CHAPTER SEVEN
Harnessing the Potential of Technological Convergence

INTRODUCTION

Chapter six has provided a broad overview of three main options with regard to bolstering the role of educational broadcasting in South Africa. The technological landscape is, however, currently being strongly shaped by the concept of 'convergence', which is widespread in use but – certainly in South Africa – still unclear in application. In this chapter, we explore briefly the meaning of convergence and then focus our attention in detail on how the South African government can most appropriately position itself to exploit the potential of technological convergence to support the provision of education and training in the country.

DEFINING CONVERGENCE

In terms of a dictionary definition, convergence is described as 'movement towards or terminating in the same point'.[1] In itself, this provides an obvious enough definition, but it requires further explanation in terms of its relevance to technological trends. One simple description of convergence provides a useful starting point for understanding the concept from a technological perspective. In brief, convergence may be described as:

> The coming together of two or more disparate disciplines or technologies. For example, the so-called fax revolution was produced by a convergence of telecommunications technology, optical scanning technology, and printing technology.[2]

This description is helpful because it provides an illustration of a completed process of technological convergence, which in turn helps us to separate the general concept from its application to a specific process of technological convergence currently taking place.

From the perspective of this report, however, the term 'convergence' will be used to described one particular process of technological convergence. This can be summarized as follows:

> In information technology, convergence is a term for the combining of personal computers, telecommunication, and television into a user experience that is accessible to everyone.[3]

A more detailed analysis of the implications of this might be the follows:

> Convergence is an on-going process which entails the coming together of the following:
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> - content from the audiovisual and publishing industries;

[1] Onions, C.T. (ed.). (1987). *Shorter Oxford English Dictionary*. Oxford: Clarendon Press. p. 418.
[2] *Convergence - ZDNet Webopedia Definition and Links.* http://www.zdwebopedia.com/TERM/c/convergence.html. Page created on 19/10/1999.
[3] Whatis.com, *Convergence Definition*, http://www.whatis.com/converge.htm . Page created on 19/10/1999.

- potentially separate physical infrastructures (such as those supporting broadcast television or telecommunications services) able to carry similar sorts of information at increasingly lower costs;
- the interactive information storage and processing capabilities of the computer world;
- the ubiquity, improving functionality and ease of use of consumer electronics.[4]

Convergence is, however, by no means a commonly agreed concept. The European Commission Information Society has, for example, recently completed a Green Paper process on convergence, in which the following was reported:

> Some comments suggested that it was unclear exactly what the term convergence represents. For others, convergence defied definition. Yet others predicted a degree of divergence in terms of the range of content and services offered…views on the pace of developments were…cautious. There was wide recognition of the reality of convergence at the level of technology and network infrastructures. But most agreed that this did not mean that convergence of either markets (in terms of the players involved) or services would automatically follow. Convergence was seen as an evolutionary rather than a revolutionary process.
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> There were clear differences between sectors as to their perception of the extent and speed of these developments, but there was the broad acknowledgement that convergence, however defined, was at an early stage and characterised by uncertainty, in particular about the level of demand there might be for such services. These differences were also reflected in the many of the examples offered as to how converging technologies are influencing both the business world and our everyday lives, many of them based on the growing popularity of the Internet. One important feature in this context was the degree to which new services offered users the possibility to customise and control the information and services received.
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> An important distinction between developments in the work environment and the home was recognised. Many considered that developments at work would be driven by the Internet, electronic commerce and PC-based activities, and would have an impact on home-use. On the other hand, and despite the increasing take up of computers in the home, digital television, offering entertainment and information, was seen by some as the predominant platform in the home for the foreseeable future.[5]

It is not the purpose of this report to debate the merits of convergence, but it is necessary to be aware of the above discussions. Most importantly, we believe that the lengthy excerpt provided above is a reasonably accurate summary of the current situation in South Africa. In particular, we believe the following points are worth noting:

- Convergence is an evolutionary not revolutionary process;

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[4] ISPO, *Public Issues Arising from Telecommunications and Audiovisual Convergence*, http://www.ispo.cec.be/infosoc/promo/pubs/exesum.html page created on 14/10/1999.

[5] EC Information Society. (1998). Summary of the Results of the Public Consultation on the Green Paper on the Convergence of the Telecommunications, Media and Information Technology Sectors. http://www.ispo.cec.be/convergencegp/gpworkdoc.html. Page created on 29th July, 1998.

- At technology and network levels, convergence is already a reality; and
- There is lack of clarity about how much demand there might be for services in a converged technological environment.

Our proposals below draw strongly on these three points. For this reason, many aspects of the proposals do not relate specifically to harnessing the potential of convergence *per se*, but rather to exploiting various technological trends evolving as this process takes effect. In many cases, this will continue to include fairly traditional uses of technologies (as has already been illustrated in the discussions of broadcasting in chapter six), but the underlying theme will be to prepare South Africa's education and training system to evolve with the evolutionary process of technological convergence by putting in place technological infrastructures that can evolve with it.

CONSIDERING APPLICATIONS OF CONVERGING TECHNOLOGIES

In chapter six, we have outlined why we believe a dedicated terrestrial educational broadcasting channel is neither financially nor educationally justifiable. The remaining proposals in that chapter focus squarely on shoring up the capacity of various educational broadcasting initiatives already in place to enable them to play a more effective educational support role. We have made this set of recommendations not because we believe that the status quo is sufficient to solve educational problems, but because we believe capital investments in new technologies need to be made within the context of the technological trends outlined above. The ideas presented below are based on a detailed understanding of the educational needs and context of South Africa (summarized in chapter two) and of the educational potential and current penetration of various technologies (summarized in chapter three and described in detailed in appendices five to nine).

In brief, we propose that educational broadcasting options two and three, as presented in chapter six, be augmented by judicious investments in open and flexible computer networks that will link a wide range of teaching and learning sites in the country. In this regard, we envisage the system harnessing the potential of a range of satellite, telecommunications, and information technologies to provide various forms of support to different elements of the education and training system. There are already many fledgling initiatives beginning this work – examples include the Multi-Purpose Community Centre initiative of the Universal Service Agency, the Department of Health's Telemedicine Project, and Schoolnet South Africa – so a key objective of this intervention will be to consolidate their investments into a single large-scale telecommunications network. Below we describe key features of this educational network.

GENERAL EDUCATIONAL APPLICATIONS

There are three broad educational applications for a converged telecommunications network in South Africa. Each is described briefly below, but these descriptions have been supplemented with a range of additional descriptions and discussions contained in chapter three and in appendices five to nine. The ideas provided below should be read in conjunction with the educational technology lessons presented in chapter four. Below we talk in general terms about potential educational applications, while under 'strengths' we describe specific applications relevant to South Africa. In this general discussion, we refer primarily to Internet technologies as a ‘shorthand’ intended to encompass the trends in convergence outlined above.

DELIVERY OF EDUCATIONAL RESOURCES

Beginning with the functionality to provide resources, one of the most immediately obvious strengths of Internet technologies in a converging environment is the capacity to provide immediately up-to-date resources to large numbers of learners easily and relatively cheaply (whether one is using the Web or e-mail technologies). Changes made to resources can become immediately available to students without incurring major additional distribution costs. Likewise, communication resources, such as tutorial letters, can be distributed more often, thus reducing costs of ongoing communication by educational providers. These trends are already becoming increasingly important in a world where curricula no longer change in cycles of five or ten years (or even longer), but need to be adapted and updated continuously.

It should be noted here, however, that the capacity to facilitate quick distribution of resources should not be taken to imply an argument in favour of turning online environments into massive ‘electronic textbooks’ (although regrettably this appears to be how most web course designers tend to use the technology). [6] There is no evidence to suggest that today’s – or tomorrow’s – students are going to be interested in simply reading textbooks on a computer screen. Thus, one needs to plan very carefully how to take advantage of this functionality without simply creating electronic textbooks (which most students are simply likely to print out and read in paper form anyway). It should be stressed here that resource distribution should not be mistaken for education, although it often erroneously is (most often by people whose understanding of education is as an authoritarian process of information transmission from educators to predominantly passive learners).

