to be made of problems that arose, and there was a pervasive sense of fear when Boxer crashed, as it still did often.

Nor was there a shared sense of the value of exploration. Instead of recognising that exploring a domain with students often provides an opportunity to demonstrate doing what are the basic activities of the domain, such as making deductions after rigorously pursuing tests,

the young researchers were unsure and hesitant. They felt that some teaching was needed, but they were not sure what to teach.

Teachers who attempt to work on exploratory learning within computational environments often have to struggle with traditional professional standards. To many, such teachers are not behaving as teachers should, and it is not obvious what the students are learning. It is not easy to develop an educational culture in which learning is considered to take place over a considerable period of time while teaching is done in discrete time, sometimes partly elsewhere by a computer system designer and partly on the spot by a teacher who maintains a supportive learning atmosphere within a classroom. (Although such a teaching culture did not exist at MLC at the time, it has been carefully developed there in recent years to exploit the learning possibilities associated with Logo.)

23.2.4 A 'Sheltered' Workshop for Students

In 1992, Zhong and three local school friends came to Sunrise to work on Boxer as apprentice researchers (see Williams and Nevile, 1993). As fifteen year olds, they were participating for two weeks in a work-experience programme. The work environment they joined was conducive to questioning, asking for help, collaborative exploration, and they joined it as Boxer explorers.

When Zhong came in for his second full day, he was anxious to get to work. He had with him a piece of paper on which there were roughly drawn Boxer-type boxes. He explained that it was a mathematics problem solving task he had been given at school during the week. He went straight to the computer.

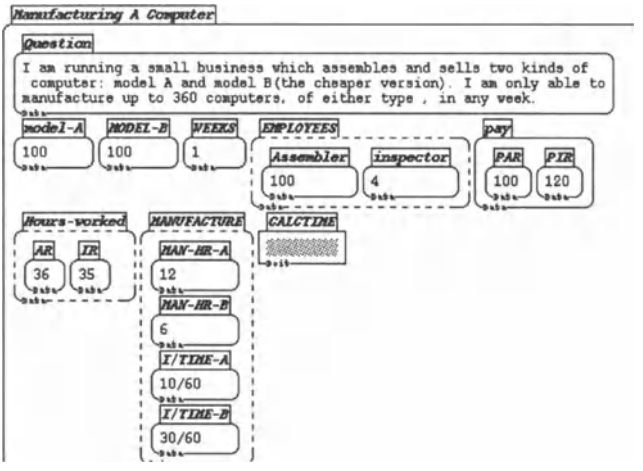

Figure 3. The boxes that Zhong 'poured' into the computer in response to his school task.

As he wrote later: "My maths project (at school) was about manufacturing and selling two types of computers....I created some data boxes which store the data about the problem. Then I created doit boxes to calculate the data I put in the data boxes. So I can see data and results very clearly."

In Sunrise we talk about *looking at* and *looking through*. On his first day with us, Zhong had *looked at* a new computational environment called Boxer and later he had *looked through* it at his mathematical problem. He seemed to be using features of Boxer in his everyday world. He came in not with an answer so much as an image of how to get one, a Boxer image: as if he could see a screen full of solution-making boxes. He was working on understanding the problem, clarifying the details, confident that an answer would become apparent, or emerge, rather than focussing, as so many school problems teach students to do, on merely identifying the "right" answer. Zhong did not seem to doubt the capacity of Boxer to do the calculation, so he focussed on what information went where. He had sketched the process on paper and was elaborating it in Boxer. Later he could examine, interrogate, edit or use it as a descriptive explanation (an assessment requirement). Zhong had done this work in Boxer for fun.

A comment.

A natural language is usually the vehicle for cultural expression which simultaneously shapes the culture. Computer languages are more often useful only for presentation of ideas or mechanical manipulation of data, textual or symbolic. Zhong's use of Boxer seemed to be as the medium for engaging with his problem, not just presenting the solution or even (narrowly but) efficiently solving the problem. Elaborating a problem completely, so completely that the answer becomes obvious, is not a common experience for students. They are more often found to be struggling to decide which solution can be matched with a given problem. Zhong's actions prompted such descriptions as 'Boxer literate;' he displayed a natural reading of the problem through the frame of Boxer that made the solving explicit.

As they worked, Zhong and his friends helped themselves to boxes that suited their purposes. They did not need to know how the boxes did what they did,[9] just if they were useful, in which case they 'stole' them. Later, they would reuse boxes they had developed or adapted earlier.

