Issues to Consider when Creating a Virtual University*

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Numerous organizations around the world are either talking about, or have already begun, implementation of 'virtual university' programs. Before undertaking such a development many issues need to be addressed. This paper introduces a set of these issues and provides the answers for one particular model that is described in some detail: the National Technological University, a satellite television educational system. The questions are then addressed for other possible models for different audiences, using different technologies, etc. In addition, contrasts are made between private and state funded (subsidized) institutions.

INTRODUCTION

DISTANCE LEARNING and the term 'virtual university' have become commonplace in the last few years primarily due to the rapid advances and the convergence of computing and telecommunications technologies. Correspondence programs and open universities have been around for many decades leading to the adage 'learning, any time, any place'. However, most of these programs have been a minor part of the higher education system especially in science and engineering. Now computers, CD-ROMs, and the Internet promise to change education dramatically and forever. Before, beginning the discussion of the creation of virtual universities, a brief history of university-based distance education is provided.

The history of university-based distance education in the United States is very interesting. Technology has always been an active part of this process ranging from the use of the postal system to the Internet. In fact, one of the most serious problems has been the over emphasis on technology and the under emphasis on basic educational processes. Many times technology has been a solution in search of a problem rather than the natural consequence of a prescribed educational model.

Text-based correspondence courses have been popular additions to many college programs. However, most of these courses are not vocationally oriented. Rather they support leisure learning or the general educational process allowing students to obtain college credits for independent study. In this case, the postal system is the technology used although equivalent courses are now appearing on the Internet, that is, pure text based courses or even simulation-based courses such as mathematics courses using Mathematica, Maple, or other software systems.

With the advent of television, a few visionary educators hailed the beginnings of a new era for education. Many universities experimented in the 1950s and 1960s with the use of television, especially for teaching large classes on campus. Many campuses implemented local cable television networks for television delivery to individual classrooms. Master teachers prepared materials for viewing by on-campus students in classes led by graduate teaching assistants. The results from these efforts were mixed. Usually the efforts were driven by the university's administrators in the hope of saving money, not by faculty, and certainly not by students. Most universities had abandoned these efforts by the 1970s. Engineering schools did not experiment with this application of television because very large classes did not exist within engineering programs. On-campus television was useful, however, because the measurements of learning outcomes showed that television-based education was effective even if not liked by the students. In other words, the use of technology, in this case television, did not hinder educational results. It should be pointed out that many of the same funding arguments are resurfacing again with arguments in favor of using the Internet for academic course delivery where the primary goal is to lower the cost of education, thus, making education more accessible.

In the late 1960s, a number of US high technology firms pressured universities to provide practicing engineers with access to postgraduate education. These businesses wanted this education because they realized that the future of the organization relied on the technical expertise of its employees. They also wanted the education delivered to the engineer at the work site because the costs due to time away from the job for working engineers to attend a local institution were too high. In some cases no local educational institutions were even available. Large corporations were

willing to commit resources to establish distance learning programs and to reimburse the practicing engineers for their educational costs. In this sense, continuing education was viewed as a benefit rather than training which is typically management driven. To this day, distance learning as applied to engineering education continues to lead the development of educational technology in the US although with the advent of the Internet this may be changing.

By the mid 1970s, instructional television (ITV) with videotape delivery had become widespread because it was based on televising on-campus lecture classes. This format allowed instructors to continue using their basic teaching/lecturing methods. Instructors did not have to learn how to create new and different learning materials or use new formats—an extremely important but often overlooked issue, particularly for faculty who are engaged in significant scholarly research.

In the mid 1980s, the next step was ready to be taken using a live satellite television network to reach a national and even international audience of working technical professionals. No single university seemed ready to accept the challenge so a new university model emerged.

NATIONAL TECHNOLOGICAL UNIVERSITY

The National Technological University was founded in January 1984. It is a private, non-profit, fully accredited institution established to serve the advanced education needs of full-time working engineers, scientists and technical managers. NTU consists of three parts: suppliers, customers, and an advanced technology satellite television network. The program suppliers are mainly established, traditional universities; the customers are sponsoring government, industry and university organizations. Today, the delivery system is based on compressed digital video technology and provides up to twelve simultaneous television channels using a single transponder on GE 3 over North America and one channel to the Asia Pacific region using PanAmSat 2. Both satellites are located in geosynchronous Earth orbits rotating at the same speed as the Earth so that they appear to be stationary when viewed from the Earth's surface. NTU is the largest and most advanced engineering education delivery network for distance learning in the world.