As an extension of the above strength, Internet technologies also support use of resources that combine more than one medium. While technical limitations still hamper the use of video resources (unless one is working within a reasonably advanced local or wide area network environment or is harnessing the bandwidth capacity of satellite), the ability to create multimedia resources – combining audio, graphics and images, and text - is a tremendous potential strength.

An additional benefit that Internet technologies can bring to designers of online learning resources is the huge resource base that resides on the World Wide Web. In itself, this is of negligible educational value, but, if harnessed effectively by educators, it can become a very useful resource. This might happen, for example, through judicious use of links to resources on the Web or by setting learning activities that demand learners to make their own selective use of this resource base. As an extension, it is worth noting that this benefit can extend to

[6] Of course - the Internet does have the additional advantage that learners or educators would have access to a range of text-book like resources, and would be able to pick and choose from these without having to purchase a book. As the storage is the investment of the content developer, the user can potentially have access to a library of text books. Also, not all web-based educational resource development should seek to be new or make full use of the multimedia web environment (using graphics, audio and video clips, java applets, links to other resources and so on). The Internet can also be a good repository for existing volumes of educational content. Consider the lucrative practice of selling sets of past examination papers - common at grade twelve matriculation and in higher education institutions. Examination papers (or sets of assessment activities) are useful to learners and educators alike. Having a database of all such assessment activities that is accessible to all who care to use it could be a substantial resource contribution to any education system.

course design processes themselves. This resource base can be harnessed to support course design and development itself, regardless of the nature of resources being developed.

FACILITATING COMMUNICATION

The second set of strengths of Internet technologies is their capacity to support a range of communication strategies, especially easy asynchronous communication between educator and learner and amongst learners. This is possibly their most important educational advantage, particularly as it opens significant new opportunities for learners to engage with educators, hence supporting changing roles for educators (as outlined in chapter four).

Of course, as people who are familiar with the full range of applications of the Internet will know, technologies such as Chat Rooms or Video Conferencing do allow for live, real-time communication as well (subject to limitations of bandwidth). However, the major new strength of e-mail particularly is the capacity to facilitate ongoing communication at times that are suitable to the individuals continuing the conversation. Thus, students can post queries or ideas to educators, who can then respond at later times. Where appropriate, this communication can be extended to include groups of people rather than just individuals. People who have used e-mail and discussion groups for business or research purposes will know the benefits that this brings – as well as the time it can save by focusing discussion - and these benefits apply equally in education. Of course, this is not intended to suggest that such communication can replace face-to-face contact; however, it can be harnessed very effectively for a range of educational purposes.

In terms of educational systems, a major component of this strength is the capacity to support the many requirements for communication to ensure the effective management and administration of the system, many aspects of which are currently dysfunctional in South Africa. Cheap, easy, immediate communication opens significant new opportunities for circulating information through education systems (whether the system is a single university or a national schooling system), not least at administrative and management levels. This becomes particularly important in an environment where extensive and rapid change is underway, which, as our descriptions in chapters one and two demonstrate, is currently the norm in South Africa. Most importantly, cheap communication systems ensure that communication can travel in any direction through a system, rather than simply consisting of communiqués from higher levels to lower levels within a system.

FACILITATING INTERACTION IN RESOURCES

Combining the above, it becomes apparent that Internet technologies can provide educators with a range of very interesting opportunities for creating resources that allow learners different levels of interactivity. Of course, this can quite easily be used poorly by educators but it can also lead to the creation of interesting and exciting interaction for learners with educational resources. Again, this is not intended to suggest that such interaction can replace all forms of direct human interaction; however, it can be used to engage learners effectively, creating richer teaching and learning environments. This can be facilitated by creative use of, for example, feedback forms, java applets, pop-up boxes, 'yes-no' and multiple-choice responses, and imaginative use of hyperlinks to guide learners through diverse learning pathways.

For example, in a printed resource, activities integrated into texts are usually immediately followed by some discussion of the activity, often discouraging learners from completing the activity. In a web environment, however, one could require some form of response from learners by developing this discussion about an activity as a response to a feedback form (thus requiring learners to submit some thoughts on the activity before seeing the discussion). To discourage thoughtless answers – and to encourage peer interaction – responses could be automatically collated and generated as an HTML page of student responses. Likewise, 'yes-no' responses could be used judiciously to guide learners down different, but equally relevant, learning pathways. In this instance, the response is used not to provide right or wrong answers, but rather to solicit information from learners on their particular preferences or concerns.

A requirement for many users is support in using various information services, whether these be primary and secondary source databases, library systems, or the resources themselves. Such services currently most often require direct interaction with the people who offer these support services, but there is a strong case to be made for providing online support services to help users. This would include the development of: intuitive search facilities that are easy to use, but accommodate various levels of complexity in searching; guides on information sources and how to find and store information; electronic library guides; guides to using, accessing, and evaluating resources; support guides on writing assignments or reports; and online examples of interactive learning methods and approaches.

BUILDING AND EXPLOITING INFORMATION BASES

In addition to the above, there is a further important trend worth noting. The rapid growth in functionality of Internet technologies opens possibilities for building and exploiting information bases in ways that were simply not possible even two or three years ago. In particular, the following developments are worth noting:

1. Developments in the digitization of information of all kinds, whether it be text, graphic, audio, or video.
2. Growing functionality of electronic databases, and particularly allowing people to:
   - Store any kind of information in digital format, with corresponding capacity to run increasingly sophisticated data queries on information once it is organized into a well-designed management information system; and
   - Run data queries - and receive the results of these queries – using HTML-based browsers, whether across the Internet or secure Intranets.
3. Exponential growth in the speed of central processing units and storage capacity of computer hard drives, matched with corresponding reductions in the relative prices of this hardware. These developments contribute significantly to functionality of databases, both in terms of quantity of data storage and speed of manipulation of this data.
4. Rapid developments in cheap electronic communication, more and more aspects of which can increasingly be automated. This is further facilitated by convergence in information and communications technologies, which allows communication such as e-mail or fax to work automatically in tandem with information databases if well designed.

Of course, the above sounds, in many ways, like the marketing jargon of information technology suppliers, elements of which have almost been repeated to the point of cliché. Indeed, such is the speed of communication and effectiveness of information technology marketing that, taken on their own, none of the above points necessarily even sounds particularly innovative, notwithstanding their relative novelty as developments.

Nevertheless, hardly any organizations or systems in South African education and training have yet devised strategies for harnessing these trends effectively to the general benefit of education and social development, indicating clearly that their real potential is not yet well understood. Instead, repetition of rhetorical statements about the developmental potential of ICTs soon starts to ring hollow, raising more questions than it answers. Nevertheless, it is worth noting that introducing the notion of an information base is here intended to provide one practical way in which South Africa can seize the opportunity to take practical advantage of the potential of ICTs. This is essential if we are to work towards reversing current trends for the development of ICTs to entrench or widen the gap between developed and developing countries.

A fundamental shift in the value of information is taking place because of the rapid digitization of information and the consequent ease of its dissemination. Historically, information has been regarded as a product, which people were happy to purchase, to the financial benefit of those social structures that controlled and profited from its production and dissemination. While certain types of information will continue to retain value in this traditional way, the vast bulk of information, once it has been developed or collated, now rapidly loses value. Printed catalogues of information become redundant almost as soon as they are printed because this information changes so quickly. Cheaper and easier reproduction and communication of information constantly reduce the time that 'privileged' access to information provides strategic advantage. Access to multiple sources of information via the Internet is making it increasingly difficult to identify the source of new ideas, while the rapidity with which new information can be circulated reduces the time for which it can be regarded as 'new'.

These changes make it essential to find ways to use information quickly in as many different ways as possible before it loses its value. These need to focus on re-using information in different ways without generating significant additional cost. In order to achieve this, it is necessary to establish effective information systems, which can allow for quick and easy manipulation of information once it has been developed or gathered. It is also advisable from this perspective to incur the minor additional cost of breaking links between gathering or compiling information and communicating it. Although this creates some additional costs initially, these can easily be amortized across the range of options that then become possible for communicating this information or using it to support a diverse range of educational opportunities. In this way, the expense of generating the information can be used much more effectively.

