# A PROTOCOL FOR AUTHORING CURRICULA FOR TECHNOLOGY EDUCATION

BY

EDWIN JANZ

A thesis

Submitted to the Faculty of Graduate Studies

in Partial Fulfillment of the Requirements

for the Degree of

MASTER OF EDUCATION

Department of Curriculum: Mathematics and Natural Sciences

University of Manitoba

Winnipeg, Manitoba

June, 1998

0-612-32930-5

THE UNIVERSITY OF MANITOBA

FACULTY OF GRADUATE STUDIES

COPYRIGHT PERMISSION

# A PROTOCOL FOR AUTHORING CURRICULA FOR TECHNOLOGY EDUCATION

BY

EDWIN JANZ

A Thesis/Practicum submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements for the degree of

MASTER OF EDUCATION

## Abstract

Procedures for developing generalizable technology education curricula will be in greater demand as students and teachers are drawn into the field of technology. School systems are having an increasingly difficult time finding the resources (human and monetary) needed to properly equip students with the technological skills of today's work force. This study investigated five different design models for developing technology education curricula. These are the: academic rationalism, technical, intellectual processes, social reconstruction, and personal relevance models. A protocol for authoring generalizable technology education curricula was then developed by combining the strengths of several of these models. This eclectic combination of models involved the academic, technical and intellectual. A sample curriculum for "Networking Technology 40S" was then developed using this protocol.

## Acknowledgments

I would like to thank my thesis committee, Dr. Reynold Redekopp, Dr. Ralph Mason, and particularly my advisor, Dr. Eric MacPherson, for his guidance and inspiration.

I would like to specially thank my wife, Anne, for her continuous love and support.

Table of Contents

## Purpose

In Manitoba, the Department of Education does not have set curriculum guides for technical courses. Instead, the Department requires teachers of these courses to submit their proposed course outlines and then approves or disapproves their request for funding. Therefore, these courses are often taught in somewhat of a vacuum. That is, teachers of these courses create their own curriculum based on their personal knowledge and their access to computer hardware and software. Thus the curriculum becomes individualized for each school instead of being consistent throughout different schools. As more students enroll in technical education courses throughout the province, more and more teachers throughout Manitoba will be faced with the problem of developing technical curricula with little or no guidance.

Further, with the suggestion of open boundaries; that is, students being able to pick whatever school they wish to attend as opposed to being sent to the school in their catchment or division, it is conceivable that many students may transfer more easily from one school to another. Therefore, if little consistency exists in the curriculum of technical courses, then students may not succeed when transferring their credits from one school to another. Although the open boundaries policy is not yet in effect, the lack of standards for technical curricula is already causing problems for students who have moved from one school to another and attempt to transfer technical credits such as Multimedia 40S, Networking Technology 40S, and others.

In 1997, the Manitoba Department of Education granted River East Collegiate approval for a Software Technology Diploma. This diploma requires students to attain credit in eight technical education courses in the field of computer software. None of these courses have a standard curriculum guide. As described above, River East Collegiate will need to develop curricula for all of these courses and any others courses that they choose to add to this program. Students taking Networking Technology 40S in River East Collegiate should have covered the same objectives and goals as those of any other school offering this course. However, this is not the case. Therefore, there is a great need for a method of creating generalizable curricula for technical education courses. For this thesis, the term generalizable will refer to being non-specific regarding operating systems, software, and hardware.

The curricula for technical courses such as Networking 40S needs to be based on set goals and objectives that can be attained by students throughout schools in Manitoba. This becomes extremely challenging as the expertise needed to teach such a course and the demand for newer hardware and software continually increases. Developing curricula in fields of rapid technological change is now a large challenge for both the Department of Education, and teachers. Goals and objectives must be created in light of several factors such as; a) the existing technical knowledge base of teachers, b) the existing hardware and software in schools offering these courses, and c) the sustainability of content even though the technology is rapidly changing. Further, as technology increases throughout society, students need to be taught more critical thinking skills and problem solving skills. Teaching these higher level skills require more expertise on the part of the teacher and the curriculum developers. Thus, the dissemination of critical analyses are needed to help guide both teachers and curriculum developers to know how to approach the problem of developing relevant technical curricula that is generalizable throughout the province.

The purpose of this thesis is to develop a method for creating generalizable curricula for technical education courses and to give a sample of such a curriculum. As more schools include technology education courses such as Exploring Hardware, Multimedia, and Networking Technology, the need for technical curriculum models based on current research becomes increasingly important. The following literature review will look at the latest findings in research regarding the issues mentioned above. The hope is to find direction for developing generalizable technical curricula.

## Conceptualizing technology education and curriculum

This literary review begins by focusing on technical literacy and Technology Education. As technology changes at an increasing rate, it becomes more and more difficult to define technical literacy and to state appropriate goals for Technology Education. Further complications become apparent when considering the availability of required equipment such as computer hardware and software. The goals and definitions may be different in a school division, a province or country, where funding is available for acquiring the necessary equipment than in those where this funding is not available. Therefore, the definition of technical literacy and the purposes of Technology Education is worthy of analysis.

After these underlying matters are addressed, the focus shifts to technical curriculum design and development. This section will examine five different curriculum models. These models are; a) the academic rationalism model, b) the technical/ulitarian or competencies model, c) the intellectual process model, d) the personal model, and e) the social model (Zuga, 1989). After these models are discussed, the focus will shift to finding a model of choice for developing generalizable technical curricula. The intent is to find both a direction for plausible curricula (goals and objectives for Networking Technology 40S) and a model of delivery (curriculum design or model).

### Technical Literacy

What is "Technical Literacy"? Who in society would we consider to be technically literate? Although literacy refers to being able to read and write, technical literacy refers to much more than being able to read and write technical information. In today's society everyone is faced with a barrage of technology. Driving a car, obtaining money from a bank account, setting a VCR, and using a computer at work and home are just a few examples of peoples' daily experiences with technology. In terms of computers and technical literacy, the level of knowledge needed today is greater than it was six months ago. Both software upgrades and hardware updates continually challenge all of us to adapt to more complex software and new hardware. Technical literacy is as much an attitude and self-confidence than how much one knows about a certain piece of software or hardware. "Computer literacy is not so much a set of skills as an attitude, a philosophy, and a sense of self-confidence. Computer literate people are able to plunge into a new technology, confident that in time they will eventually master it" (Eleanor Choo, 1997). Basic technical knowledge or skills when merged with confidence and attitude creates technical literacy.

## Technology Education

Although there are numerous definitions of what is meant by "Technology Education", two main streams of thought emerge. First: Technology Education is using or implementing tools of the trade (artifacts); and second, hands-on use of the tools (artifacts) is not enough to be technically literate. For the purposes of this paper, the term "technology" will refer to the use of computers, software, and computer-related courses.

At first glance, although it is beginning to appear dated, it makes a lot of sense to see Technology Education as grounded in purposeful human action, or "praxis"(Frey

1989). Students need to implement technology to get a feel or understanding of technology. Frey (1989) goes on to suggest that to some educators, technology knowledge "arises from activities and praxis rather than the esoteric life of the mind and ideas" (p.29). This thought is reiterated by Rogers (1995) in his study of technology education curricular content as perceived by secondary Trade and Industry (T&I) instructors. In his study, instructors perceived the affective domain competencies (ability to follow instructions, showing pride in workmanship, being dependable/punctual, being conscientious/honest...) as more important benefits of technology education than competencies in the cognitive (interpretation of drawings, knowledge of economic factors, knowledge of the invention process....) and psychomotor (apply scientific principles, construct drawings, ...) domains (Rogers, 1995).

Pucel (1992a; 1992b) proposed ten categories of technology education curricular content: 1) technological method, 2) common tool usage, 3) common equipment usage, 4) basic technological process, 5) materials, 6) terminology, 7) environmental concerns, 8) social values, 9) scientific principles, and 10) economic factors. Pucel suggests that the first six categories should be the primary focus of technology education programs. The other four should be integrated into other curriculum areas. Wright (1992) suggests that although "the arena of technology is the practices used to develop, produce, and use artifacts" (1992) the impact it has on society must also be taught. Therefore, technology educators should allow students to study (i) the processes used by practitioners (technologists) to develop new technology, (ii) the areas of technology which represent the accumulated knowledge of practice (specific applications), and (iii) the impacts of technology on humans and their environment A program that excludes any of these foci would be incomplete (Wright, 1992).

In the minds of many students, adults and teachers, technology education is defined as studying tools (computer software), and machines or devices (computers and computer networks). "However, to define technology as artifacts is to restrict its meaning and to necessitate the continual updating of the definition as more and more products appear on the market" (Gradwill & Welch, 1990, p.1). It is therefore important to consider technology education as more than 'just' studying the tricks and tools of the trade. Problem solving, critical thinking skills, and ordered ways of working must be stressed in today's technology curriculum (Herschbach, 1992). Johnson (1992) reiterates this by suggesting that today's technology workers are expected to have an understanding of organizations, be able to work in teams, and communicate at a high level. "In actuality, the workforce must have the ability to learn in order to keep pace with the constantly changing world" (Johnson, 1992, p.2). That is, to attain technical literacy one must be able to think critically on their feet in order to solve problems. Technology Education must therefore address these issues along with those of praxis or hands-on activities.

Although teaching praxis or hands-on activities are obviously important, we must be cautious to avoid the seductiveness of the machine luring students and teachers away from matters that could serve them best (Zuga & Bjorkquist, 1989). The curriculum must emphasize problem solving strategies, higher level thinking skills, communication skills, managing skills, and team or cooperative work. Technical curricula should not "solely be a collection of facts which are likely to be superseded but must include problem solving strategies aimed at bringing about change" (Shields, 1996, p.2). After all, there will be machines (computers and networking software) of greater power tomorrow, making today's machine specific knowledge limited in value (Zuga & Bjorkquist, 1989).

The above research implies that the definition of Technology Education is more than using artifacts and having basic technical skills. Technology Education incorporates critical thinking and problem soloving as well. Johnson (1992) argues that because contemporary curricula need to emphasize understanding and higher level thinking skills along with physical and basic skills, the task of developing curricula is more complex than ever. This complexity is augmented by the fact that most schools and school division in Canada are in times of fiscal restraint. Chinien (1995) suggests the only way Canadian students will have equal access to technology is by forming a technology education consortium for program design and implementation. This could save useless duplication of course content and help to develop curricula with goals that are attainable by schools across Canada. Currently, school divisions in Manitoba are allowed to offer technical courses based on goals and objectives stated by the individual teachers of the courses instead of a set curriculum.