When NTU was founded, the following set of issues were raised. With hindsight, these or a similar set of questions should be asked anytime that a new distance education or 'virtual university' is contemplated. The questions are:

1. Who are the target learners?
2. What are their needs?
3. Who will be the appropriate providers?
4. Who will be the stakeholders?
5. How will the instructional materials be handled?
6. What is the appropriate delivery technology?
7. How will this be financed?
8. What will be the support mechanisms?
9. How will the endeavor be evaluated?

One of the important items to notice in the list above is that 'the appropriate delivery technology' question is number six and is only one part of the process. Many groups or organizations seem to start with the technology and then build the rest of the organization around the selected technology rather than addressing the educational goals first and then selecting an appropriate technology.

Who were NTU's target learners? From the very beginning, NTU's targeted learners were full-time working technical professionals and their managers employed in industrial, government, and university locations. Because these people are both busy and highly mobile, conventional campus-based continuing education does not work for them. In reality, they may be the organization's most valuable employees and providing continuing education must fit within their, often hectic, work and travel schedules. Any continuing educational opportunity must be extremely flexible to meet their needs.

Many people use the terms 'distance learning' and 'open learning' interchangeably. This is not the case. The answer to the question on who is the targeted audience determines whether or not the program is open. Open learning programs concern access. Programs that admit students based on academic qualifications are not open learning programs. If programs use qualifications based on non-academic measures such as age, etc., the program is an open learning program. The misconception arises because distance learning programs do not have a fixed number of available student slots because of limitations due to physical facilities so most undergraduate educational programs that are offered at a distance are also open. However, when the decision is made to offer graduate education at a distance, programs are not open because academic qualifications become a requirement for admission.

What are the targeted learners' needs? These adult, technical professionals need both technical and managerial education and training. In order to have career security and growth opportunities, these adults need to continually refresh and update their skills. Both for-credit and non-credit courses may fulfill these needs. It is important to note that the targeted learners are working technical professionals and, therefore, already have achieved at least the entry level degree necessary for their employment. In the United States this means a Bachelor's degree as a minimum although many NTU students have received more advanced degrees such as a Master's or even in a few cases, a Doctoral degree. Individuals with advance degrees may have now found that their careers have taken unforeseen paths requiring

new information and knowledge. An example might be a physicist now supervising a software development group. NTU decided to only offer Master's degree programs and currently awards thirteen M.Sc. degrees (computer engineering, electrical engineering, engineering management, computer science, management of technology, environmental systems engineering, chemical engineering, manufacturing systems engineering, material sciences engineering, software engineering, health physics, transportation systems engineering, and special majors, a program where the student with his or her academic advisor develops a unique multi-discipline program) and an International MBA.

Who are the appropriate providers? In the case of for-credit, academic course offerings, engineering colleges and institutes are the primary providers for engineering courses and business schools are the primary providers for management courses. NTU decided not to go into competition with the universities for academic courses but to leverage their investment in video production and experience and to use their facilities such as 'candid' video classrooms, broadcasting studios, etc. Universities join NTU and use NTU to market and distribute their courses to full-time working technical professions. For non-credit short course offerings, colleges of engineering; professional societies such as the American Society for Mechanical Engineers (ASME), the Institute for Electrical and Electronics Engineers (IEEE), and others; corporations; consulting companies; government laboratories; and NTU itself, are all providers.

Who are the stakeholders? i.e., who has to 'buy-in' for success? In order to provide 'product', deans, faculty, and customer executives must become stakeholders. In this case, top-down support was absolutely necessary for success. The intent was to use traditional faculty at participating universities for all course offerings, that is, NTU would outsource education. The primary reason for this decision was the short shelf-life for postgraduate engineering courses. Postgraduate courses change so rapidly that the cost of developing standalone materials was thought to be prohibitive. No up-front investment for faculty work would be required. The participating university would bear the cost of continually updating the courses and paying the faculty for teaching the course to on-campus students. Thus, the offerings would remain fresh. This decision established NTU as the world's first 'virtual' university.