Possibly most importantly, it becomes essential to develop effective strategies for storing information in ways that allow it to be very easily manipulated for future purposes. If information about educational resources, courses, and programmes is stored in a database, it then becomes easily available for future applications. In this way, research can build on growing knowledge bases, rather than repeating basic work already conducted. This can maximize the value of money spent on course design and development or educational research. It can then also – where appropriate - be easily made available via the World Wide Web for access by other researchers in South Africa, thus contributing usefully to developing an effective educational resource and research base in the country. This has the potential spin-off of developing the country's international reputation as a producer – and not just a consumer - of information.

Another point emerging from the above discussions is that increasingly value lies not in possessing information, but rather in developing the skills and capacity to manipulate it effectively for new applications. This indicates clearly the importance of developing management information systems that allow for cheap, easy, and logical storage and retrieval of information. There is added benefit to creating interfaces to information that enable users to engage with certain types of information themselves with little or no intervention by other people. If a simple web interface is added to such a database, it would be possible for educators and learners to select their own search criteria and extract relevant resources very quickly and at no additional cost to a national education system (or an individual educational provider). This simple search level adds tremendous value as an educational resource. It is also very cost-effective, because changes made to the database are reflected automatically via the web interface. The lengthy processes of writing pages in HyperText Markup Language (HTML) are removed, because most pages can be generated automatically from the database

For all the above to work effectively, though, it will be necessary – at both systemic and institutional levels – to invest financial and human resources in:

- Establishing the types and combinations of information needed to support teaching and learning environments, target learners, and strategies for making this information accessible to all learners;
- Developing appropriate conceptual frameworks for computer-based management information systems; and
- Designing electronic database architectures that can be used to organize, store, and allow for multiple uses of information.

We believe that this has some important immediate applications in South Africa, particularly in terms of building the capacity of certain systems to administer themselves effectively.

POTENTIAL EDUCATIONAL PITFALLS

Of course, as well as creating possibilities, Internet technologies contain many potential educational pitfalls. Almost inevitably – as with most technologies – most of these are linked to the way in which the technologies might be used (or misused) rather than anything intrinsic in the technologies themselves. The following list outlines some of these pitfalls, which we present here to inject a note of caution into otherwise very positive-sounding discussions about the potential of these technologies. It is by no means exhaustive.

1. *Potential for poor use*. Although this a really obvious sounding observation, it is nevertheless worth reinforcing that there is as much potential for poor use of Internet technologies as any other educational technology. As has been the case with many technological innovations (such as radio and television), there has been a proliferation of rhetoric about the potential of Internet technologies to provide simple solutions to very complicated educational problems, much of which is generated by the marketing strategies of technology vendors. Of course, as the use of these technologies develops, a more sophisticated, critical understanding and rhetoric will emerge. Nevertheless, in the absence of this, it is currently necessary to remember that Internet technologies offer no magical panacea to educational problems, and can thus be used just as poorly as any

other technology. As has been suggested above, they can also either function as a catalyst for educational transformation or entrench existing educational practices.

2. *Resource design is complicated and time-consuming.* A second potential pitfall of Internet technologies is that complexities of resource design and development demand time and high-level skills. This problem becomes particularly acute in environments where human and financial resources are limited, and can be further intensified when poor financial planning leads to heavy expenditure in technological infrastructure that, in turn, absorbs budgets for curriculum and resource design and development. This problem is – almost paradoxically - masked by growing ease of use of different technological applications. For example, it is now very easy to generate HTML pages without learning coding, making it much simpler for people to generate their own web sites. This ease of use can easily mask the complexities of the educational or instructional design that is necessary to create effective web resources. This is reflected in the proliferation of online 'educational' material that is little more than reams of text on a screen.

   Of course, this problem can be used to advantage if harnessed effectively. This is because these technologies and software applications have lowered financial and skill entry levels for people interested in exploring their educational use, thus enabling well-managed budgets and design processes to invest a greater percentage of expenditure in course design and development. The key to turning this pitfall into a possibility is effective management of resources. It is, however, worth noting that design of online learning resources can be very time-consuming. Discussion with people who have developed better quality resources, as well as consultation of international research, suggest that ratios of at least 150 to 200 hours of design time to each hour of learning time are not unusual.

3. *Confusing rote response with interaction.* A key benefit that ICTs have brought to the business world is the ability to automate certain rote tasks (such as management and retrieval of data or delivery of communication). Many of these benefits can be harnessed both in the administration and provision of education. However, they carry with them the potential danger that of confusing rote response with interaction. Some educational theorists differentiate between different levels of interaction, with rote response as a very low level of interaction moving up to more sophisticated levels of interaction. While this is perfectly valid, we would argue that rote response and interaction are actually different processes, the former being designed in ways that can actually impede interaction on the part of learners.

   In the use of ICTs and online learning, multiple-choice questions and automated responses are probably the most obvious educational activities that tend to encourage rote response. At a more sophisticated level, design of automated learning pathways that 'guide' learners down a single 'right' path often also encourage rote response to and simplistic memorization of learning resources. Of course, this is not intended to suggest that there is no place for these educational strategies. In certain working environments, memorization of key information may be essential to successful operations. When, however, this approach becomes pervasive within an entire educational intervention, it starts to become highly problematic, and is likely to place serious limits on the effectiveness of that intervention.

4. *Effective use requires information literacy skills.* One of the features of increasing use of e-mail and the growth of the World Wide Web has been that there is a proliferation of useless information. This raises interesting challenges, and points clearly to the importance of developing effective information literacy skills. Of course, the term 'information literacy' is itself the subject of some debate.[7], Darch, Carelse, and Underwood argue that information literacy has two components. The one is a set of skills which enables users to identify their information problems and needs, find information irrespective of source or medium, and critically evaluate and use the information. The other is understanding a domain of knowledge, so that an information user is able to evaluate the significance of information in relation to a problem in that domain.

   In a later article (19 May),[8] Darch states that information literacy is not just a new name for something which we have always done. It is more than just a set of skills like being able to access a library catalogue or to understand the limitations of the television news. Darch argues that it implies a self-conscious awareness of the way in which information systems work (including modern electronic systems), of the dynamic link between a particular information need and the sources and channels required to satisfy that need. Developing these types of skills in learners who are going to use online learning environments will be essential to their successful implementation.

5. *User unfamiliarity.* Linked to the above point is the difficulty – particularly in South Africa – that most potential users, both educators and learners, are likely to be unfamiliar with Internet technologies. Of course, this depends on the nature and level of the educational intervention, but it is a potential pitfall that needs to be factored into conceptualizing the use of such technologies. If one peruses existing online learning resources, it quickly becomes apparent how many assumptions have been made about proficiency of use of the technologies that learners are expected to bring with them. Likewise, strategic decisions to develop online learning strategies are usually taken with little or no reference to the capacity of the educators who will be expected to drive these strategies. Consequently, in designing educational interventions using Internet technologies, it is always necessary to take account of the levels of expertise of educators and learners, and to ensure that appropriate levels of capacity are developed as part of the intervention. This, of course, has the spin-off benefit of developing important new skills.

6. *Uncertainty around copyright issues.* A minor, but important, point to note is that online learning often raises uncertainty around copyright issues. Although it is debatable as to how long copyright will remain a relevant concept as more and more information is digitized, it is certainly still a reality. Thus, one still needs to be careful about not breaching copyright when developing online learning experiences, particularly if one starts making extensive use of resources that exist on other web sites or that have been gathered through e-mail discussion groups. Issues of intellectual property protection will need to be carefully considered, and appropriate policies developed in concert with similar processes taking place in other social sectors in South Africa and internationally.

[7] Darch, Carelse, & Underwood, 'Higher Education Review, supplement to the *Sunday Independent*, 12th May 1996, p. 8.
[8] Darch, C. 'Higher Education Review', supplement to the *Sunday Independent*, 19th May 1996, p. 9.