[9]Boxes produced in one context, or for one purpose, can be easily adapted to more general or different purposes. The scoping of Boxer is specially designed to make this intuitive use of modularity available to naive users, but without losing the possibility that more expert users might wish to decide how to scope their boxes.

The Boxer culture encourages sharing of its literature and this in turn encourages multi-disciplinary use of Boxer tools, boxes. This process shifts attention to the notion of tools as objects that are examinable, editable, extractable, like soft software that can serve simultaneously as tools and design prototypes (see Roschelle, this volume). Zhong and his friends were inhabiting the Boxer environment, moving freely about in other people's workspaces and exploring what they found, hunting and gathering. They also built their own spaces. They had items they liked and reused, and discrete subspaces. They structured their space as they thought appropriate. Sometimes when they needed new boxes, they made them step-by-step, ignoring the sophisticated models around them.

23.2.5 Computer-assisted Problem-solving

After two full days of working in the Boxer environment playing with other Boxer worlds[10] and working on small programming exercises, Zhong and his friends were set a major task. The problem was one from a set in a public test for older students who had two weeks to work on it. Many of these older students had ' en advised by their teachers to choose another, simpler problem (VCAB, 1990).

> One Sunday evening, five people with infectious influenza arrive in a large city with a population of about two million. They go to different locations in the city and thus the disease begins to spread throughout the population. Epidemiologists are trying to model the spread of the influenza....
>
> Finally, they assume that each infective person infects a fixed fraction f of the number of susceptibles, so that the number of infectives at week n + 1 is
>
> $i_{n+1} = f \times s_n \times i_n (1 \times 10^{-6} < f < 2 \times 10^{-6})$ where
> i = number of infectives, s = number of susceptibles and n = week number
>
> The disease runs its course in an infected person over two weeks during which the infected person is themself infective only in the second week. What limiting values does the model predict for the number of infectives? How are they related to f and the population size?

The guidelines for the Victorian Certificate of Education Mathematics Challenging Problem state that students "should include a clear statement in your own words of what the problem is about, what assumptions you had to make and how you interpreted what you had to do. It should also state what could constitute a solution to the problem." (VCAB, 1990)

---

[10]The activities that take place in a Boxer environment require new words to describe them. Because data and program boxes exist in the one environment the production or work of a person can not be described as a 'program' or 'text' or 'graphic' as is more usual in specific applications or programming environments. People working in Boxer tend to talk about producing 'boxes' or 'worlds.'

Natalie began by writing out the problem in her own words. She worked away from the others at this stage.

Sam and Raymond started by making boxes on the screen. At first they made no distinction between people who were *infected* and those who were *infective.* But when they noticed the need to think differently about the two groups, they included another category of *carriers.* The data-boxes (variables) contained values the students used. On many occasions they thought about the problem by pointing to variables on the screen, touching them as they talked about what was happening. They arranged their boxes into groups: a row of starting variables, a row of on-going tallies of *infectives*, *carriers* and *normal* people and then a row of doit-boxes that changed the values of the variables as the process progressed. At this stage they were clearly building a model of the information given. The spatial arrangement on the screen reflected important distinctions for them.

A comment.

Sam and Raymond were building a solution structure: It could be run with different values to see how well it worked; it was in itself a formal statement of the solution process. They used imperative expression. Their solution was actionable; it led to a solution set rather than to a representative solution. They were working on a functional representation of the problem, not just a numerical result. They seemed to assume that if they got the boxes right, they would inevitably get a solution.

In fact, they encountered a major problem. They tried a different rate of infection and their model was "blown": The number of people was increasing. They were very surprised. They asked a Boxer expert who was working nearby to help them, but then ignored his advice, perhaps because they did not understand it at the time. The boys continued working for a while and then tried the advice they had been given. They added some boxes that would make for better presentation of their solution, such as a graphing box and a history box, both appropriated from elsewhere, and wrote about their project in a journal box. Within one-and-a-half hours, their work was complete. (They had concurrently made a video recording of their activity that they later annotated.)