The focus of this review now shifts to finding a curriculum model that is best suited for developing generalizable technical curricula for Technology Education courses.

## Curriculum Models

The work of Zuga and Herschbach has helped a great deal in charting technology education curriculum theory and models (Hansen, 1995). According to Zuga (1989), curricula designs are the arrangement of the major components of curriculum and how the subject matter is conceptualized. Herschbach (1992) describes curriculum design as a "logical way to organize instruction"(p.1). They agree there are five basic curriculum designs; a) academic rationalism; b) competencies (technical/ulitarian); c) intellectual processes; d) social reconstruction; and e) personal relevance (Herschbach, 1992; Zuga, 1989; Zuga, 1993).

The academic rationalism model focuses on knowledge that is grouped by subject matters and taxonomies of content (Zuga, 1989). "The content of instruction is selected to address the objective, and the various instructional elements, the means, are then designed to assist students in attaining the objectives" (Herschbach, 1992, p.1). According to Zuga (1989), this model is based on the social efficiency theory which argues that children need to be molded into the patterns used by adults in order to help them adapt to adult society. "Social efficiency theorists accomplish this task with the use of goals, objectives, and outcomes" (Zuga, 1993, p.53). When applied to the field of technology education, the academic rationalism designs move from the study of artifacts to an in-depth look at the field of technology. This allows students to study technology for the sake of technology. That is, technology as a unique field or discipline would be much like the fields of mathematics and science. "The recent emphasis on technology as a discipline, ... has created an interest in the academic model among technology educators" (Zuga, 1989, p.12).

The technical/ulitarian or competencies model focuses on specific performance objectives. "Objectives, or outcomes based on task and process sequencing, become the organizing elements of the curriculum rather than the taxonomy of content one might find in the academic model" (Zuga, 1989, p.5). Herschbach (1992) states that the most noticeable feature of this design is that it is performance-oriented rather than subject-oriented. This approach to curriculum design is rooted in the work of Ralph Tyler in the 1950s and is commonly termed an 'ends-means model' (Herschbach, 1992). Zuga (1993) suggests that technical design, like the academic design, is based on the social efficiency theory. This makes a lot of sense when considering the social efficiency theory as being goals, objectives, and outcomes based. The difference is that academic model focuses on objectives derived from the taxonomy of the field while technical model focuses on behavioral objectives or performance of skills. This model of curriculum aims to produce a work force with selected technical skills. To date, this approach to curriculum model is the most common choice amongst technology curriculum planers (Zuga, 1989).

The intellectual process model deals with the development of cognitive process, critical thinking, problem solving, creativity, and self-confidence, rather than a structured discipline (Zuga, 19989). Herschbach (1992) suggests that there is no set way of organizing content using this design. This model is based on a human development theory which emphasizes the normal development of children (Zuga,1993). "Students are seen as active participants in the educational endeavor and the social efficiency notion of filling empty heads and molding raw materials are rejected" (Zuga, 1993, p.54). Johnson (1992) feels that this is the way of technology education will move in the future. With this model, students are encouraged to become problem solvers and critical thinkers as opposed to becoming the trades-person of past graduates from technology programs. Johnson (1992) states that the primary goal of all education should be that of developing intellectual processes and describes how an intellectual processes curriculum could be used to achieve this in technology education. However, this is the least common means of current curriculum design (Zuga, 1989).

The personal model is learner-centered (Zuga, 1989). In this model, less emphasis is placed on predetermined content because the selection of content follows from the learners' interests, learning styles and abilities (Herschbach, 1992). Control of the choice of activities is given to students and the teacher becomes a facilitator. This design has been used in the development of entry level high school multimedia course where the needs and interests of the students ranged too greatly to make any other design seem feasible. Like the intellectual process design, this model is also based on a human development theory (Zuga, 1992). Although this model is often integrated by technology teachers via student-selected projects, there are very little suggestions in the literature as to how to implement such a design (Zuga, 1989).

The social model is based on reconstructionist theory, also know as the social meliorism theory, and deals with realistic or real world situations (Zuga, 1989; Zuga, 1992). This model has two opposing aspects. One the one hand, "the model could focus on social reconstruction on the assumption that the future of society can be changed as a result of the educational activities of the current generation...on the other hand, a social model could also focus on social adaptation on the assumption that students are the raw materials of society, and they need to be shaped to conform to existing social values" (Zuga, 1989, p.6). In this model, "there is less concern for learning particular knowledge, so little distinction is made between the what (content) and how (delivery system) of instruction" (Herschbach, 1992, p.1). Zuga believes there are many teachers of other subjects who tend to imitate the social model (Zuga, 1989).

Model of Choice for Technology Education

So which model is best suited to technology education? Two of the main contributors to the field of technological curriculum design, Zuga and Herschbach, do not agree. Herschbach advocates the technical or competency model. Although he has some reservations about its perceived narrowness in prescribing instructional content, he feels these shortcomings can be overcome by defining competencies in broad enough terms to include problem solving, critical thinking skills, and ordered ways of working (Herschbach, 1992). On the other hand, Zuga does not advocate any one model. There is "no reason for a single curriculum theory underpinning technology education" (Zuga, 1993, p.63). She feels that an eclectic combination of models is best.

Pucel (1992) also believes in applying more than one model. "If the goals are clear, instructors and curriculum developers can apply alternative approaches to accomplish these goals" (Pucel, 1992, p.29). However, Zuga and Pucel also differ in some aspects. Pucel seems to favor the personal model where students are given autonomy over the content.

Johnson (1992) suggests that some references from cognitive psychology lend support to the intellectual process model. "By modeling the desired intellectual processes, students will discover that there are many ways to solve problems, that experts make mistakes, and that seemingly simple problems are very complex in the real world" (Johnson, 1992, p.6).

Shields advocates the process model, but identifies some problems with it. "Unfortunately, it appears that research is at a comparatively early stage in determining both what a process view of technology means to a teacher and consequently how this meaning may be translated into professional practice. Problems also become evident in evaluating the learning activities and planning programs" (Shields, 1996, p.4).

Many of current business-driven workshops on computer networking adopt the technical competencies view. Workshops by both technical colleges and corporate entities such as Microsoft and Novell focus on skills and related artifacts. They often state their learning objectives in terms of hands-on, measurable tasks. For example: a course on Microsoft NT given by Image Word (an authorized technical education center at http://www.imageword.com.au/outlines/) has the following objectives: create and administer user group accounts ; define user rights; create server-based profiles; troubleshoot problems regarding the network; manage disk resources; set-up and administer permissions for files and folders; set-up a printing environment and administer it; back-up and restore files and folders using tapes, etc. Another example: a short 5 hours course given by CBTsystems (at http://www.cbtsys.com/CBT/CURICULA/ courses/nt40005/nt40005.htm) has the following objectives: configure the NT environment; use the system configuration features of Control Panel; choose a file system; describe the roles of user profiles and system policies; manage user profiles and system policies. These courses are set up for people to become proficient at running and maintaining technical networks. The goals are defined directly in terms of the skills companies or business will pay for.

This should not be the case for public education institutions. Technical teachers and curriculum developers must attempt to do more than teach technical skills. While the current literature can help us refine our perceptions as to what technology education is about, it is not clear which curriculum model is superior to the others. All five models have merits. Perhaps the best solution is to adopt Zuga's notion of integrating the strengths from the different models in curriculum development. This is especially important when designing curricula for different types of technical courses with different goals. A multimedia course could and perhaps should use a different model than a computer networking course. However, the notion of having students learn more than basic technical skills seems central. In today's society, problem solving, team work, and critical thinking skills are too important to neglect.

## Choosing a model for authoring Networking Technology 40S

All of the models have characteristics or aspects which can be incorporated when developing generalizable technical curricula. However, certain characteristics of each model are best suited to certain types of pedagogical activities. Since the purpose of this thesis is to find a suitable model for the delivery of technical curricula and to give a sample of such curriculum (Networking Technology 40S), the focus will now shift to implementing the research in developing the Networking Technology 40S curriculum.

The curriculum for Networking Technology 40S will comprise three fundamental fields of thought; a) the language of computer networking (introduction/overview), b) technical skills pertaining to computer networking (artifacts), and c) the ability to critically think about the whole enterprise of computer networking (planning, advising, problem solving).

As computers and technology in general becomes more complex, the need for developing technical language skills becomes more apparent. Students will need to be able to understand fundamental concepts of computers and technology. A lexicon of terms, concepts, and acronyms surrounds the field of computer networking. This is enhanced by the ever-increasing popularity of the Internet. Concepts and terms such as: TCP/IP, Ethernet, Fibre, 10BaseT, and others are becoming everyday terms. The need for studying technology for the sake of technology, at least in terms of computer networking, seems clear. Therefore, the overview or introduction to networking unit will employ concepts of the academic design. That is, this unit will take an in-depth look at the field of networking technology. The focus will be on treating computer networking as a field of study with it's own language, concepts and job opportunities. This first unit will begin with a brief history of computer networks and will then move on to the specifics of networking such as; hardware, software, cabling, topologies, protocols, and various other aspects of the field of computer networking. It will also give students a chance to look at the impact that computer networks have on society today and will likely have in the future. This overview or introduction unit will end with a glossary of terms needed for the rest of the course.

In the second unit, students will install and configure the various components required in creating a computer network. This unit will be performance-oriented and is thus best suited to the technical design. The technical model is the dominant model of choice for developing  select technical skills. In here it is expected that students will have to install network cards, configure and install network software, and generally do all the hands-on behaviors required for networking computers. That is, this unit is modeled after traditional technical courses that emphasize the development of 'trades' like skills.

The third unit (thinking critically about networks) will use the intellectual process design. Here the students will be encouraged to become problem solvers and planners as opposed to the typical 'trades' person of the above unit. Although the intellectual process model lacks a coherent framework, it is the model that holds the most promise for developing technical curricula to produce technically literate students. This model aims to develop self-confidence, creativity, critical thinking and problem solving. These are the attitudes and skills that need to be developed in order for students to succeed in the field of technology. Since little research exists on how to implement the intellectual process model, Johnson's (1992) article "A Framework for Technology Education Curricula Which Emphasizes Intellectual Process" will guide the development of this unit. The attempt here will be to incorporate Johnson's intellectual process model to give students a chance to act as network consultants. That is, this unit will allow students the opportunity to develop skills in; defining a problem, comparing and classifying networks, identify attributes and components of networking, and other intellectual process skills, by devising solutions to various networking scenarios.