TECHNOLOGICAL BREAKDOWN

THE MODEL IN BRIEF

In brief, we propose judicious investments in networking teaching and learning sites (including schools, adult learning centres, health clinics, multi-purpose community centres, and a range of other potential sites) around cluster hubs. Via a wide area network, these hubs will provide access to network servers for the teaching and learning sites connected to them. They will provide connected teaching and learning sites with the full functionality of a distributed computer network, including access to web sites, e-mail facilities, and centrally stored database systems. We anticipate that this distribution network will be connected nationally via a combination of satellite bandwidth, telephone lines, and wireless technologies. Each network server will be equipped with the hardware capability to serve its teaching and learning sites as if they were thin clients.[9] This will provide individual teaching and learning sites with maximum flexibility in terms of deciding what equipment they wish to use to connect to the network. Some may use expensive, new Personal Computers (PCs) or Apple Macs and others cheaper, refurbished equipment. Still others may use much simpler equipment as it is developed (for example, a television set and a set-top box).

This flexibility will be facilitated by ensuring that everything that is sent via satellite to the cluster hub is developed using Internet protocols, which will ensure that all engagement by individual sites can take place using web browsers. Additional computer functionality can then be achieved by adding greater capacity to individual teaching and learning sites as this becomes affordable. For example, an adult learning centre may start with a computer with a 486 Central Processing Unit (CPU) and limited Random Access Memory (RAM), using this only to allow e-mail exchange and use of nationally created database systems. Over time, however, it may wish to expand this use by installing word processing or spreadsheeting software onto this computer to support various administrative and educational planning processes. It may then get to the point where it desires to use computers to support learners directly, and finds money to invest in a thin client network with 30 terminals, thus creating a small computer laboratory. Thus, it replaces the PC with a thin client network, using the network server to connect to the national distribution network. The system will facilitate this type of scaleability with ease, as well as allowing different hardware platforms (in this example, a PC and a thin client network) to connect to the same national system using Internet Protocols. As the individual site expands, it loses none of the functionality of its previous platform.

This broad model can be represented graphically in terms of Figures One and Two. It is necessary to stress that Figure One is a presentation of a communications infrastructure, and *not* an educational model. Figure Two extends the model provided in Figure One by

[9] A thin client network is a computer network where the hardware of individual work stations is minimized to reduce costs. Users access information directly from the server, with the local work station simply providing a keyboard, mouse, and monitor to allow the user to work. Unlike fat client networks, software programmes and data are not permanently stored on local work stations, but are accessed directly from the server as required. As Whatis.Com, points out, 'The term "thin client" seems to be used as a synonym for both the Net PC and the network computer (NC), which are somewhat different concepts. The Net PC is based on Intel microprocessors and Windows software (Intel was a leader in defining the Net PC specification). The network computer (NC) is a concept backed by Oracle and Sun Microsystems that may or may not use Intel microprocessors and would use a Java-based operating system.' (Whatis.com, *Thin Client Definition*, http://www.whatis.com/ Page created on 19/10/1999).

indicating possible infrastructure at a local level. This diagram does not represent a teaching and learning environment. There are too many elements of a teaching and learning environment missing for this to be viable. It is simply not possible to paint a picture of possible teaching and learning environments before structured participation of one or more educational organizations is organized. The process of developing teaching and learning environments and models of the teaching and learning strategies that will drive them must, by definition, include the input of educators responsible for designing them.

BUILDING BLOCKS OF THE MODEL

Within this model, there are four broad components, each of which will need to be put in place by mixing and matching different technologies as appropriate. These components are as follows:

- Distribution Network.
- Cluster Hub.
- Access Networks.
- Teaching and Learning Site Equipment.

We describe each in turn briefly. These descriptions are supplemented by more detailed descriptions and financial information provided in appendix eight.

Distribution Network

The distribution network refers, in effect, to the broad telecommunications 'backbone'[10] connecting the entire education and training system. Given the way in which various telecommunications systems have developed internationally, this network infrastructure will not ever belong to one single agency; it will be the sum of the parts of different telecommunications systems owned by different agencies. In South Africa, key agencies will include, but not be limited to, Telkom (terrestrial and satellite telecommunications systems), Vodacom and MTN (cellular communications systems), Sentech (terrestrial and satellite broadcasting systems), Orbicom (satellite broadcasting systems), and a range of Internet Service Providers (represented by the Internet Service Providers' Association of South Africa).

From the perspective of the education and training system, the specific telecommunications technologies used to connect disparate components of the system is of less relevance than whether or not they provide the system with the bandwidth required to use the network for the desired purposes. As the purposes for which different elements of the system will wish to use the network will vary (see specific examples below), different technologies for creating a distribution network will suffice for different elements of the system. What will, however, be common amongst different elements of the system will be a desire to secure this networking capability at the lowest possible capital and recurrent costs and with the least possible maintenance requirements. For this reason, it is critical that a distribution network is developed and managed as a coordinated exercise, taking into account the particular needs of different aspects of the system. In this is not done, the network will evolve disparately and in a fragmented fashion, making it more expensive and less effective.

In our preliminary cost projections provided in chapter ten, we have postulated that the distribution network should aim to ensure that the bandwidth capacity of the network from different centres to local clusters and sites should be as big as possible to enable transfer of multimedia resources wherever possible. For this reason, we have proposed that cluster hubs at least are equipped with satellite reception equipment to enable large scale point-to-

[10] A backbone is a larger transmission line that carries data gathered from smaller lines that interconnect with it. 1) At the local level, a backbone is a line or set of lines that local area networks connect to for a wide area network connection or within a local area network to span distances efficiently (for example, between buildings). 2) On the Internet or other wide area network, a backbone is a set of paths that local or regional networks connect to for long-distance interconnection. The connection points are known as network *nodes* or telecommunication data switching exchanges (DSEs).

In this instance we are using the term 'backbone' primarily in the latter sense.

Definition taken from: Whatis.com, *Backbone Definition*, http://www.whatis.com/ Page created on 19/10/1999.

multipoint distribution of data via satellite. The return paths of the distribution network will not have the same bandwidth requirements, as the majority of ongoing communication taking place in this direction is likely to consist of text (with correspondingly smaller bandwidth requirements). For this reason, we anticipate that telephone line connections (terrestrial or cellular) between cluster hubs and central server systems will suffice. These could allow cluster hubs to dial up to central systems on a regular basis or, where feasible, allow for a permanently open leased line connections.

Cluster Hubs and Network Servers

The following two definitions help to explain the concept of a cluster hub:

> In general, a hub is the central part of a wheel where the spokes come together. The term is familiar to frequent fliers who travel through airport 'hubs' to make connecting flights from one point to another. In data communications, a hub is a place of convergence where data arrives from one or more directions and is forwarded out in one or more other directions. [11]
>
> In information technology marketing and infrastructure terminology, a cluster is a group of terminals or workstations attached to a common control unit or server or a group of several servers that share work and may be able to back each other up if one server fails. [12]

In terms of these definitions, cluster hubs can allow data transfer between computers located anywhere within the education system, with physical location likely to depend primarily on the functions that the network is be expected to perform. So, for example, a cluster hub may provide all universities and technikons in the country web access to a database on a server in Pretoria. Similarly, a cluster hub may provide users in a computer laboratory access to a video server located in the same room (as is the case currently in the Shoma Foundation's project).

As with the distribution network, however, the common thread running through all elements of the education and training system will be a desire to achieve required functionality from computer networks at the lowest possible cost. In thinking about a national system, it is necessary to consider investments in cluster hubs and network servers with reference to the infrastructure and capacity of individual teaching and learning sites. We believe that there is merit in making judicious investments in cluster hubs and network servers that network reasonably small numbers of teaching and learning sites (say, between ten and forty) within a geographical region as this has certain benefits:

- Storage capacity investments can be focused on wide area network servers, allowing for widespread dissemination of educational resources and software applications that are accessed by individual teaching and learning sites via caches on network servers. This assumes, of course, that all resources and software applications developed for storage on these servers are based on Internet protocols, thus enabling cross-platform, web browser-based access by individual teaching and learning sites to.
- Upgrades in both storage capacity and processing power can focus on investments in cluster hubs.
- Investments in the physical security of equipment can be made in a more targeted way, as the key equipment (the cluster hub and network server) will be located at fewer sites.

[11] Whatis.com, *Hub Definition*, http://www.whatis.com/ Page created on 19/10/1999.
[12] Whatis.com, *Cluster Definition*, http://www.whatis.com/ Page created on 19/10/1999.