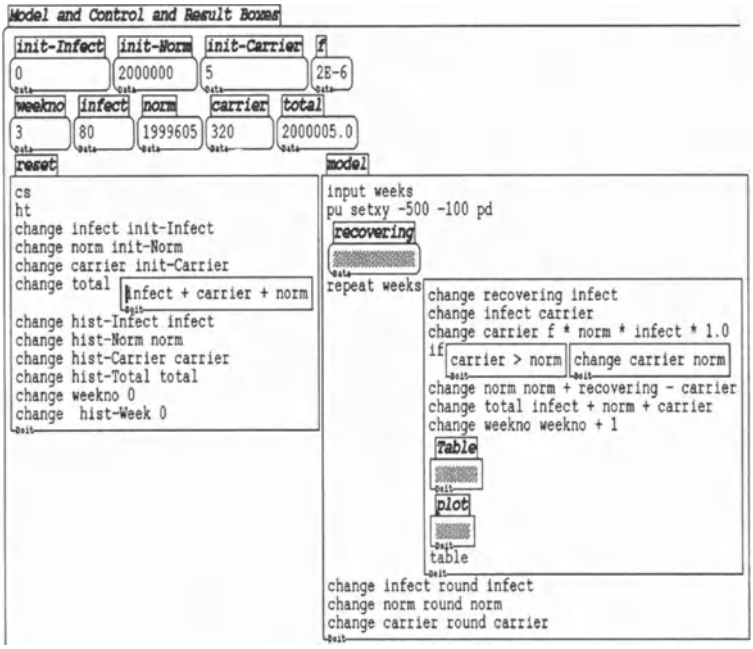

Figure 4. Part of the Influenza world that students developed.

A comment

Gaining access to generalisation of a particular problem is not usually available to students until they have attained a fairly high level of understanding and competency with a particular domain. Using Boxer, the students were moving between the particular case and the generalisation of that case, and it was in this movement that they were to discover inconsistencies in their solution. The students saw Boxer produce radically different behaviour for different parameters which made it easier for them to identify the variability in the general case.

This possibility depends on the consistency of Boxer: What the students were getting as feedback was not an error message but a consequence of their misunderstanding that was manifested as commanded, without fanfare. Until the students were ready to make sense of the increasing population, they did not have a problem with it; all they saw was output that could be read as contradictory. When they later tried to repair the gap in their reasoning, they edited what they

had as a solution process until they could no longer see problems with it. Later still, when they tested the solution more extensively, new problems became obvious and they had to do more work. The form of feedback seems to have been critical in this cycle.

23.2.6 Collaborating With Boxer

Not only is the expression of ideas in Boxer possible in a very wide range of forms, and the Boxer screen a good mediator of conversation between collaborating users, but Boxer seems to participate in the process of developing those ideas. Students using Boxer (in the cases reported above and others) talk about what Boxer is doing and how *it* makes it easy, and also how "almost anything could be done with Boxer." Such rash statements can only indicate how users feel about working with Boxer, but when considered in association with the kind of observations we have described, we are inclined to think that users often feel they are *collaborating* with Boxer.[11]

We distinguish between a sense of being able to anticipate another's behaviour, actions, ideas, and actually finding in ourselves something which we suspect (or at least feel) might not have been there but for the presence of the other. It has been noted that after working with Boxer, users sometimes act as if they are *using* Boxer even though it is no longer there. It can become, as some tools do, truly internalised. Further, some users familiar with Boxer commence tasks by apportioning some of the task to the in-built design features of the Boxer. One example is provided by the use of empty boxes as placeholders for boxes to be somehow produced later. This action is both seductive and productive: productive in that it encourages the user to work in ways that suit the tools available, but seductive in that it often leads the user to attempt activities that ultimately prove too ambitious. Either way, we believe the user could be said to be working *in collaboration with* Boxer.

Collaborative activity is a mode of interaction with others. It requires a significant giving and taking, reliance one upon the other, joint production by all involved not just belief that the other can produce, as might be the case with cooperation. It is more closely related to inhabiting an environment than building one. A collaborative computational environment contributes to the user's activity not just by performing functions for the user (as would an environment that was built), but also by providing a familiar and appropriate context which otherwise might not have been available for the user's activity. The successful inhabiting of the Boxer environment supports the building of a particular problem solution using Boxer.

[11]This phenomenon is not unique to Boxer. Using a word processor, one can *collaborate* with the computer's facility for restructuring the text, correcting the spelling, and so on.

23.2.7 Handling Data in Boxer

In another situation, some students were building a database. They were using a template box that they had adapted to their purposes and were busy organising their data when they suddenly noticed they were also form-filling. This shift in focus led them to question the nature of the form they had created, and only then did they seem to become aware of its complexity and that it determined how the data was to be used. The grouping together of the particular set of descriptors in the record template formed the basis for their later interrogation of it. This *programming* had occurred naturally, simply as a result of organising the data on the screen, making particular spatial connections between them, putting this before that. At the time, the students did not appear to think of themselves as programming and so it might be said they were not programming then, even though their actions produced what was later used as a significant part of their data-handling program. This early work determined how they later accessed their data.