Although the social model and the personal model have things to offer as well, they are not incorporated in the following sample of generalizable technical curricula. The personal design model is well suited for developing multimedia curriculum or other technical curricula that require a certain amount of artistic or learner-centered activities. However, it lacks the structure that is needed for a technical course such as Networking 40S. Likewise, the social model, which is not concerned about the specifics of content and the delivery of that content, is not well suited to the development of a computer networking course. Therefore, these two models are not incorporated in the following Computer Networking 40S curriculum.

**Networking Technology 40S**

General Learning Outcomes:

1. To understand computer networks and computer network topologies.
2. To understand the process required in planning and designing computer networks.
3. To develop a knowledge base for networking issues such as the legality of sharing applications and resources, data sharing, and security.
4. To setup and configure a small to medium sized computer network.
5. To develop skills in trouble_shooting computer networking problems.
6. To develop a knowledge base for employment opportunities in the field of computer networking.
7. To develop an attitude for life long learning.

Specific Learning Outcomes:

At the end of this course students will be able to:

* devise layouts for computer network environments given different scenarios.
* setup and configure a computer to act as the network server in a dedicated server environment.
* setup and configure computers in a peer_to_peer environment.
* setup and configure a computer to be a client or workstation in a dedicated server environment.
* establish resources such as data sharing, application sharing, and print sharing on a computer network.

* investigate job opportunities in the field of computer networking.

* have a working vocabulary in the area of computer networking.

* critically investigate computer networks in terms of; networking topologies, benefits of networks, hardware requirements, cost of networking, size of network, speed of networks, easy of installation and maintenance, and security.

**General Course Overview**

Introduction to Computer Networking.

This unit will introduce students to the concepts and terms required for computer networking. Topics include: a) the history of computer networking and the language associated with this technology, b) the hardware and software requirements for computer networking, c) the impact of computer networks on both the society of today and the future, and d) the job opportunities in the field of networking technology. All students must know the glossary of terms given at the end of this section. Familiarity with the language of networking is imperative for the units to follow.

Installing and Configuring Networks

This unit will discuss in detail many of the issues involved in establishing different types of computer networks. This unit focuses on the hands-on practical issues of establishing networks. The focus is to establish the concept of computer networking by installing and configuring all the pieces (hardware and software) required to connect two computers in a peer_to_peer network. This will then be expanded to a small LAN of about five or six computers. As the unit progresses, more complex networks which involve servers and clients will be introduced. Although Novell's Netware or Windows NT are good choices for the more elaborate or complex network environments, an AppleShare network will be enough to teach the necessary concepts. Students will learn; a) peer_to_peer networking using both coax (or LocalTalk) and ethernet, b) client/server networking using ethernet, c) how to establish resources for a network, and d) trouble shooting tricks and techniques.

Thinking Critically about Computer Networks

This unit will require students to think critically about the field of computer networking technology. They will be given the opportunity to evaluate and contrast different network topologies, hardware, software and other aspects of networking. The focus is on developing intellectual process skills like; a) identifying attributes and components of networking, b) comparing and classifying networks, and c) devising solutions to network problems. These thinking skills will be developed by having students create plausible solutions to given network problems or scenarios.

**Time Allotment**

As a one-credit course, Networking Technology 40S requires approximately 110 hours of instruction time. In order to reach the stated objectives this course requires students to have access to computer hardware for at least 60% of the allotted time.

**Sequence**

This curriculum outline contains 3 sections (Unit1: An Introduction to Computer Networking, Unit 2 (a - d): Hands-on Networking, Unit 3 - Thinking Critically about Networks) that require the given sequence. Although discussing client/server networks prior to peer_to_peer networks is not a problem, the order suggested seem to be a logical approach taken by many reference books and computer workshops.

**Hardware and Software Specifications**

The focus of this thesis is to write the following curriculum in a generic fashion. The assumption is that technical curricula such as Computer Networking 40S can and should be taught via generic concepts rather than specific software and hardware. The more access the students have to different network software and hardware the better, however all of the concepts can be taught on a simple low-end Macintosh network. Windows users will need some kind of networking software beyond Windows 95. Although Windows95/98 can be used for the peer-to-peer networking topics, it does not allow for the central server/client environment. The suggestion would be to obtain an NT environment that will allow you to connect Win3.1, Windows 95, NT workstation, and Macintoshes.

**Evaluation**

Evaluation should be based on: a) theoretical concepts of Networking, b) application of the skills(practice), and c) the ability to problem solve or think critically about networks.

Assessments can be carried out in various ways, such as the following:

- written tests (25% of over all grade);
- practical hands-on tests (students at the server and/or the client computer) (50% of over all grade);
- projects (25% of over all grade).

## Unit 1 - An Introduction to Computer Networking

**The student should:**

1. Define a computer network.

"two or more computers that are linked in order to share resources (such as printers, CD-ROMs), exchange files, or allow electronic communication".

(Used by permission, http://fcit.coedu.usf.edu/network/)

"two or more computers connected together by a cable so as to share data and communicate with each other".

2. Identify historical aspects of connecting computers.

- the first computers(1950's) were *mainframes (huge, expensive - millions of dollars, monsters that occupied entire buildings but only giving a few people access to computing).*

- these mainframes were used to crunch data entered via *punched cards (cards encoded with holes and then feed into a card reader terminal attached to the mainframe).*

- the data process was done at night in batches, this meant that your results were not available till the next morning.

- by the 1960's, offices were becoming equipped with modems, printers, card readers, and *"dumb" terminals (screens/monitors with a keyboard but no internal memory or processing capabilities).*

- this new office could buy time on a mainframe to use its processing power to aid in various offices needs, this was called *time-sharing (leasing time on a mainframe).*

- by the 1970's, offices were beginning to install *minicomputers (small versions of mainframes that are less powerful yet powerful enough for offices and businesses and are a lot cheaper - hundreds of thousands of dollars).*

- this local processing power brought about increased efficiency and use of computers.

- by the 1980's, microcomputers become available changing the office and business environment again.

- since microcomputers have their own processors as opposed to "dumb" terminals that do not, instant access to computing power became available to each person with a computer on their desk.

- this created a need for file or data sharing so as not to lose the integrity of data.

- by the late 1980's companies such as IBM were creating local area network (LAN) software.

3. Describe different types of computer networks.

a) LAN - Local Area Network

- a local area network is a network that is confined to a relatively small area. It is generally limited to a geographic area such as a computer lab, school, or building.(Used by permission, http://fcit.coedu.usf.edu/network/)

- in general, a local area network is a small computer network that consists of a server and several (or as many as a few hundred) workstations linked together.

b) WAN - Wide Area Network

- a wide area network connects large geographic areas together. In this type of network thousands of computers are linked together. In essence, the difference between a LAN and a WAN is the size of the network and the geographical distance between the computers on the network. A WAN may consist of a group of LAN's from different geographical locations.

c) Internet - International Network

- the Internet consists of millions of computers communicating over telephone lines. To date there are millions of computers acting as hosts (servers) while millions of other computers are used as workstations to serf the net.

d) Intranet

- is like the internet but is accessible only within an organization. These networks often use the World Wide Web interface to distribute information however access to the information is restricted to those who have identified IP numbers.

4. Identify the hardware requirements for computer networking.

a) File server - a file server stands at the heart of most networks. It is a very fast computer with a large amount of *RAM (Random Access Memory)* and storage space. The network operating software resides on this computer. Shared resources such as data files, and software applications also reside on the server. The server is usually the most expensive computer on the network.

Specifications for file servers - teachers should present several lists of requirements for network file servers at this point. The following list is only ONE example. This list needs to be updated with the times, that is, the following list will need to be modified and updated every 6 months in order for this to be relevant.

* 166 megahertz or faster (Pentium, PowerPC)
* a fast hard drive with at least four gigs of storage
* a tape back-up unit
* several expansion slots
* a high quality, fast network interface card (NIC)
* at least 32 MB of RAM

**NOTE**: students should be given the opportunity to price out a file server when given specification. This could be an assignment in the Server Unit. At this point, familiarity with the minimum required specifications is all that is needed.

b) <u>Workstation</u> - any computer connected to the server is called a client or workstation. Technically, workstations are referred to as nodes. Almost any type of computer can act as a workstation. Although most workstations have internal hard drives and floppy drives, these are not necessary requirements. However, a Network Interface Card (NIC), network software (drivers), and the appropriate cables are required.

c) Network Interface Cards (NIC) - The network interface card (NIC) provides the physical connection between the network and the computer workstation. Most NICs are internal, with the card fitting into an expansion slot inside the computer. Some computers, such as Mac Classics, use external boxes which are attached to a serial port or a SCSI port. Laptop computers generally use external LAN adapters connected to the parallel port or network cards that slip into a PCMCIA slot. (Used by permission, http://fcit.coedu.usf.edu/network/)

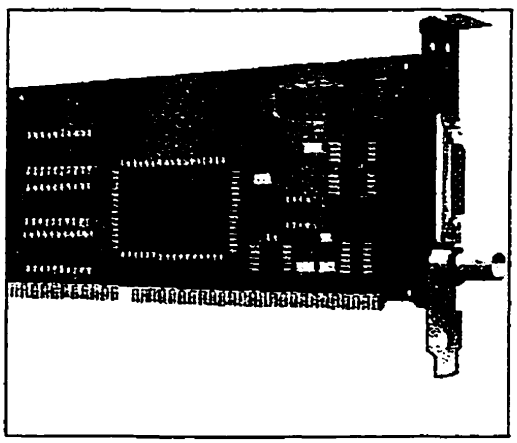
**NOTE**: Students should identify the three most common interface connectors.

i) Ethernet Cards

ii) LocalTalk Connectors

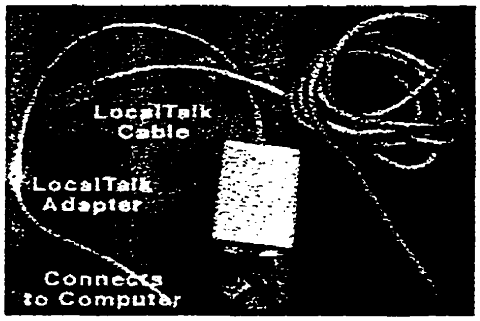
iii) Token Ring Cards

i) Ethernet - a type of communication card that breaks the data into addressed packets which can be transferred over coaxial, twisted pair, or fibre optic cabling.



(Used by permission, http://fcit.coedu.usf.edu/network/)

ii) LocalTalk Connector - Apple's solution for networking Macintosh computers. Although localtalk has an advantage over ethernet in that it does not require a hub ( more on this later), it is much slower than ethernet and only works with Macintoshes.