Loss of equipment at individual teaching and learning sites will be correspondingly less problematic, as expensive equipment and data will predominantly be stored centrally (see following section for specific examples).

- Backup of critical data can focus on the information on network servers, and even, using a distribution network architecture, managed remotely.
- Investments in contingency plans for hardware failure (for example, mirrored hard drives) can be limited to cluster hubs and network servers.
- Technical maintenance skill requirements at local levels can be minimized, as the system will assume a lowest common denominator of access to facilities via web browsers. Where technical capacity does not reside locally, local equipment can be stripped down to simple thin client-equivalent hardware, where users simply turn the web browser on and off like a television set and immediately boot up a logon screen for direct access to the WAN server via a cluster hub.[13] Simple applications can even be used to take users through processes of learning the technical skills of using a mouse and keyboard.

Access Networks

In connecting individual teaching and learning sites to cluster hubs, there is a range of technical options – either involving cabling or wireless[14] networks – and these are outlined in detail in appendix eight. Many of the technologies that can be used are the same as those for the distribution network, as is reflected in the tables in appendix eight. Differences in technological application are likely to relate primarily to the relative size of the network. As we are using the terms here, access networks are intended to refer to small WANS (or even LANs where sufficient computers exist in one location, such as a university campus) connecting a limited number of teaching and learning sites to a central server. The distribution network will then connect these individual networks to a broader network.

It becomes clear from this brief description that our proposals mirror what is already happening technologically with the rollout of the Internet. This is certainly correct, and we believe a major strength of this model is that it does not demand investment in completely new technology, as many teaching and learning sites already possess the basic equipment needed to connect to such a network. The focus is on bringing this access to *all* teaching and learning sites, particularly to those that will not otherwise gain access to such networking capacity in the foreseeable future. The networking proposals presented here, while modelled on the architecture of the Internet, contain an additional critical feature, and that is the capacity of different elements of the system to set up secure Intranets that are not open to the general public. The combination of a distribution network, cluster hubs, and access networks will facilitate easy creation of any number of secure Intranets for different aspects of the education and training system, and each of these can be administered by the agency most interested in establishing them.

The key function of access networks then will be to link individual teaching and learning sites to central servers (via LANS or WANS) to enable these sites to access all of the services available via cluster hubs (specific examples are provided in the following section). From this perspective, the most important requirement is to ensure that these networks provide the

[13] It will be expected that users are, at least, literate.

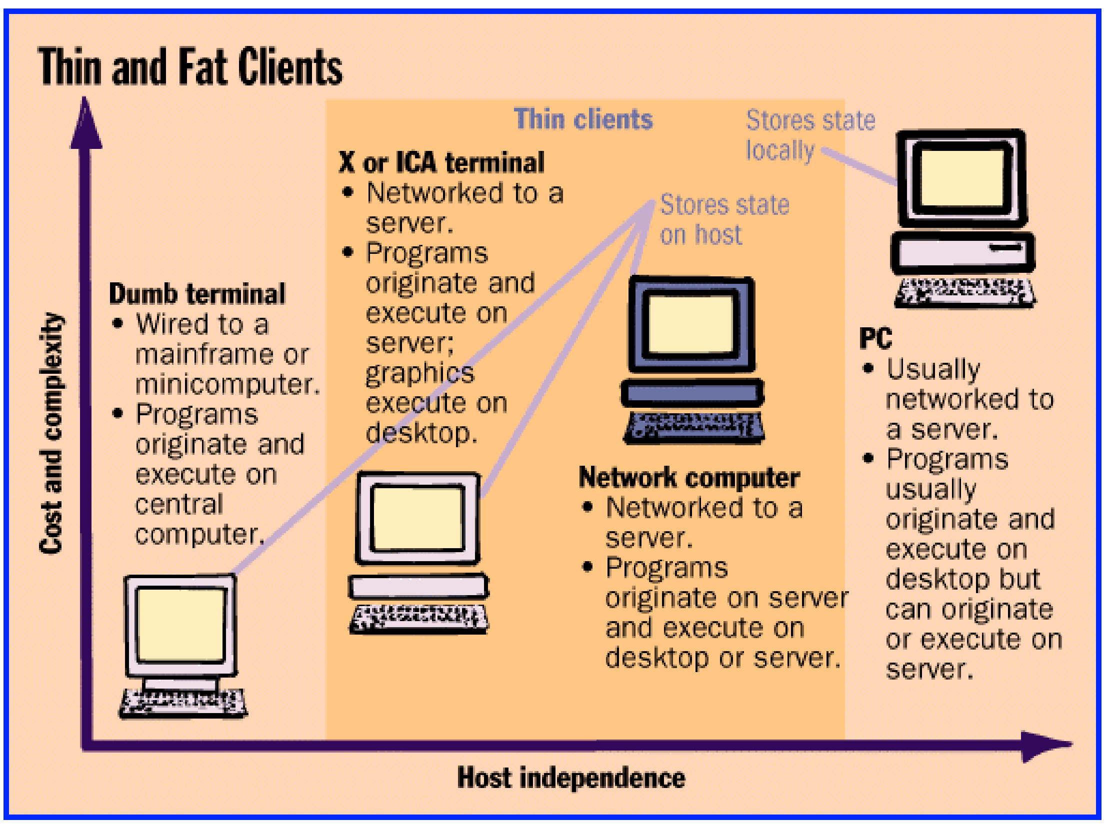
[14] Wireless refers to a communications, monitoring, or control system in which electromagnetic or acoustic waves carry a signal through atmospheric space rather than along a wire. In most wireless systems, radio-frequency (RF) or infrared (IR) waves are used. Some monitoring devices, such as intrusion alarms, employ acoustic waves at frequencies above the range of human hearing.
Definition taken from: Whatis.com, *Wireless Definition*, http://www.whatis.com/ Page created on 19/10/1999.

necessary bandwidth capacity to perform relevant functions (both in terms of actual bandwidth and the hours for which the individual sites might need to be connected to a network server to access these functions). Thus, for example, providing sites with e-mail and access to central databases will require low bandwidth but high availability in terms of time, while delivery of packaged content might require high bandwidth but lower availability. The technology required for individual networks will depend very much on current technological infrastructure within a specific region (for example, penetration of telephone lines or cellular networks in place). In our costing models in chapter ten, we have assumed a mix of networking technologies for different geographical clusters.

We believe that the basic minimum should be to aim to connect all identified teaching and learning sites to basic e-mail and administrative services within three years. The aim should be to ensure that the fees charged for this connectivity are based, wherever possible, on flat rates for permanently open connections. This is because, where networks require individual teaching and learning sites to pay fees for usage of the network, this will inevitably prejudice those teaching and learning sites with the smallest budgets, which are, in turn, those that need these services the most. From this base, we believe that growth in the network bandwidth to accommodate growing volumes of resource delivery will soon follow.

Teaching and Learning Site Equipment

The final building block is the equipment at teaching and learning sites themselves. The diagram presented below differentiates between different models of computers, using the concept of thin and fat clients as the scale.[15]



[15] Byte Magazine, April 1997 / Cover Story / Cheaper Computing, Part I, http://www.byte.com/art/9704/img/047csh2.htm

One of the central advantages of the model we are proposing is that it does not set constraints on what equipment individual teaching and learning sites. Any type of computer capable of loading a web browser (from a telephone with monitor attached to a Pentium III PC) can connect to the network and access whatever services are being provided. Likewise, any existing networks in teaching and learning sites can either connect to a cluster hub or directly to the distribution network.

From this perspective, we have focused our attention on those teaching and learning sites that have no equipment and possibly no technical skills. The model of cluster hubs and access networks has been conceptualized with servicing such sites as the primary goal. The following illustrative description gives a sense of how this could work

> An adult learning centre with very basic equipment and no electricity is provided with a refurbished 486 computer (with limited hard drive space and RAM) and a printer, together with solar panels to power the equipment. This computer is connected to a cluster hub 15 kilometres away using a radio data network. The computer has a Linux operating system with only a java-enabled web browser loaded. The system is pre-configured to take the user straight to a logon screen on the web browser when she starts the computer. On completing the logon screen by entering a username and password, she gains access to a range of e-mail and administrative services, as well as getting the opportunity to access a range of packaged ABET resources that she needs to use that day. On completing her e-mail, adding the names of ten new learners who recently joined one of her programmes, typing and printing a message to be pinned on a notice board, and downloading some useful teaching resources, she simply switches the computer off as she would a television set. This automatically ends her session on the server, requiring her to log on again if she restarts the computer later.