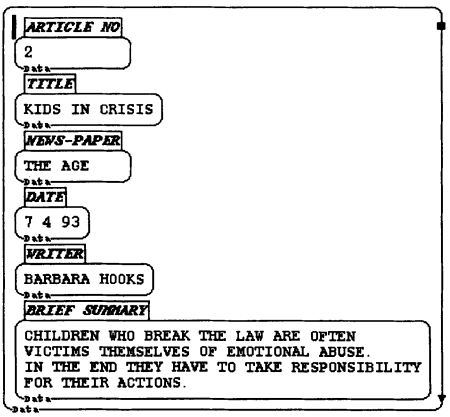

Figure 5. Students' data-record which was simultaneously their program for handling the data.

A comment.

Unless programming was a normal/natural part of expressing ideas, could this have happened? The students were not explicitly programming when they made their programs, but it appears the medium was one in which programming was a natural consequence, or activity, and so it was something that the medium contributed to the students' endeavours. Spatial arrangement and naming of boxes on the screen, de facto, creates usable computational structure. Again, we claim the students were collaborating with the medium, this time in doing the programming.

It is this kind of activity that supports the notion of a new form of literacy, a form of literacy that is intimately and intrinsically connected to the activity of programming. The students were attending to organising the data, by doing what felt to them like setting it out neatly, and indirectly producing programs. It might be said that the programs are a side-effect of the activity being undertaken in/with Boxer.

23.2.8 Prototyping

Peter Nunn, a qualified and experienced librarian, used Boxer as a library catalogue prototyping environment as part of his work for an information systems masters degree. At the time, Boxer was not robust, on-line help was not available, and he did not get much instruction in Boxer programming as he did not want to learn to program. But Nunn read a lot about Boxer and spent many hours with those using it, listening to what they said and watching what they did. He made some interesting comments, as if he was a regular user: "Areas of particular interest in Boxer are: the ability to store graphics; the ability to provide hypertext links; the ease with which the database/interface can be reconstructed; and the use of a 'comments' field that the library user can add to." (Nunn, 1992, p. 61)

Nunn, like a number of others, had visited Sunrise planning to use Boxer to build a particular system and its interface. Independently, he and the others found that what they were building *was* the interface. Nunn had chosen Boxer to get away from the very technical library systems that he thought were alienating to naive users. He was impressed by the power of Boxer but soon found he had problems with its openness. He worried that a library system would need some parts accessible (read/write) and some secure. He did not like what he described as the minimalist symptoms of Boxer design and considered that it might have been more friendly to have something such as icons to click on. "The 'clean screen' approach of Boxer does not assist the novice user." (Nunn, 1992, p. 74)

He seemed to find himself within Boxer, as an inhabitant might, and was concerned about the nature of the environment.

> Boxer's hypertext features combined with an in-built hierarchical nature give Boxer elements of chaos and order at the same time. Boxer [is like] a teenager's bedroom...when used as a personal information tool the screen can appear untidy and unstructured, like junk strewn all over the floor. On the other hand boxes can be used to sort thoughts and objects neatly, so that all the socks go in one box and all jumpers in another. Boxer allows information to be hidden or put on display and arranged either arbitrarily or in a highly-structured way depending on the application. (Nunn, 1992, p. 77)

23.2.9 Framing an Exploration

Kok Heng Chan was a computer science graduate and business information systems masters student when he started to use Boxer.

> Boxer provides tools for users to combine the elements of their choice to build their own computational environments or microworlds....This ability to group and build marks Boxer out as a *constructible* medium....Boxer is a programming language in its own right. But programming is not the ultimate goal. It is a consequence of the broader aim of providing a general purpose computational tool or medium. (Chan, 1992, p. 6-14)

Chan used Boxer as a medium for his exploration of object-oriented programming, what he called OOPs, the object-oriented paradigm. He concluded by saying that if Boxer had a few more OO attributes it would provide an excellent "medium for learning software construction" that could be "extended for training and educating professionals for software construction."