(Used by permission, http://fcit.coedu.usf.edu/network/)

iii) Token Ring Cards - a type of communication card that is used to pass tokens (of information) from one computer to another. This card looks like the above ethernet card except that it generally has a nine pin DIN connector instead of the other connectors.

d) <u>HUBS</u> - also know as concentrators are devices that connect the cables from the workstation and server together. That is, the hub usually contains 8, 12, or 24, RJ-45 ports mounted into a frame.

There are two types of hubs:

a) passive

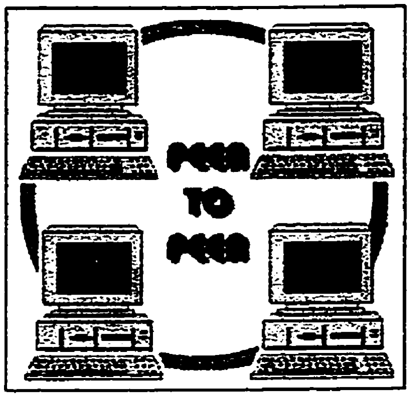
b) active.

The passive hub simply splits the signal, that is, allows the signal to pass from one device to another. The active hub amplifies or boosts the signal as it moves it from one device to another.

e) Routers - a device that translates information between different network protocols. For example, you need a router to connect your LAN to the internet.

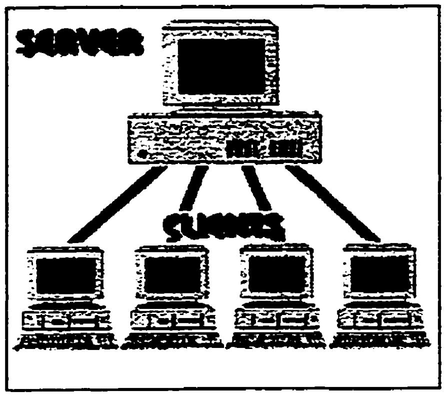
5. Identify two different network operating systems and be able to give the advantages and disadvantages of each.

a) Peer -to-Peer - a network where the computers are all considered equal. That is, there is no central (boss) computer that controls the network. Rather the computers on the network share resources (printers, files) with each other. This works well for small network environments (less than 100 workstations). These types of networks (Win 95, Apple System 7.0 & O.S. 8, Windows for Workgroups) are very easy to setup and configure. In fact, peer-to-peer networking is built into the above mentioned operating systems thus eliminating the need for a network expert or administrator. However, peer-to-peer networks do have the down side of not being very robust. They lack in security and centralization. Since there is no central computer, there is a loss of control over files and applications.



(Used by permission, http://fcit.coedu.usf.edu/network/)

b) Client/Server - in this type of network there is a central (boss) computer called the server which sends and controls the flow of information. The workstations in return only request information and do not provide resources for the network. This however is not always the case, many networks are a combinations of client/server and peer-to-peer. Typically in a client/server network the server is a fast, expensive computer that contains the networking operating system (NT, Novell, UNIX, Appleshare). The file server is the heart of the network, providing both resources and security. This leads to a large problem when the server crashes or goes down. That is, the entire network of printers, files, applications and security ceases to exist. The advantages of a client/server network are centralization, security, size (large networks of thousands of computers), and accessibility (servers of this nature can be accessed remotely). However, there are disadvantages as well. These networking operating system require experts to: a)setup and configure the network, and b) maintain and manage the network. This can be very expensive.



(Used by permission, http://fcit.coedu.usf.edu/network/)

6. Identify the most common network protocols.

a) Ethernet - the most widely used protocol. Ethernet uses an access method called CSMA/CD (Carrier Sense Multiple Access/Collision Detection) where each computer listens to the cable, and then, if the cable is clear, it sends a packet of information to which ever computer it wishes to communicate with. A collision occurs when two or more computers attempt to send a packet of information at the same time. Both computers will then back off and retry to transmit after a short delay. This is normal for an ethernet network. Since the delays are short and transmission rate is fast (10mbps), this protocol is becoming the standard for computer networks.

b) LocalTalk - Apple's own network protocol. It was developed for the Macintosh platform which can establish peer-to-peer networking without the need of additional software. This method uses CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance). That is, a computer signals its intent to transmit before it actually does so.

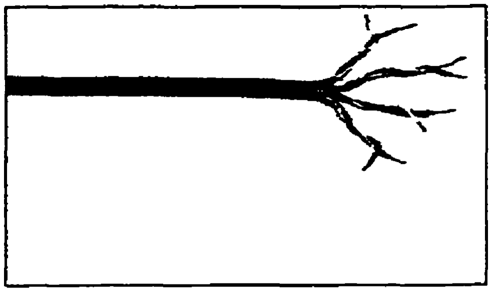
c) Token Ring - this protocol was developed by IBM in the mid-1980s. In this protocol a packet of information, called a ring, is passed from one computer to the next. The computers are connected in a logical ring with the signals of information moving from one computer to another along the ring. Due to the increased popularity of ethernet, token ring has decreased in popularity.

d) TCP/IP - Transmission Control Protocol/Internet Protocol. The standard protocol for communication on the internet.TCP and IP were developed by a Department of Defense (DOD) research project to connect a number different networks designed by different vendors into a network of networks (the "Internet"). It was initially successful because it delivered a few basic services that everyone needs (file transfer, electronic mail, remote logon) across a very large number of client and server systems. Several computers in a small department can use TCP/IP (along with other protocols) on a single LAN.

(Used by permission, http://pclt.cis.yale.edu/pclt/comm/tcpip.htm)

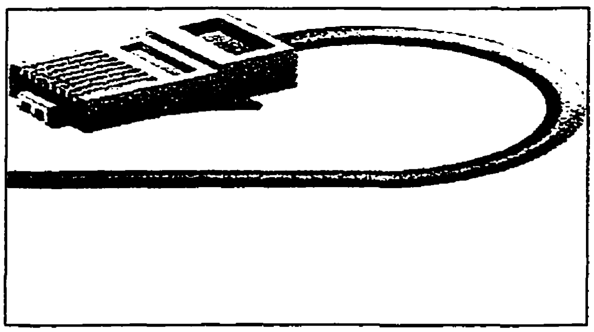
7. Identify the different cabling options available for computer networking and be able to give the advantages and disadvantages of each.

a) Twisted Pair - comes in two formats: shielded and unshielded. The unshielded twisted pair is the most popular and the quality may vary from telephone-grade wire (less than 4mbps - category 1) to extremely high speed (100mbps - category 5). Most schools use the medium (or category 3) quality which can transmit 10mbps. Shielded twisted pair is twisted pair with an extra shielded cover over the twisted wires. This is needed in areas of high electrical interference. The wire is called twisted pair because it consists of four pairs of wires that are twisted together.



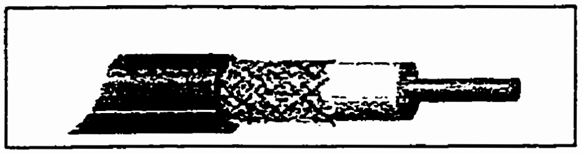
(Used by permission, http://fcit.coedu.usf.edu/network/)

The standard connector for twisted pair cabling is a plastic jack (RJ-45) that looks a lot like a typical phone connector. The difference being that a phone conector is designed for a cable with 4 separate wires whereas the RJ-45 connector is designed to work with a cable that contains 8 separate wires.



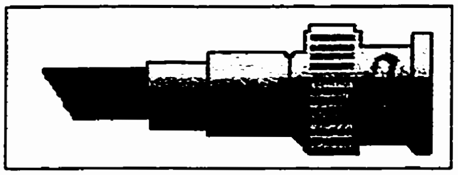
(Used by permission, http://fcit.coedu.usf.edu/network/)

b) <u>Coaxial</u> - also comes in two flavors: thinnet (10Base2) and thicknet (10Base5). Coaxial cable contains a single copper conductor surrounded by a plastic layer of insulation. The insulation layer is covered with a metal shield to help reduce interference. The final layer is an outside protection layer.



(Used by permission, http://fcit.coedu.usf.edu/network/)

Different types of adapters are available for BNC connectors, including a T-connector, barrel connector, and terminator.



(Used by permission, http://fcit.coedu.usf.edu/network/)

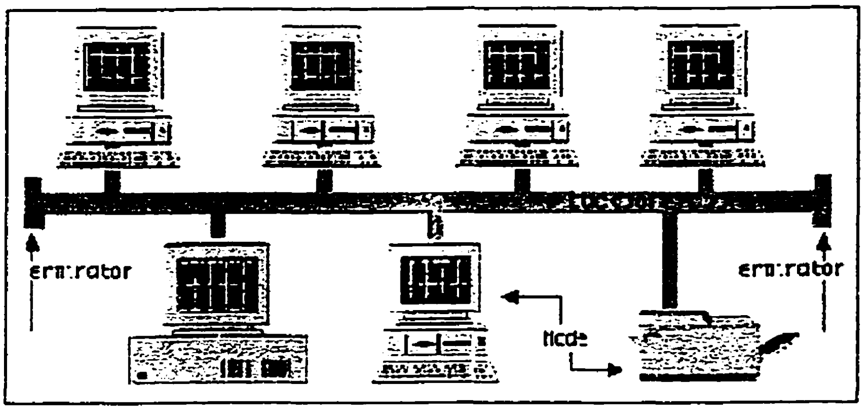
c) Fibre Optic - consists of a center glass core surrounded by layers of protective material. Of the given cables, this is the most high speed and the most expensive. It transmits light rather than electronic signals thus eliminating the problem of interference.

(Used by permission, http://fcit.coedu.usf.edu/network/)

The most common connector for fibre optics is the ST connector which looks similar to a BNC connector.

8. Identify the most common network topologies and be able to state their advantages and disadvantages.

a) Linear bus - a linear bus topology consists of a main run of cable with a terminator at each end. All workstations and servers on the network are connected to the linear cable. Ethernet and Local Talk networks use a linear bus topology.



(Used by permission, http://fcit.coedu.usf.edu/network/)

Advantages of a Linear Bus Topology

•Easy to connect a computer or peripheral to a linear bus.

•Requires less cable length than a star topology.

Disadvantages of a Linear Bus Topology

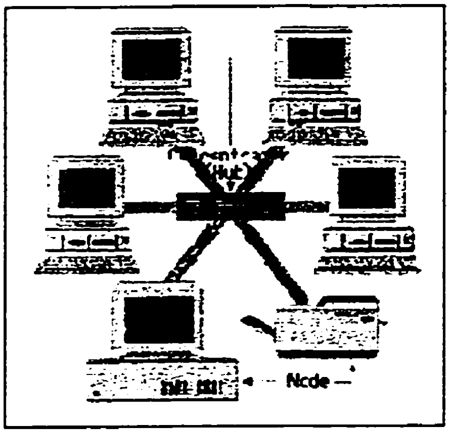
•Entire network shuts down if there is a break in the main cable.