The keyelements of this illustration are as follows:

- Critical data is stored centrally, thus minimizing the extent of problems if computer equipment is damaged or stolen. In the former case, damaged equipment can quickly be 'swapped out' rather than the site having to wait for return of repaired equipment.
- The choice of operating software and software applications removes a key cost.
- The hardware configuration enables the user to treat the computer more like a television set than a computer, as it does not require laborious opening or closing procedures to get to the desired application.
- Additional applications – including word processing and basic spreadsheeting – can also be made available via the web browser.
- While they are useful, the system does not necessarily require electricity or telephone lines to be set up at teaching and learning sites.
- This example does not have to apply to other sites. Likewise, when the learning centre gets more money, it may wish to upgrade its computer facilities. Provided it purchases equipment that can support a web browser (as all upgrades from this technological platform inevitably will), access to the system remains possible. Thus, it can choose to purchase one new Pentium computer or install an entire network of thin or fat clients, and link this LAN to the same cluster hub.

STRENGTHS

We have already alluded to several of the strengths of the above models, in our descriptions of both educational applications and the technological model. In considering further strengths of the above, it is easiest to describe some specific applications for the network and then describe some generic strengths.

EXAMPLES OF SPECIFIC APPLICATIONS

The following examples simply describe a few possible applications of such a network. Each of these ideas is based on supporting the work of existing projects, most of which are struggling with the problem of rolling out network infrastructure on the scale they require. Thus, the intention of the above descriptions would be to consolidate expenditure on the basic technological backbone, while providing each project the space to continue to operate as is currently intended. There are no doubt many other initiatives or applications similar to those described below for which this network might be relevant.

Supporting Schools[16]

There are several ways in which a network such as that described above might support the schooling system. We believe that possibly the most powerful component of the above model is that it is not limited to the educational function of resource delivery. Large-scale technology rollout initiatives that focus solely on resource provision often fail for three key reasons. First, they are based on the assumption that resources will reach a school or the correct teacher to be used in a classroom.[17] Second, they assume that the resources delivered can actually be used effectively by the system. As we have indicated in the previous chapter, this assumption often proves fatal, particularly in systems where basic communications and administration are not functioning effectively. Third, they assume that people will start using the resources quickly and that all schools will require and use the resources at the same time. This also often proves dangerous, and is likely to be particularly so in the case of web-based multimedia resources.

If, however, one is able to link a technological platform for resource delivery to one that can perform other functions, this can then be used very effectively. The system described above can be used to help to overcome two fundamental problems dogging the schooling system; communication and administration. In the case of communication, it is well known that a key problem is that many schools do not receive basic communication from provincial or national departments, nor are they in a position to engage in dialogue when they do receive circulars. At the same time as current communication systems are not sufficiently efficient, they are also very expensive, relying as they do on physical circulation of large quantities of paper, much of which never reaches its intended destination. The system described above can build communications capacity – in both directions – through the full schooling hierarchy;

[16] More detailed ideas about using Internet technologies in schools are provided in appendices five and six.
[17] Soul City, the Media in Education Trust, and SABC TV Education – all of which have been engaged in resource delivery to schools – have all noted the difficulties of getting resources into schools. This relates to the full range of technology options for resources, be they printed materials (newspapers inserts, posters, booklets, teacher guides, or learner workbooks), video or audio materials (where schools have televisions, radios, audio and/or videocassette recorders), or multimedia materials. Anecdotal accounts of the boxes of resources that sit in district or principles offices - never to be opened – demonstrate the difficulties associated with distributing even printed materials.

national-provincial-district-school. It can do this by providing e-mail facilities to every school in the system, allowing large-scale delivery of communication to schools, as well as creating return pathways for schools to communicate back up the chain, amongst each other, or with key educational support agencies

A key component of the administrative functions at a school involves managing the learning resources within it, a function made significantly more difficult at most South African schools by their isolation, paucity of access to relevant information, and inefficient communication options available to them. By establishing, a well-functioning communication system for all schools – including access to information about available educational resources – teachers and administrators will be able to communicate with the people and organizations engaged in resource production. They can order resources rather than having volumes of materials delivered to them when they may not want or need them.[18] In this model administrators or teachers could have access to a database of existing educational materials from which to choose and place orders and could receive e-mail communication (which would be very cheaply distributed to the entire system) on new resources.[19]

More importantly, the system described above can allow schools to perform basic administrative tasks much more efficiently. This becomes possible by locating web-based database applications on the network servers to which individual schools will gain access via cluster hubs. These applications can provide four basic modules for schools initially:[20]

1. A simplified timetabling package, which will enable schools to prepare timetables for the year. This application should enable schools to plan the year in terms of available teachers, subjects (learning areas), available classrooms, and student cohorts. It can significantly reduce the time required to prepare timetables, while ensuring that schools have timetables ready by the beginning of the school year.
2. Simple student and teacher record-keeping systems (linked to the timetabling system). This should enable schools to track student progress by keeping records of their personal information, marks, learning pathways (subjects taken), and progress through grades. Importantly, this could also be used to replace manual admissions processes currently run by schools, which is one major reason for delays in the production of timetables in many places. It could also be used to produce regular reports for distribution to parents. This system should also be used to keep basic information about teachers at schools, including basic personal information, qualifications and teacher upgrading pathways, subject specializations and levels of specialization, and other relevant information.

[18] There is currently tremendous resource wastage in the education system as various NGOs, curriculum development units, and educational organizations invest time and effort in producing good quality educational materials. When faced with the common problem of distribution through the school system, many resort to a 'spray and pray' strategy. Resources are sent out in bulk (either through newspapers or in bulk mailshots) in the hope that some one will locate them, find them useful, and use them with students. This strategy is the result of two common and valid observations: there is no clear communication network through which to communicate with all schools directly and most schools are poorly resourced. Establishing a good communication system throughout the schooling system will greatly enhance the efficiencies and effectiveness of all the existing educational resource development initiatives. There is also a problem repeatedly encountered of poor communication within schools themselves.

[19] This is not to suggest that resources should necessarily have to be purchased (although this is of course possible), but schools could be required at least to complete an order for a resource before it is mailed to them. With a communication network in place, there should be no (or little) need to send out wasteful bulk mailshots to schools.

[20] All of the ideas contained below are based on actual packages that have already been developed and, in many cases, tested in schools with no or little computer literacy skills.

3. A basic accounting package, which will enable schools to track income and expenses in the school. This package can also be used to require schools to account for how they are spending the money received from them by government. Standard accounting systems are too complex for most schools to operate effectively, as few schools have administration personnel qualified in even basic book keeping, so simplified software applications would be necessary.
4. A basic resource administration package. This can help provide information on basic resources (textbooks, audio-visual equipment, furniture, and so on) for decision-making and planning by school governors, teachers, parents, and students. This would help to ensure more effective use and maintenance of basic school resources, and could be linked to the basic accounting package to facilitate this.[21]

Because data from this system will be stored on network servers around the country, it will be possible to turn this system into a national data warehouse for schools.[22] This can enable the system to perform a range of functions over and above those micro-level functions described above. For example, it will become much easier to determine which schools do or do not have timetables ready by the beginning of the school year, either locally, provincially, or nationally. Likewise, it will be possible to require schools to submit accounts, which can then be easily checked at provincial level. In addition, surveys such as the School Register of Needs, which are both expensive and soon out of date, can be replaced by automatic queries run on the national data warehouse. An additional spin-off benefit of this would be that it would facilitate gathering of information on learners that will be required by the South African Qualifications Authority (SAQA) for its National Learner Records Database (NLRD). According to Samuel Isaacs, Executive Officer of SAQA, a major problem for the NLRD will be the gathering of accurate information from schools, particularly primary schools. Such a system provides a potential long-term solution to this problem, although obviously the implementation of the NLRD will be up and running before it can be implemented.