Who will integrate the instructional material? NTU's decision was to have faculty have the control over any programs offered. NTU established a traditional faculty committee governance structure, however, the faculty are decentralized representing all the institutions involved. A chair for each discipline is chosen. Each chair then creates a curriculum committee charged with defining the requirements for the degree, keeping the curriculum current and selecting courses to be offered for the degree program; an admissions committee charged with evaluating the credentials of prospective students; and a group of advisors to work with admitted, degree-pursuing students. Again, the memberships of these committees are fully distributed among the participating universities.

What is the appropriate delivery technology? For NTU, television was the technology of choice. The decision was to use satellite television broadcasts directly from the originating university, that is, to simulcast the class as it was happening on the campus. Thus, the NTU students are simply remote students in a regularly scheduled on-campus class. The students at the remote sites were using their video receive environment as a 'virtual classroom'.

The major problem with the decision to use satellite television in 1984 was the high cost. To lower the cost, NTU pioneered split transponder technology in 1985, that is, NTU was the first organization in the world to broadcast two analog television channels on one transponder, thereby, halving the cost of each broadcast hour. This early pioneering of technology carried over into 1991 when NTU became the first user of compressed digital video and today NTU delivers 12 simultaneous channels on one satellite transponder, a six-fold increase over the use of split transponder technology. As a technology pioneer, NTU continues to lower the cost of satellite television broadcasting.

A secondary question related to the delivery technology concerned whether to design and build or contract for the delivery system. NTU decided to build its network and contracted for satellite transponder time for the life-time of the satellite to lower costs. The best buy for a satellite transponder is nearly always before the satellite is launched. NTU is currently operating on its fourth satellite. It began broadcasting in 1985 on GSTAR 1 but that satellite's useful life ended in 1992. NTU then signed a life-time contract with AT&T's Telstar 401. On 11 January 1997, Telstar 401 failed catastrophically in what was the world's first total communications satellite failure. NTU quickly negotiated a short-term, interim contract with a SBS 5 customer and shared operation with the customer on a transponder on this satellite from February to October 1997 when GE 3 became operational. NTU now has a for-the-life-of-the-satellite contract for one transponder on GE 3.

Unlike commercial broadcasting systems, the NTU network is fully decentralized with uplinks at each participating university and downlinks at every customer site. Network control is operated from NTU's headquarters in Fort Collins, Colorado, with backup at the University of Arizona in Tucson. Network control broadcasts the appropriate signals to turn on and off the

transmitting uplinks and the corresponding receiving downlinks.

In December 1993, NTU contracted with PanAmSat to broadcast one compressed digital video channel into the Asia Pacific region twenty-four hours each day, throughout the year. For the Asian operations, the GE 3 signal is received at Napa, California and rebroadcast to PanAmSat from their teleport. The extension into Asia allows NTU to broadcast two non-credit short courses five days a week and as many as twenty academic for-credit courses each of three terms per year. M.Sc. degrees may be earned in electrical engineering, computer science, and engineering management and the international MBA degree, which was designed for management students in Asia, is also offered. The international MBA degree program was initiated in January 1998 and is the first NTU degree program with participating universities originating courses from outside the United States. As business in Asia expands, additional satellite broadcast capability can be added in order to support additional degree programs.

In 1990, NTU joined the Internet. For the first three years the primary activity was electronic mail but in 1995, the explosive growth of the World Wide Web greatly facilitated NTU's distribution of on-line information, admissions and course registration. The Internet also enhances both student-to-student interactions and student-to-faculty interactions. The Internet flexibly supports asynchronous interactivity nearly eliminating telephone interaction or fax transmissions. Again, for the working professional, this mode of interaction is the way they now conduct business in a highly interconnected world operating over twenty-four time zones daily. It is not uncommon to find engineering design groups with components on three continents communicating via the Internet and the World Wide Web. In fact, distance education now looks much more like the world of work than traditional face-to-face education.

How was the system to be financed? Because the decision was made to make NTU a private, non-profit institution, state and federal funds were not available for start-up costs. This meant that other forms of financing would be necessary. One-time network access fees were invented to provide the necessary start-up funds and continue to provide operating funds not covered by the pay-per-view income. When an organization joins the NTU satellite network, they pay a one time fee that is dependent on the number of employees physically located at the site. Organizations may also pay a larger fee and join as a whole organization making all sites eligible to participate in the network. About thirty organizations have elected to join the network this way.