•Terminators are required at both ends of the backbone cable.

•Difficult to identify the problem if the entire network shuts down.

•Not meant to be used as a stand-alone solution in a large building.

b) <u>Star</u> - a star topology is designed with each node (computer, peripheral) connected to a central network hub. All the data passes through the hub before continuing on to its destination. Star configurations usually use Ethernet or Local Talk protocols.




(Used by permission, http://fcit.coedu.usf.edu/network/)

Advantages of a Star Topology

•Easy to install and wire.

•No disruptions to the network when connecting or removing devices.

•Easy to detect faults and to remove parts.

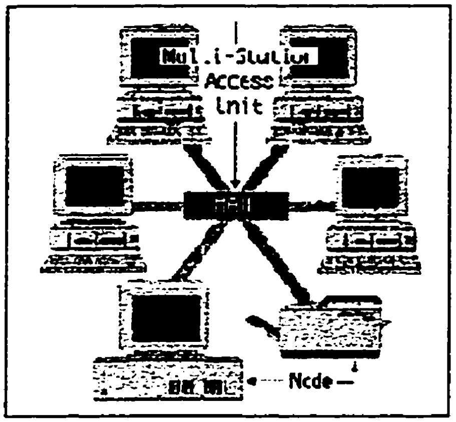
Disadvantages of a Star Topology

•Requires more cable length than a linear topology.

•If the hub or concentrator fails, nodes attached are disabled.

•More expensive than linear bus topologies because of the cost of the concentrators.

c) <u>Star-Wired Ring</u> - this appears the same as a star topology except that in the center of this network exists a multistation access unit (MAU) instead of a hub. The MAU allows information to pass from one machine to another in a circle or ring. The Token Ring protocol uses a star-wired ring topology.




(Used by permission, http://fcit.coedu.usf.edu/network/)

**Summary of Cables/Protocols/Topology**

| <u>Protocol</u> | <u>Cable</u> | <u>Speed</u> | <u>Topology</u> |
|---|---|---|---|
| Ethernet | Twisted Pair, Coaxial, Fiber | 10 Mbps | Linear Bus, Star |
| Ethernet | Twisted Pair, Fiber | 100 Mbps | Star |
| LocalTalk | Twisted Pair. | 23 Mbps | Linear Bus, Star |
| Token Ring | Twisted Pair | 4 Mbps-16 Mbps | Star-Wired Ring |

9. State the impact of computer networks on society.

Have students use the Internet and computer magazines to find information for the following types of questions:

a) How have computer networks change the office environment over the past 15 years?

b) How are computer networks (including the Internet) changing today's office environment?

c) How are computer networks changing a school and the delivery of education?

d) How are computer networks changing the way people buy and sell goods?

e) What effect does the Internet have on the way people communicate?

f) What kinds of changes have been made to the legal system (laws) in the past few years?

g) How has the introduction of remote terminals for money transactions changed the way society functions?

h) What role do computer networks play in war?

i) How do computer networks (especially the Internet) provide freedom of expression?

NOTE: The following magazines and WEB sites would be useful for the above discussions:

* IEEE: Technology and Society Magazine
* http://www.byte.com/
* http://www.currents.net/

* http://neumann.computer.org/

* http://ejournals.cic.net/toc.Topic.html

10. Describe the job opportunity in the field of computer networking.

    a) Network Administrator

    b) Network Security Specialist

    c) Data Recovery Operators

    d) WEB designers and programmers

    e) JAVA programmers

    f) Cable and hardware specialists

    g) Sales (hardware, software, cabling)

    h) Computer Engineering

NOTE: use the WEB (Internet) for information about Computer Networking Jobs.

12. Know the following terms:

    LAN, WAN, Internet, Intranet, File Server, Client/Workstation, Ethernet, AppleTalk, TCP/IP, Token Ring, Hub, Router, Peer_to_Peer, Twisted Pair, Linear Bus, Star, Peripherals, Modem, cable, 10Base2, 10Base5, 10Baset, Coax, Node, Network Interface Card, Protocol, RJ-45, Ports, JAVA, Novell, NT, Appleshare, Terminator, Tree Topology, Segment, Fibre Optics, BNC, Workgroup.

## Unit 2A - Establishing a Peer-To-Peer Network

**The student should:**

1. Connect two computers using peer-to-peer network software without a hub (Appleshare, Win95)

    a) Identify the components needed to network two computers:

    - cabling (either coax with two T- connectors -PCs, or two PhoneNet connectors and a PhoneNet cable- MAC).
    - two network interface cards with coax connectors - PCs.
    - software (MAC system 7 or higher, Win95).
    - two computers (one to share resources and the other to use or access the shared resources).

    b) Physically connect the two computers

<u>**FOR PCs**</u>

Install and configure the Network Interface Card

NOTE: for PCs/Win95 you will need to install and configure the Network Interface Cards before you continue (see the Read-me file that comes with the network card and then configure with the disks distributed with the card).

Here is generally what needs to be done.

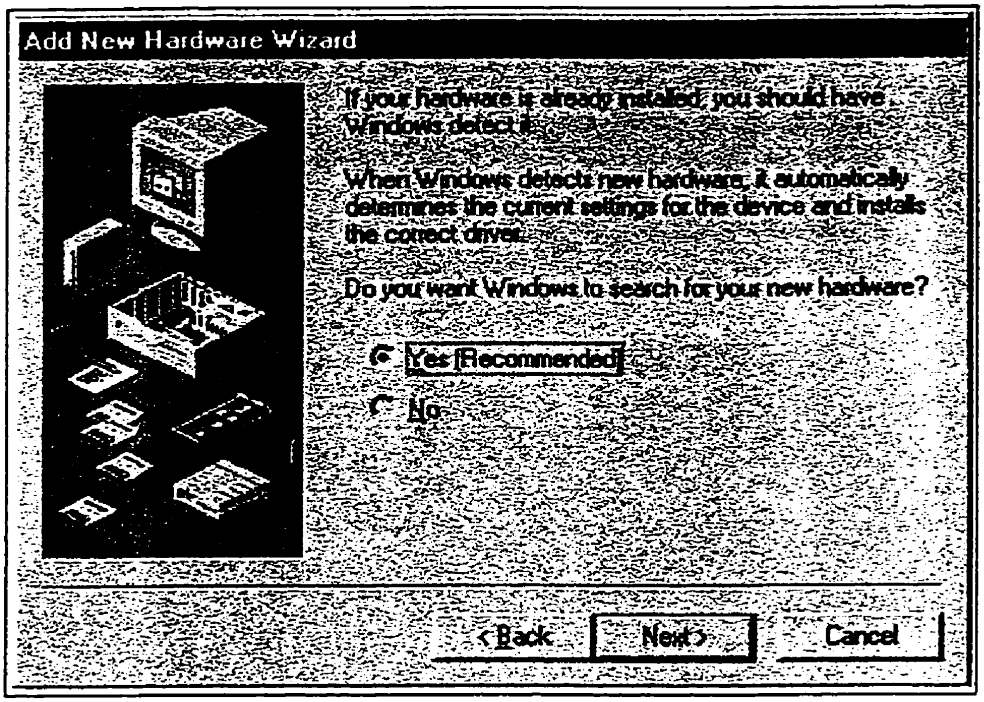
<u>Adding Your Network Adapter</u>

1.Open up the Control Panel

2.Click on Add New Hardware

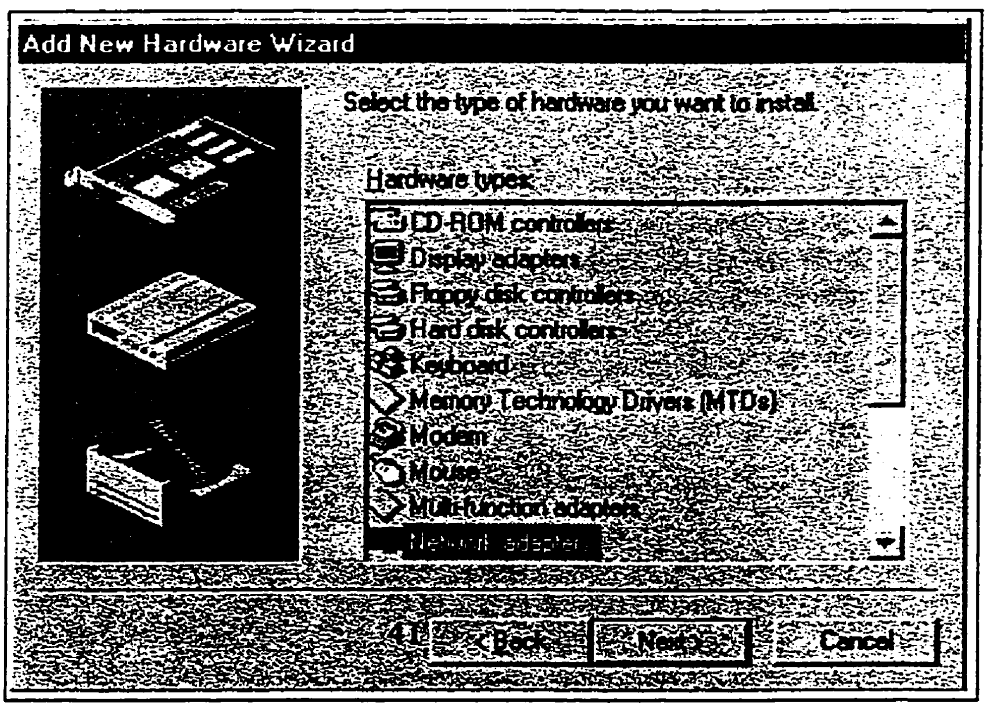
3.Click the Next button

4.You can either have Windows95 search for the adapter by selecting YES or select NO to manually enter the adapter.