Using these kinds of functions, it will be easier to target problem areas in the system and focus efforts on getting these functioning effectively. For example, schools that do not log on to the system or are not providing basic information to the system can be targeted for professional development support, disciplinary action, or other corrective measures. When such problems become manifest across an entire district or province, it will be possible to start isolating other possible causes for administrative and management problems.

The above functions contain powerful financial arguments in favour of the roll-out of such a system, and can also easily leverage greater efficiencies out of the schooling system in a

[21] This system could, over time, be integrated with systems making resources outside a school more accessible. The resources available to a school might include in-service training, Famsa, Lifeline, the Welfare department various museums and libraries and technical orientation centres, NGO organizations, community groupings like healers and farming cooperatives, and businesses that can help to link the world with what goes on in the classroom. These resources can be used more effectively when several schools access them in tabloid fashion. This can be achieved through the time table by allocating days, or portion of days in the learning block or specifically into the Annual calendar using public holidays or special days and the print generated as learning resources.

[22] Of course, some schools already run their own computerized systems. In these instances, it would not be necessary to require them to keep duplicate records. Rather, import applications can easily be developed to allow regular transfer of administrative data into the central administrative system. Such submissions should be required of schools - to ensure that the national system is as comprehensive as possible.

reasonably short time (probably less than three years). We will discuss this in greater detail in chapter ten, but the example of timetables is illustrative even here. The following demonstrates the kinds of productivity gains that a system such as this can achieve very quickly. The Deved Trust, a non-governmental organization working with schools in Alexandra township in Johannesburg, estimates that manual construction of a high school timetable takes approximately three weeks anywhere in the world, and will occupy more than one person for much of that time. It asserts that, if this process can happen before schools close at the end of the year, little teaching time is lost. If it happens after the start of the school year, and, for many schools worst affected, in the middle of a fluctuating school enrolment and an uncertain staff complement, at least twenty person days per school are lost in planning and re-planning before even building the timetable. Often, the whole staff is caught up in the pressure and wrangling about teaching loads. However, if teachers only know what they finally will be teaching, in late February or early March, up to six weeks of teaching time per teacher are lost or seriously compromised. (Timetables delayed until April are a fairly common feature through schools in South Africa.)

If one assumes that this problem affects 6,000 schools, which have an average of ten teachers each (we have kept the average low on the assumption that many of these will be small rural schools), then 1,800,000 teaching days are lost. Adding the time taken to prepare timetables (assuming that 24,000 out of 30,000 schools compile timetables manually, and that it would take no more than one person day to prepare the timetable electronically[23]), increases this to 2,256,000 person days. If an average teacher's salary is R5000 per month (including benefits), this translates into a daily cost of R275 (assuming a 215-day working year). Based on this, the single problem of timetables not being developed efficiently (leaving aside the opportunity costs of not having students learning in classrooms and a range of other related social costs) currently costs the system R620,400,000. Seen in this context, the costs of rolling out such a system become significantly more affordable.

More importantly, though, as the network expands, it will be possible to use it for a range of other purposes, including large-scale transmission of web-based educational content to support teachers and learners in classrooms. We believe this is a central strength of the system, because it overcomes the two problems mentioned at the beginning of this illustrative example. First, it ensures that administrative and communications problems are being directly targeted as part of the intervention. Second, it allows slower growth in use of resources being delivered using such platforms. Such resource delivery mechanisms generally grow quickly, but off a low base, making it unaffordable to maintain the infrastructure to the point where it can achieve economies of scale through mass use. Given the above financial arguments, the costs of maintaining this infrastructure can quickly be covered through its administrative and communications functions, allowing this evolutionary growth in use of the system for resource delivery and other similar educational functions to take place over five or six years. From a resource delivery perspective, there are several web-based content development projects focusing on schools under way,[24] and these resources could be circulated through the system for use by teachers and/or learners. The general benefits of this have been discussed earlier in this chapter.

[23] The latter estimate is corroborated by the work of the Deved Trust in Alexandra.

[24] Examples of organizations involved in such projects include the Learning Channel, the Shoma Foundation, the University of the Western Cape's Botany Department, St Alban's College's Tecsas Project, and Cyberschool Africa.

Mass Literacy Campaign

As we have indicated in chapter three, adult illiteracy is a major problem in South African education and training, and the Department of Education has resolved to 'break the back' of this problem within five years. A network such as the one described above could support such an initiative in many ways. First, it could establish communication networks between all of the agencies currently providing adult literacy programmes, enabling better coordination to evolve without centralizing control. This could enable establishment of simple, but crucial, support mechanisms for adult educators, such as ongoing listserv discussions, e-mail circulation of case studies of successful practice, searchable databases of existing educational resources,[25] or contact lists of support agencies and individuals.

More importantly, though, it could enable these projects to begin to share their resources and then to participate in resource development projects where these projects are shared between different projects. Resources could, in the first instance, be developed for printing by adult educators in learning centres, but there may also be longer term possibilities for developing web-based content for use by learners themselves. Because many such programmes are located in industry and commerce, there are better opportunities for providing larger scale access to computers for learners than is likely to be possible in the school sector. Touch-screen technologies – such as those used currently in teacher centres by the Shoma Foundation – can simplify use of such technology by adult learners. The SABC is currently planning a broadcast support intervention in the field of adult literacy, in partnership with the Department of Education's Adult Education Directorate, and web-based resource development projects might be initiated in tandem with this broadcast campaign.

Another vital function for a network of this nature would be to facilitate the creation of national databases about adult learners. As with the school system, this will be critical to the long-term sustainability of SAQA's National Learner Record Database. It may also be viable to build more sophisticated database applications such as those proposed for the school system to support rollout of a mass literacy campaign. A key component of such a mass literacy campaign will be to ensure that South Africa's education system is able to support learners in moving though the accredited ABET levels should they wish to pursue these pathways. A database that accurately reflects learner information in a mass campaign could assist the department in planning and implementing its multi-year plan.

Telemedicine

In the *White Paper for the Transformation of the Health System in South Africa*, the Department of Health notes that

> Communication strategies for health promotion have been restrictive and have favoured target audiences that are literate, urban based and who have easy access to print and audio-visual media. The language of health promotional messages and the ethnocentric nature of a majority of messages suggested that communication strategies were inadequate and narrow in their focus as health promotion tools.[26]

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[25] The Department of Education's ABET directorate has completed an audit of adult basic education materials. This is to be extended to include some evaluation commentary on each resource. Access to such information, as well has how to order the resources listed would greatly support adult educators and organizers.

[26] Department of Health. *White Paper for the Transformation of the Health System in South Africa.* http://www.health.gov.za/health02.htm.

One strategy it is currently investigating to contribute to solving this problem is the use of telemedicine. The Telemedicine Telejournal has the following description of the concept:

> Telemedicine reflects the convergence of technological advances in a number of fields, including medicine, telecommunications, computer engineering, informatics, artificial intelligence, robotics, materials science, and perceptual psychology.
>
> 'Telemedicine,' according to the Institute of Medicine definition, is 'the use of electronic information and communications technologies to provide and support health care when distance separates the participants.' This conceptualization, sometimes characterized as '*clinical* telemedicine,' emphasizes applications that link clinician to patient or one clinician to another. It includes a wide and rapidly expanding array of technologies and approaches for communicating patient data, voice, or images in order to assist, augment or replace in-person clinical encounters. The necessary technology and administrative support range from simple and inexpensive to very complex and expensive…Telemedicine is employed for a variety of purposes and goals. The potential to create or improve access to health services, especially in rural areas, remains important, but is no longer the major rationale. Telemedicine applications purport to improve the quality of care by improving communication and access to information. Telemedicine applications are found within urban areas, within and between hospitals, between ambulances and hospital shock trauma units, within the operating room or intensive care unit, in classrooms and labs.[27]

Clearly, a network such as that described above can make a major contribution to implementing telemedicine strategies in South Africa. As with schools and adult basic education systems, access to accurate (and fast changing information) in all parts of health care systems is critical to planning and implementing health-related campaigns. The Department of Health has set up two task teams, one focusing on content and the other on infrastructure, to drive its processes. Linking their work with this initiative would both add to the value of this initiative and help the Department of Health to achieve its goals as quickly and cost-effectively as possible.[28]

South African Police Service

The South African Police Service (SAPS) – working with Business Against Crime, the CSIR, and SAIDE – has recently completed a first phase of strategic planning around how to harness educational technologies successfully to support professional development of the police force. While there is not yet certainty as to what precise applications there will be for technologies such as those described above, there appears to be broad commitment to making investments in a technological backbone such as that described above to support delivery of

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[27] Telemedicine Journal. *Definition of Telemedicine.* http://www.telemedicine.to/telemedicine/definition.html. Page created on 21/10/1999.