The existing know-how in the local and regional ITV systems at the participating universities was also available resulting in little training costs necessary to broadcast nationally and even internationally. In other words, the instructional television history and experience that the participating universities brought with them was used to keep start-up costs of NTU very low. Each participating university had previously used ITV to reach their local and regional businesses and government agencies.

NTU arrange joint ventures with universities and other producers by sharing revenue. Copyright remains with the originating producer. NTU markets and administers the courses. Typically, NTU passes about 55 percent of the revenue to the producer. The universities pay their support staffs of television engineers, as well as their local operating expenses from their revenues. In other words, the producers are required to cover all costs to get the signal up to the satellite. NTU then covers the costs for administration, marketing, billing and collection, and the satellite transponder. The customer pays for local site support and local site administration. All maintenance is handled by each site whether producer or customer although NTU will do this on an individual contract basis.

The major problem with the financial organization of NTU was that as a non-profit organization, raising funds for new activities was nearly impossible. On 1 July 1998, NTU created NTU Corp., a for-profit affiliated company. The purpose of this move was to out-source and aggregate all non-academic functions to the new organization such as marketing, sales, non-credit continuing education courses, operating the satellite network, finance functions, and computing support. A minority position was sold in the new organization in order to raise funds for increased marketing and deeper sales penetration into both existing and new customers. Also, the new funds are to be used to implement a state-of-the-art replacement of the compressed digital video system that has been used since 1991.

What are the support mechanisms? When an organization joins the network, they are required to name a local education site co-ordinator. This person acts on behalf of NTU at the site but they are normally paid for by the sponsoring organization. The site co-ordinator is responsible for approving student registrations, and for interacting on behalf of the university for course assessment by proctoring examinations, when required. Arrangements were also made with a company to be NTU's bookstore to facilitate students getting appropriate textbooks and published notes in a timely fashion. At NTU's headquarters, central administration and satellite network control were established. NTU maintains the students' transcripts (grade records), awards credits and grants degrees. Nearly all of NTU's students are on a full tuition reimbursement program, that is, the employer pays for the student's education. In the United States, tuition reimbursement programs are considered to be a benefit. This is true of academic students only.

Non-credit training courses are usually budgeted for by the student's management team or centrally within the organization.

How will the endeavor be evaluated? From the very beginning, an outside consultant was contracted to evaluate every course, every instructor, each university and each receive site. In addition, NTU sends out 'early warning detection' messages. In the early days of NTU these were actual post cards mailed to each student during the first week of classes to find out if the student was experiencing any difficulties with the course such as poor audio or video quality, late notes from the instructor, difficulty in communicating with the instructor, poor visuals, etc. Returned cards identifying problems were forwarded to the appropriate place for problem resolution. Today, all of this is handled by electronic submission and consequently resolved much faster.

NTU has always made it a practice to act on evaluations. For example, instructors ranking in the bottom 20 per cent are dropped from the network. This mechanism provides openings for new instructors and even new participating universities. NTU currently has one of the world's largest databases of faculty and course evaluations and annually awards twenty outstanding teacher awards to the twenty highest ranking faculty as evaluated by the students. In addition, NTU accumulates the grades of the on-campus students in each of the courses offered. This permits NTU to compare the grades received by the NTU students with the grades received by the on-campus students taking the same class. Over NTU's history, NTU's students have consistently out-performed their on-campus peers by a 0.3 grade point average or higher. Why is this? Maturity and motivation are certainly key factors, but it does prove that televised learning for graduate engineering education for working adults is effective and distance learning for these students is efficient, flexible and meets their academic and professional needs. Anecdotally, nearly all 1300 NTU graduates, to date, express themselves by stating that except for NTU they would not be obtaining a Master's degree. This indicates that NTU attracts students who otherwise would not be continuing their education. Direct delivery to their place of employment is the key idea that enables them to continue to learn while maintaining a full-time job with all its inherent responsibilities.

As an aside, the next obvious extension of this model is direct delivery to the home or small office. Low cost, small diameter antennae coupled with set-top boxes or personal computers offer the possibility to take compressed digital video telecasts to the small or home office.