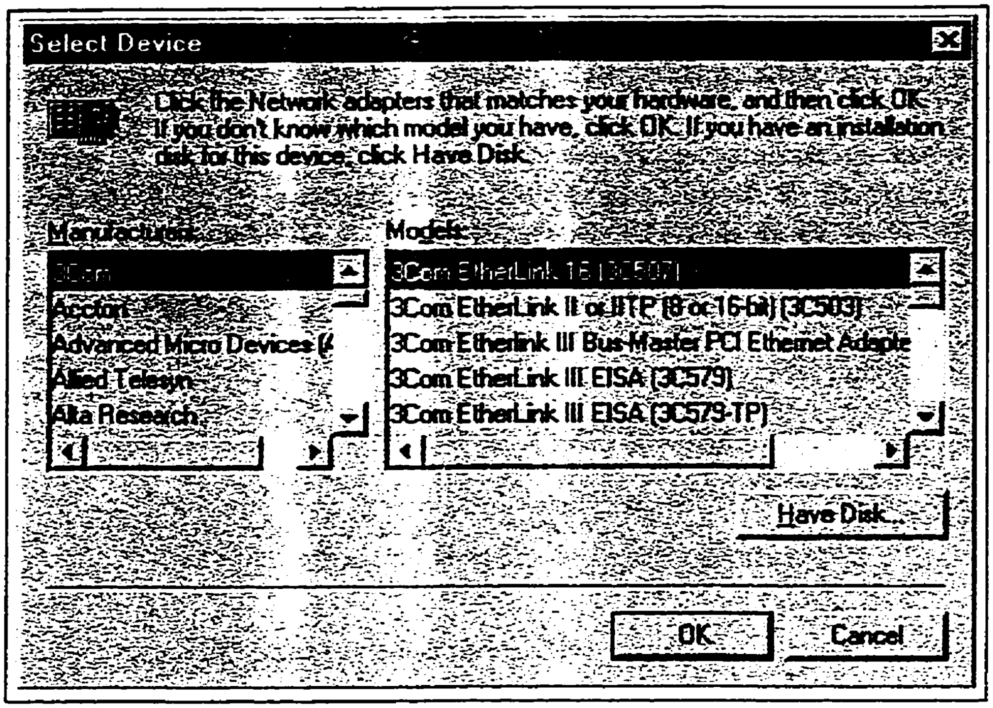



5.Click the Next button

6.If you selected NO, you will need to manually select an adapter.



7. Click next.




8. Reboot if requested.

**FOR Macs**

Since Macintosh computers come with network capabilities built into the system, all that is needed are two LocalTalk connectors and a LocalTalk cable. Simply connect the a LocalTalk connector to the printer port of each Macintosh and then connect these adapters together with a LocalTalk cable. This will allow you to construct a peer_to_peer network using Apple's LocalTalk protocol.

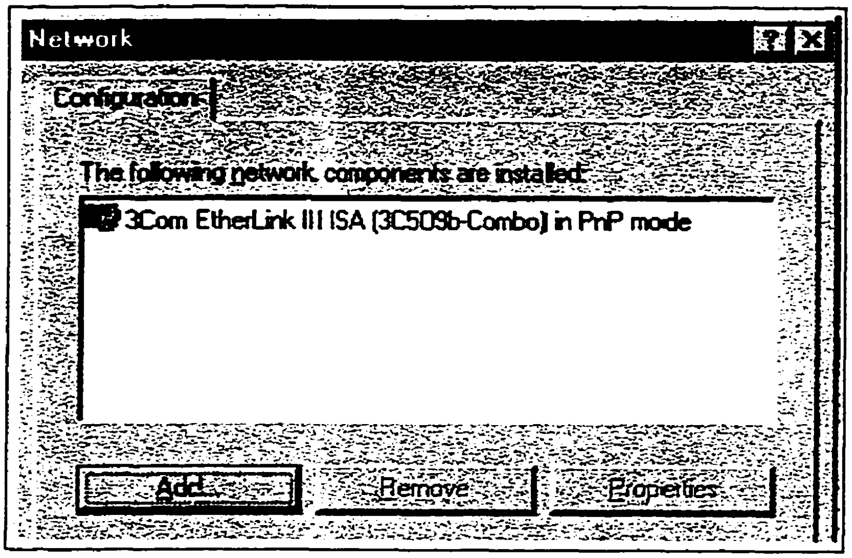
c) Configure the computer that will share resources (act as server)

**For Win95**

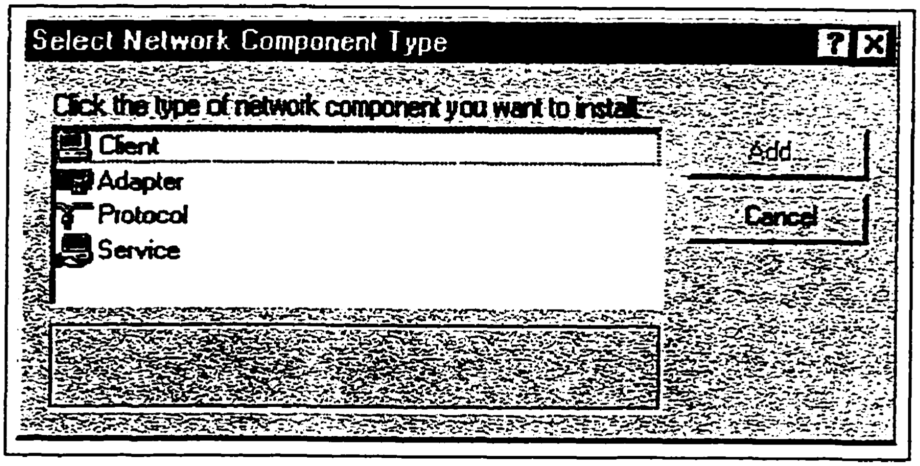
- open My Computer.

- open Network and the following window should appear (after properly installing the NIC).

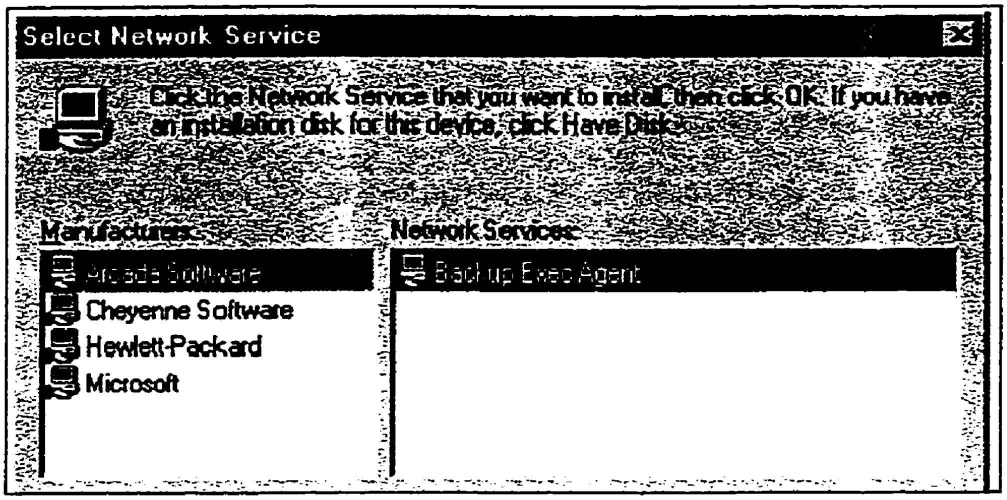
NOTE: your card should appear in the pop-up window shown below (may be different than 3COM Etherlink III ISA).




-click the ADD button and the following window should appear.



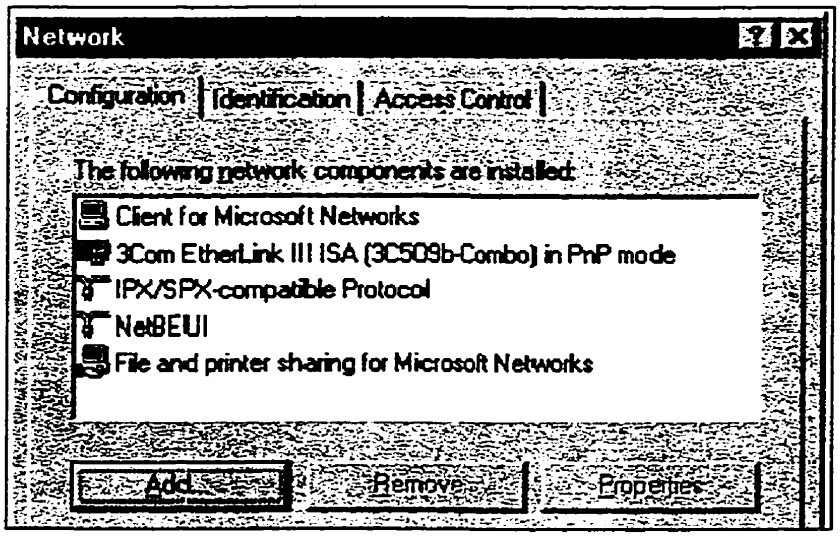
- click Service and then the ADD button to get to the following screen.




- click Microsoft and then four categories will appear in the above Network Service window (i.e. the window on the right side above)

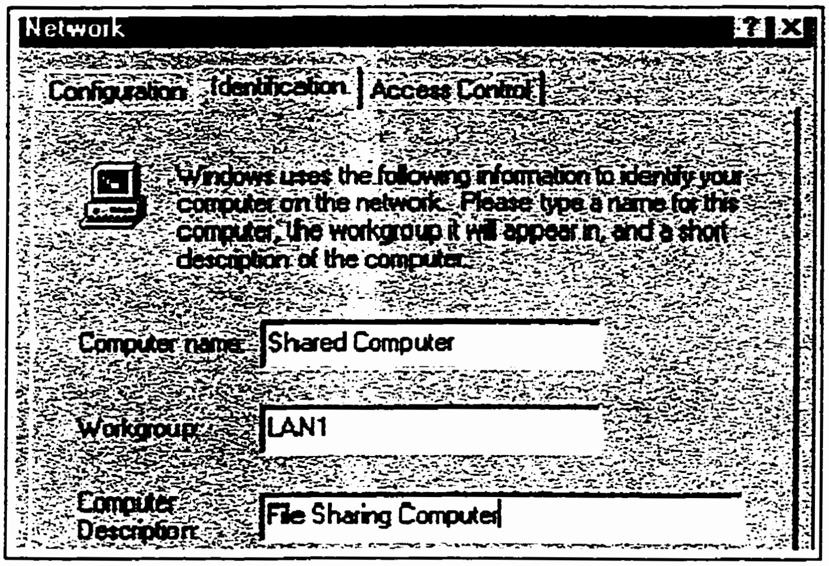
- from the choices given, pick "File and print sharing for Microsoft Networks" and then click OK.

- the following components will have been added.



- since Win95 is very user friendly, most of the components above will now be configured. However, you need to identify this computer on the network.

- click on the identification tab at the top of the above window and identify this computer (example configuration below).