[28] There are also obvious links between the network and with educational broadcasting inititiaves relating to health care (described as options in the previous chapter). Soul City has produced several successful multi-media campaigns with a health focus. As with the schooling example of the need for information about and access to educational resources, healthcare workers and patients need good communication and administration systems - to communicate with themselves - as well as to gain access to the existing resource base. Soul City distributes printed, video, and audio materials to healthcare networks (including hospitals, clinics, and pubic consultancies), and could befit from having reliable national networks through which to communicate directly with each site.

education to the police. Already, Pol-TV uses television broadcasts via Teletuks to deliver programming to learners. By creating new educational interventions harnessing the types of technologies outlined above, SAPS believes it will be possible to meet many of its professional development needs. To this extent, it intends to implement various pilot projects to test the most effective ways of using such technologies to meet these needs. Again, the benefits of consolidating investments in the basic technological backbone, as described above, holds significant potential for making this a possibility.

Supporting Distance Education and More Flexible Learning Opportunities

As a final example, such a system could potentially support many distance education programmes in South Africa. Distance education has a long and somewhat chequered history in South Africa, and many distance education providers have discovered several common problems with distance education delivery. These include the expense of implementing effective face-to-face tutorial support, difficulties with running efficient administrative systems, and the problem of unreliable national communication systems (particularly the postal system). Many educational providers using distance education providers are already exploring use of technological networks such as those described above to help to solve some of these problems and to create more flexible learning environments. For example, the University of Pretoria has established a Telematic Education Unit to use 'technology (telematics) to enhance the teaching and learning environment, mostly "over a distance"'.[29] The words 'mostly over a distance' are used because the aim of 'Telematic Education' as understood by the University is to provide flexible and technology-enhanced learning environments, not only for remote students, but also for on-campus students. The University of Pretoria launched its fully integrated Virtual Campus in October, 1999. Likewise, the University of South Africa has invested resources in the development of a Student Online System and is currently planning pilot projects in the development of distance education digital learning systems. These types of interventions – and there are many in higher education in South Africa – are mostly hampered by the need to make fragmented investments in technological infrastructure. Ability to use a common technological backbone, such as the one described above, could create significant cost efficiencies for these types of programmes, allowing them to divert their spending into other areas such as course design and development and tutorial support.

GENERIC STRENGTHS

These specific descriptions outline several strengths of the technological models proposed above. From these, however, emerge a few generic strengths that are worth mentioning briefly.

- *Multiple applications*. Possibly the most obvious generic strength emerging from the above descriptions is that such a technological network has a wide range of applications, both in terms of the functions it can support and in terms of the different education and training sectors that might harness its potential. A central weakness of many educational technology investments historically has been that they have focused on a narrow range of applications (the traditional notion of a dedicated educational television channel is an example of this). If this application proves not to be successful, the temptation has been to invest more money to make it work, particularly if the initial investment was major. This can lead to a very dangerous cycle of financial wastage. In this instance, because the

[29] Internal document - transparency from a speech about the unit, collected from Tom Brown on the 27/01/1998

network can serve many potential purposes, it becomes significantly easier to redirect expenditure if it is discovered that particular applications are unsuccessful. This significantly reduces the risk of the initial investment.

- *Technological flexibility*. Linked to the above point is that the technological model proposed is based strongly on flexibility and open standards. This means that investments already made can be incorporated into the network as it grows. In this way, the model does not constitute a 'new' investment in traditional terms. In many ways, it will consolidate and build on investments already made and infrastructure in place. In addition, this technological flexibility will accommodate a range of directions within different aspects of the education and training system, thus not forcing people to accept any particular constraints in deciding to connect their teaching and learning sites to the broader distribution network.

- *Linking to existing initiatives*. This benefit also extends to the fact that – as the examples used above illustrate - the proposed technological model will link a range of existing initiatives rather than constituting a single new initiative. Throughout this and the previous chapter, as well as in various appendices, we have made reference to a wide range of initiatives, the work of all of which can both benefit and benefit from the rollout of this technological backbone. More examples of these partnership possibilities are also provided in chapter nine.

- *Enhancing productivity*. We believe that a central strength of the model proposed above is its capacity to enhance productivity in basic ways. We have provided one simple illustration of this in the example of school timetables. As part of building our financial models in chapter ten, we will provide further examples of this.

WEAKNESSES

Earlier in this chapter, we provided examples of potential pitfalls associated with educational applications of Internet technologies. In chapter four, we also provided a series of lessons learned from historical use of educational technologies both internationally and in South Africa, many of which could be construed as potential threats or weaknesses of the above models, depending on how these models are implemented. We will not repeat these here, but will reiterate that these do pose significant threats if not taken seriously. In addition, there are further potential weaknesses to the model. We will describe these briefly below, and then aim to present some potential solutions to this in the following two chapters.

- *An expensive system.* Possibly the most obvious 'weakness' of the ideas presented above is that their implementation will not be cheap. Of course, at one level, it may be possible to argue that one should leave various systems to continue rolling out this technological backbone in an evolutionary way, as is happening currently, in which case this problem would fall away. However, as we warned in chapter four, the net effect of this currently is to widen the social gap between rich and poor, both within South Africa and between South Africa and richer countries. We believe, therefore, that a sustained strategic investment in this technological backbone is necessary to overcome this problem and this cannot be achieved without significant cost. Illustrative costs are provided in chapter ten, but it is worth stating as a weakness here, as finances are always a major impediment to projects of this nature. The only way in which we believe this can be achieved is to establish this project as a priority and re-orient expenditure from the overall educational budget towards this investment. As the timetabling example has illustrated, this can have a significant impact on improving the efficiency of overall expenditure within the education and training system, but it requires strong political commitment. We believe that the current political dispensation has been setting strong precedents to enable this to happen, but it will depend on high-level political champions seeing the value of the investments.

- *The need for coordination*. Another weakness of the models presented above is that the success of the initial investment depends on a range of agencies (the illustrative uses of the system gave some examples) agreeing to consolidate their technological investments. This runs against the grain of how these kinds of initiatives currently operate, as fragmentation is still the operational norm across large sectors of South African society. Linked to this is the unfortunate reality that many people remain intent on using initiatives such as this as opportunities to develop their own empires, which they then jealously guard against potential erosion. Many such ‘empires’ exist, and coordination of the kind mentioned above cuts across these fragmented power bases. For this reason, a key to success will be effective coordination, driven by people who have empathy with these problems and can position this initiative in such a way that it creates benefits for all to join it. We believe that this is possible, but it is a difficult task. In chapter nine, we turn our attention to some strategies for achieving this in terms of organizational structures.

CONCLUSION

This chapter has attempted to open significantly the original concept of a dedicated educational broadcasting service by describing potential strategies for harnessing the potential of technological convergence. We have argued the need to establish a new type of dedicated ‘service’, which creates a widespread telecommunications network for the education and training system. This network can then be used for a range of educational applications, from communications and administration to resource delivery. In highlighting some of the potential weaknesses of the model we presented in this chapter, we have focused particularly on the problems of implementing the network. We intend to explore these problems in greater depth in chapters nine and ten, but will first present a consolidated statement of the vision we have for a dedicated educational technology network for South Africa. This will merge the ideas in this and the previous chapter by presenting a specific set of proposals. There may be some repetition in this, but believe it is necessary to re-present the concepts of these two chapters as a single, integrated model.