NTU is one model for non-traditional education. NTU draws on the existing infrastructure and leverages faculty productivity in an era when these are important considerations. Because of the high cost of postgraduate engineering education, we may see traditional universities de-emphasize M.Sc. education on campuses preferring to concentrate on the Bachelor's and Doctoral programs. This, in fact, may already be happening at a few progressive universities by increased sharing of postgraduate courses. It will be interesting to see if other postgraduate programs such as teacher training, law, medicine, journalism, etc. follow in the footsteps of engineering.

OTHER MODELS

In re-examining the nine questions posed during NTU's formation, many other responses were possible. For example, the target audience need not be full-time working technical professionals. Choosing a different audience results in a completely different model. Non-working adults might be the audience. Undergraduate students could be another possibility. Distance education has been shown to be effective for nearly any age but the more maturity the students have, the better the acceptance. Beware of thinking of distance education as a panacea for education's many ills such as high and expanding costs, lack of teachers, or building and operating budgets.

NTU chose to use existing faculty in traditional participating universities. In this model, courses are new each time they are offered. A different model results if faculty are hired as consultants to develop courses that the delivering organization then owns or pays royalties for. Be careful of course shelf-life. Even undergraduate engineering and computer science courses may have only a few years (typically 2 to 3) of usability without major redevelopment, e.g., text books change or are revised.

Delivery technology is another important consideration. Many organizations are caught up in the Internet and World Wide Web frenzy. It is an exciting technology but again it has limitations and is not the ultimate technology answer because there probably is no ultimate technology. Each new technology should be adapted for education as it makes sense. Over the Internet, high quality streaming video demands as a minimum 300 000 to 500 000 bits/second of bandwidth. Streaming audio and static graphics, so-called 'talking tablet' technology works successfully through current telephone lines and modems. Pure text courses may also utilize this technology. We may see a number of such initiatives in the coming year. NTU plans to offer a Master's degree in Information Technology Management globally via the Internet beginning in early 1999. Courses will be unbundled with instruction, tutoring and assessment individually priced. Students will be able to begin the program at any time but they will have time constraints on finishing a course, probably a maximum of four to six months. Course development will be contracted by NTU to individual faculty but the universities will also share in the

revenue in order to support keeping these courses fresh, as well.

Financing is a major issue. NTU is a private, non-profit institution and suffers from the lack of capital for investment. With hindsight, NTU should probably have been created as a for-profit entity but this would probably have been unfavorably received at the time. Universities were either private, non-profit, or state supported in the United States. Today, this picture has altered. Education, like health care, is undergoing a revolution in the US. For-profit institutions are expanding at a great rate and old ideas about profit and non-profit are being challenged. Today, the fastest growing university in the US is a for-profit organization.

State or federal support of distance education means that education is once again subsidized. Such programs may or may not be better off. If a plan is not built that successfully continues the operation and growth of a virtual university, when funding declines or disappears, viability may be jeopardized. Clearly, successful and continued funding is a key criterion for operation.

SUMMARY

What lessons can be learned from the NTU experience that other virtual universities can draw upon? A few may be briefly summarized here. Set the objectives and design the system to them. Flexibility and response times are key success factors. Decentralization keeps central administration small. NTU has only 9 full-time employees yet contains all the features of a traditional university. Do not underestimate the human and organizational issues: NTU expends a great deal of energy and resources working directly with its providers and customers to be as responsive as possible, yet it could devote even more if resources were available. However, when dealing with 49 participating universities, over 90 non-credit producers, and 250 sponsoring organizations with over 1100 receive sites, it is easy to be overwhelmed. Do not be intimidated by the technical and organizational challenges. In NTU's case, the customer provides sponsor site management and the user is the learner. The good news is that distance education fits the way adults live and work much better than traditional education/ training models but the design must offer flexibility for the adult learner and their work interactions. And finally, continuously adjust to changing conditions by focusing on job skills and needs which are changing at a phenomenal rate. New careers come into existence daily, it seems.

Education in the world is under attack in ways that ultimately will affect the overall quality of life for everyone on this planet. Nations must recognize that their human resources are their most valuable resource. Creativity and the ability to turn ideas into reality are the hallmarks of engineering. Much of the world's wealth has been created by engineers. Faced with issues of self-sustainability, while creating an increased quality of life for all, engineers will require unparalleled and unmatched innovation and creativity. Such goals will only be achieved by 'first class' educational opportunities for all mankind. Nothing else will suffice.

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