- click OK and you will be prompted to restart your computer

<u>Setup a shared drive</u>

- double-click My Computer on your desktop, then select the drive you wish to share.

- click the right mouse button, and select the Sharing option. The Sharing dialog box will appear.

- choose a name that you would like to share the drive as.

- choose the type of access you'd like to allow to remote users.

Read-Only access means that remote users can only read the information on the drive - they cannot change or delete any files. Full Access gives remote users the ability to delete files and/or directories, make new files and/or directories, and rename files and/or directories. You can allow both types of access, depending on passwords, by selecting the Depends on Password option.

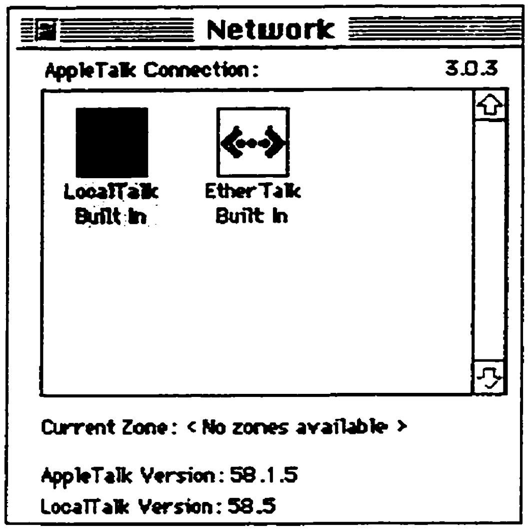
- choose and fill in passwords for the different types of connections. If you enter a password, remote users will be prompted for a password when they attempt to connect to your drive. If you enter no password, remote users need only connect to the shared device, and they will have access. Press OK and Windows 95 will prompt you to confirm your password(s). Your drive will then be shared (it will display a little open hand under the drive icon in My Computer).

Setup a shared folder.

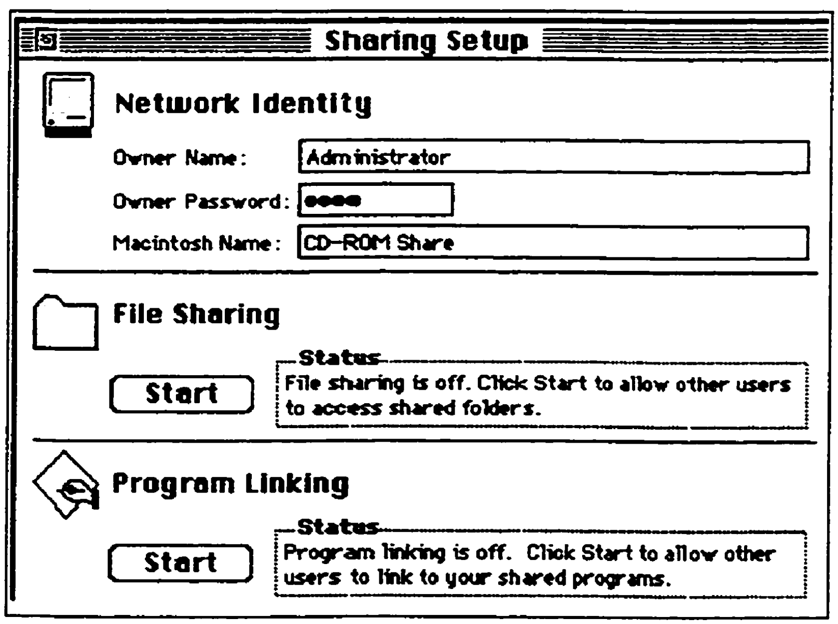
Sharing a folder is identical to sharing an entire drive, except that you select a folder icon before pressing the right mouse button, selecting the Sharing option, etc. If you share a drive and share a folder on the drive, both will be displayed as shared resources when remote users connect to your machine.

**FOR Macintosh**

- open the Chooser and activate LocalTalk (make sure AppleTalk is active).



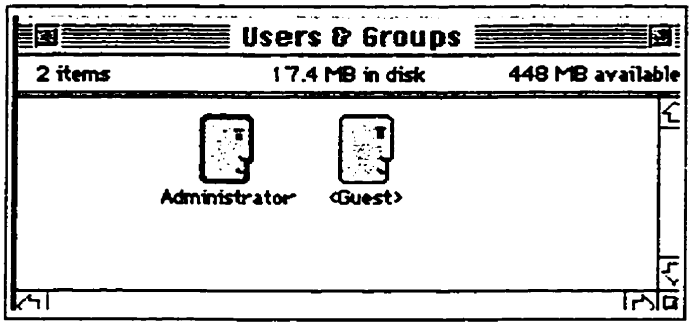

- open the Sharing Setup in the Control Panel and configure as shown below.



- type an Owner Name, Owner Password, and Macintosh Name

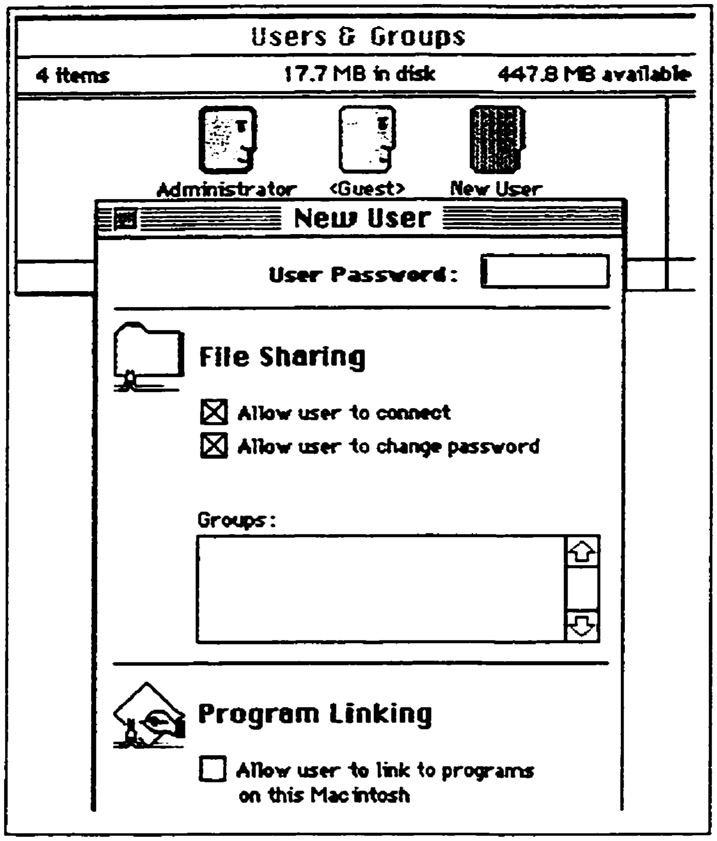
- click Start for both File Sharing and Program Linking. Note: program linking will allow other computers to run applications off of this computer.

- open the Users & Groups in the Control Panel. The following users should have been created.




- choose New User from the File Menu and then give a name for the new user (example REC).

- open the New User (double click on the icon) to see the following window.

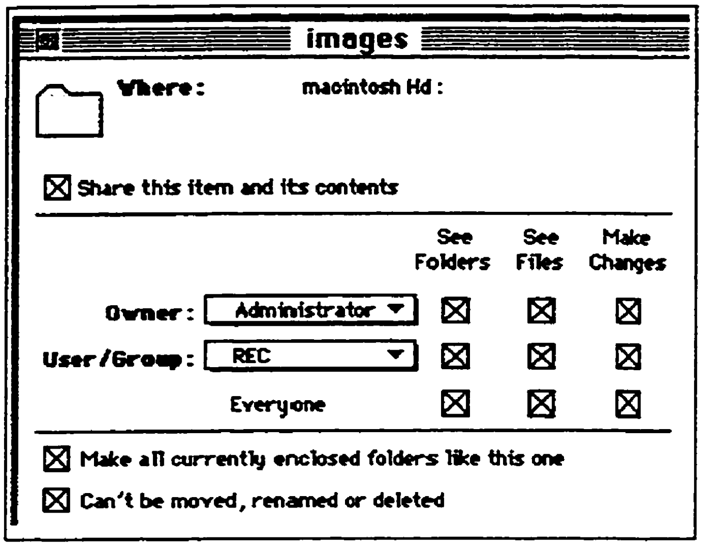



- set "Allow users to connect", but, depending on security issues, you may wish to not set a password and therefore you don't need to set the "Allow user to change password".

- the Program Linking feature is as described above.

- close this window and select a drive, folder or CD-ROM that you want to share.

- choose Sharing from the Files Menu to see the following window.




- decide on the purpose of this shared solder before setting the above settings. That is:

  a) you need to set "Share this item and its content"

  b) the owner (Administrator) should have full access

  c) for the User/Group select the name of the user that you are giving access (example REC)

  d) set the "Make all currently enclosed folders like this one" and "Can't be moved, renamed or deleted" as you wish.

- Save and close window.

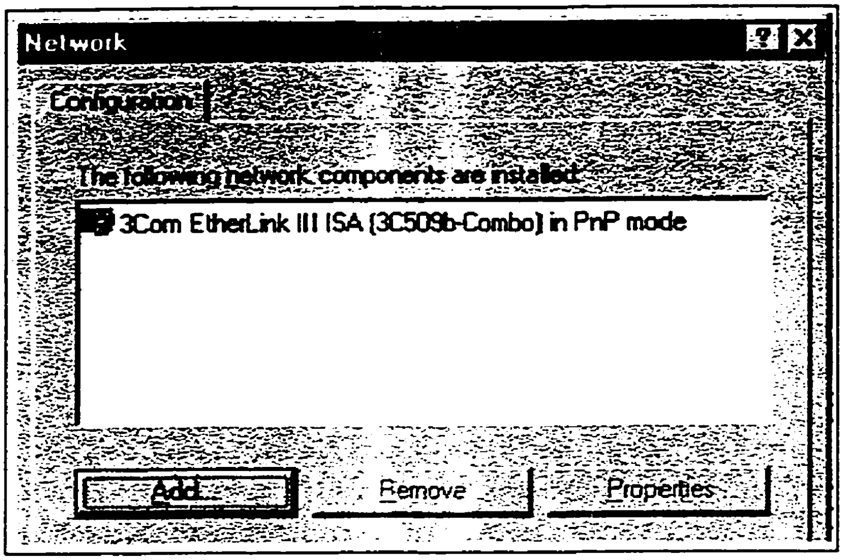
d) Configure the computer that will access the resources (act as client)

**FOR Win95**

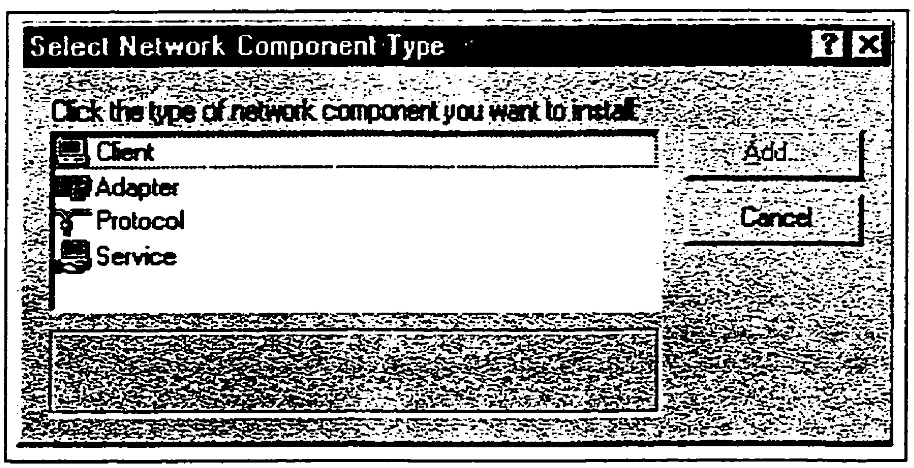
- open My Computer.