> *A comment*
>
> *As Chan tried to move into the Boxer environment, he used his knowledge of another world, the OOPs world, to make sense of Boxer. In doing this, he came to make distinctions and connections between other worlds and Boxer that helped him come to know the characteristics of both better. For him, Boxer was more of a space to be explored in the light of other experiences than a world to be built for some particular purpose.*

23.2.10 Building a Knowledge Space

Cielito Baria, a political science graduate, studied methodologies for developing business information systems as part of her master's course. In a case study of herself developing a personal knowledge space in Boxer, she described her coming to inhabit Boxer as one might the process of working up a new garden.

> The representation of this knowledge space exploits the possibilities of a computer screen as an expressive medium—an interactive work place with structured text, built in simulations and databases in a way that anyone can construct things which are usable in ways to suit their personal needs. More importantly, others would be able to reconstruct their own personal versions by being given access to the design of the work space....[My work] demonstrates the idea of a 'Boxer design approach,' a method of designing in a new computational environment. This approach illustrates the power of designing systems using a flexible system with programming capabilities. Boxer was found to have features that are necessarily useful and helpful to developers in system design. Most important is the use of spatial and naive realism in Boxer considered helpful in the design of any system because users can build their own worlds with visibility of the world as a major

> consideration...."systems design is more of an art than a science and those who do not practice the art naturally can either adapt specified techniques to help them," or as suggested in this thesis, try using different tools in a different type of computing environment....
>
> The implications of not having started with a comprehensive plan can be disastrous for developing large IS projects. But in the case of using the 'Boxer design approach,' a developer can work in a different kind of design environment because Boxer draws heavily upon the flexibility of the programming environment. This flexibility enables changes to be accommodated by the system as they occur....(Baria, 1993)

Baria concluded that many complex methodologies are developed to cope with inadequate programming languages. Her recommendation to others was to abandon programming environments that necessitate using cumbersome methods. The distribution of MIS design to harness the involvement of the user, possibly with something like Boxer, would overcome many of the problems associated with lack of sufficient communication between the client and the MIS designer that underlie most of the design difficulties in MIS. Baria's description of her interactions with Boxer lead one to think of ecologies, of Boxer as an environment where the user's needs and demands are shaped by the environment as much as they shape it. For Baria, building and inhabiting Boxer seemed to be symbiotic processes.

23.2.11 Teaching Others to Use Boxer

Charles Nevile worked with Nunn, Chan and Baria on their projects and more recently, with school students. He often talks about Boxer drawing on his Logo experience and warns against making the same mistakes, as teachers of Boxer, that many made as teachers of Logo. He considers that understanding computer science is an important part of gaining facility in Boxer but adds that this understanding can be developed by using Boxer critically. The high level of programming available in Boxer tends to have naive users attempting what, in other contexts, might be very complex programming. The code required is not always complicated in Boxer but being able to talk and think about what is required can be. This makes the difference between a simple and a complex solution to the problem in many cases.

> *A comment.*
>
> *Charles Nevile draws attention to the value of a sympathetic cultural background for one trying to work in Boxer. Initially, inhabiting Boxer is easier for those with some sense of Logo or Lisp, or computer science, but building within Boxer does not directly benefit from a knowledge of these languages, though the way of thinking about what is to be built often does.*

23.2.12 Learner Control of the Environment

Joy Nunn stated her reason for working with Boxer:

> I wanted to use Boxer to model an ecosystem. To see if I could represent my understanding of a food web using Boxer and in the process learn about my existing understandings....I also wanted to have a model that could be changed to represent any ecosystem that students had data about. This data could be secondhand or collected as a result of field work....The other challenge was to have a model that could be manipulated in any way by the user without any restriction built-in by the programming of the model. (Nunn, 1993, p. 1)

She had used other software with students but often felt it controlled the students too much, so she wanted to see if "Boxer could provide the environment of *learner control* and *learner power*" (p. 2). She was looking for an environment that at least would support, if not promote, a pedagogical culture she liked. She wrote of her collaborative work with a Boxer expert, who was not a biology expert:

> The model we produced was more than what either of us would have achieved if we were working on our own. Boxer allowed us to try out our ideas in trial and error approach. We could construct our model in parts and then progressively put the parts together. We were made constantly aware that the combined parts gave results in excess of the combination of individual parts. This led us off into a discussion of Chaos Theory.... (p. 5)
>
> *Comment.*
>
> *In this case, Nunn draws attention to the role played by Boxer in the learner's development of awareness of her own, and her partner's, knowledge and interests in the domain under investigation. Boxer's mediation of the conversation between the two users gave them access to what Nunn was seeking as learning opportunities which were broader than might otherwise have been initiated by interaction with a computer, or another student without a computer.*

23.3 What Can We Learn From All This?

The concerns being attended to by Sunrise users of Boxer have ranged incredibly: the relationship between kinship structures and native languages; the relative relationship of two turtles travelling one on top of the other; the design of business information systems for commercial use; the design of personal knowledge spaces; the investigation of the spread of disease among a community infested with influenza; the development of a management system for stamp dealers and one for a school library; the design of an appropriate interface for general library users wishing to access specialised library catalogues; the idea of object oriented programming and its utility in the design of business information systems; music....

Boxer demands a mind shift from traditional thinking about computing to a new way of understanding literacy. Generalisation, for instance, is not just a declaration or form of speech but can be imperative, a spatial location; tools for computation are not necessarily content-free and can be both content and operations on content; such issues as the distinction between content-free application packages and subject-specific software are not just blurred by "integration" in Boxer but become structurally inappropriate. Boxer alerts us to the possibility of a constant interplay—where moves toward generalisation or specialisation easily follow needs, involving construction via deconstruction; doing and undoing; localising and globalising; modularising and integrating; exploring and exposing; expropriating and expanding.

There is, it seems, a sense in which one both inhabits and builds Boxer. At first the screen is bare, or covered by incomprehensible boxes; the landscape is blurred and uninviting. It is like an Arctic snow-scape. In time, the richness of Boxer becomes apparent, the snowflakes characterisable. Like Inuits with their expressive richness for describing the snow, their facility for construction with it, Boxer users seem to find a richness within Boxer that is not obviously waiting to be exposed. Only by interaction with the environment, by cultural adaptation symbiotically with it, by building personally meaningful structures within Boxer, do they come to know its capacity to which they in turn have contributed. And to the extent to which users seem to contribute to the form of what they have as Boxer on their computers, Boxer seems to contribute to their form as users and thinkers.

Boxer does not come easily, and it is not likely to leap into popular culture. For those who have persevered with it during its development, Boxer appears to have something very special which endears it to them, despite the many inadequacies they will admit they have encountered in their experiences. Boxer seems to be something we love in a deep way: Boxer users know that the many bells and whistles they like and depend upon in other computer packages may never be in Boxer, but somehow they don't mind. We value Boxer for what it offers (in actuality and virtually), not what it lacks. Perhaps Boxer is like the beloved country cottage which offers a unique opportunity to come into contact with so many precious things that are too often overlooked in the presence of glitter and haste.

It is hard to imagine abandoning Boxer for a better package. For a start, it is not just a package and secondly, it has too much of each devotee invested in it for this to be imaginable. It is like wisdom: It is what the user makes it, but in this process it somehow makes the user. Perhaps this is the measure of what Boxer demands from its users and the key to the question of whether one builds or inhabits Boxer.

References

Baria, C. (1993) A new approach to building information systems and the role of users in the development process, Unpublished Master of Business (Information Technology) thesis, RMIT

Chan, K. H. (1992) A study of the object-oriented paradigm and information technology industry, Unpublished Master of Business (Information Technology) thesis, RMIT

Eliadis, B. (1987) A hypothetical secondary student's project using Boxer, in *Sunrise Notes*, No. 2, Melbourne: ACER

Kay, Alan (1976) *TLC Logo*, Cambridge, MA: The Learning Company

McLaughlin, M. (1993) Keynote presentation at Australian Association for Research in Education Annual Conference, Freemantle

Nevile, L. (1993) Is instructing to constructing as instruction is to construction?, Paper presented at the Australian Education College Annual Conference, Melbourne, September

Nunn, P. (1992) Constructing a hypermedia catalogue using Boxer, Unpublished Master of Business (Information Management) thesis, RMIT

Nunn, J. (1993) Can Boxer be used to build an EcoWorld?, Working paper presented to the First International Boxer Conference, RMIT, July

Roschelle, J. (1993) Spreadsheets in Boxer, in *AECJ*, 8/2, 4-11, Brisbane: ACCE

VCAB (1990) Victorian Certificate of Education mathematics challenging problem, Melbourne: VCAB

Williams, D. and Nevile, L. (1993) Calculating, constructing, collaborating and communicating mathematically in Boxer, in Mousley and Rice (eds.) *MATHEMATICS: Of Primary Importance,* Melbourne: Mathematical Association of Victoria