- open Network and the following window should appear (after properly installing the NIC).

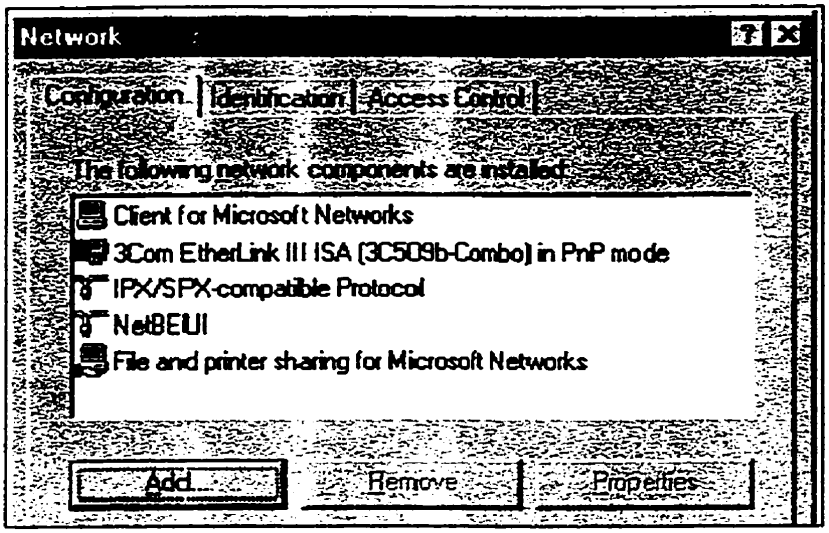
NOTE: your card should appear in the box below (may be different than 3COM Etherlink III ISA).




- as above (for the computer sharing the resources) click the Add button to get to the following screen.



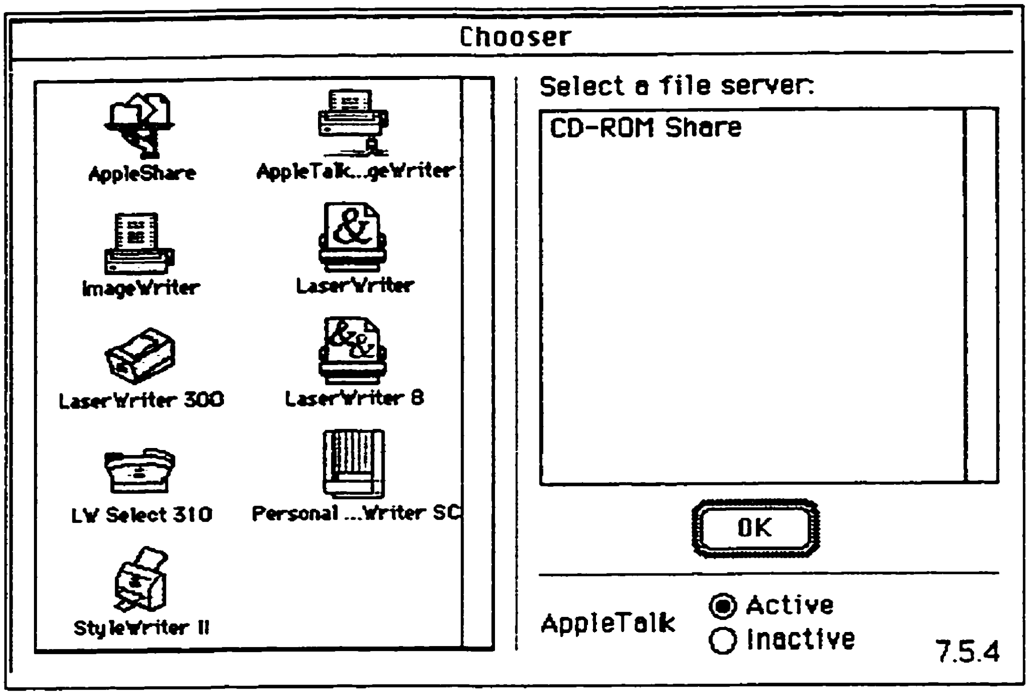

- Choose client and then ADD to get to the following window.



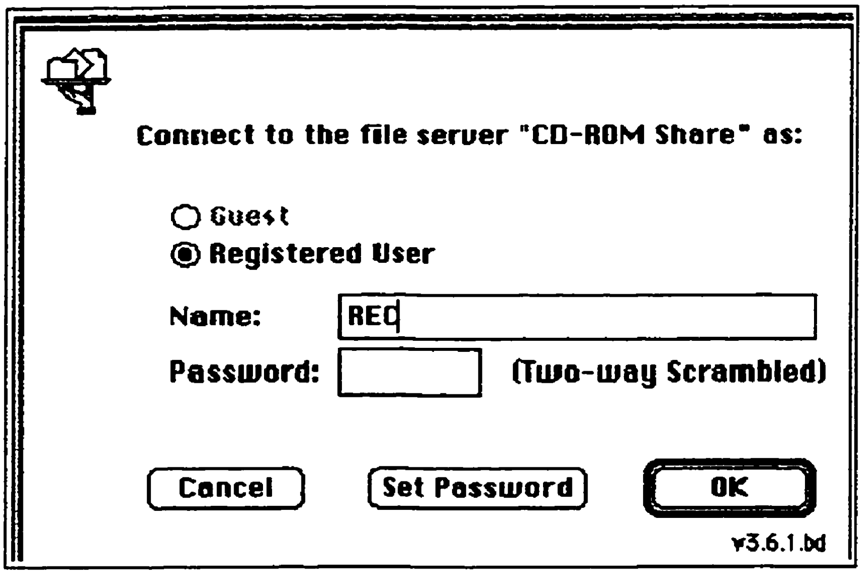

- click the Identification tab at the top of the above window and then name this computer and type in the name of the workgroup (from the example above this would be LAN1).
- click OK and restart the computer (you will be prompted to do so).
- after restarting the computer, open the Network Neighborhood.
- the name of the shared computer ("Shared Computer") should now exist in the Network Neighborhood, double click the "Shared Computer" icon to gain access to this computer.

**FOR MAC**

- setup LocalTalk as in server above.
- open Chooser and click on the Appleshare icon to see the following window. Note: the name of the shared computer should appear in right window.

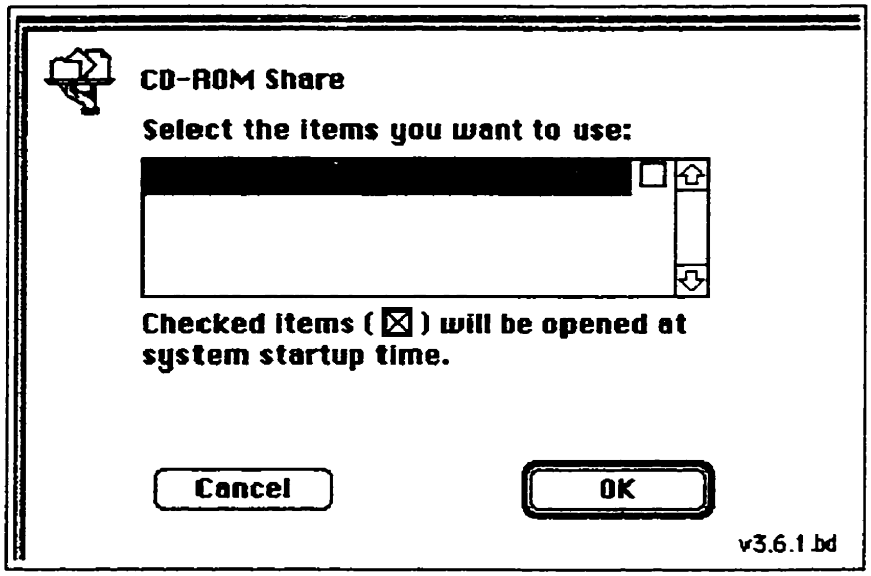



- Click on "CD-ROM Share" or whatever name you gave to the sharing computer and the following window should appear.

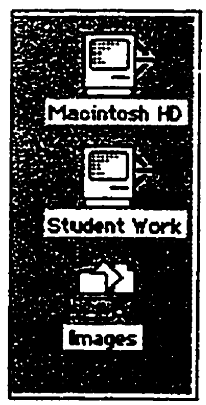


- type in the user name and password (from above example: user is REC with no password).

- Click OK to see the following window.




- Click OK and the Images folder should appear on the desktop as a shared drive.




- You have now connected and have access to the "Images" folder on the shared computer.

2. Connect several computers using peer_to_peer network software with a hub (Appleshare, Win95)

The procedure for this is as described above with the following exceptions:

**<u>For PCs</u>**

- replace the coax cable with twisted-pair cable.

- run a twisted-pair cable from each computer to the hub.

**<u>For Macs</u>**

- replace the LocalTalk adapters with ethernet adapters.

- replace the LocalTalk cable with twisted-pair cable.

- run a twisted-pair cable from each computer to the hub.

- open the Network in the Control Panel and change the protocol from LocalTalk to EtherTalk.

3. File Share a printer on a peer-to-peer network.

The steps needed for this are a lot like the steps taken to share a folder or drive. Due to the various types of printers and drivers available, it is difficult to give the exact steps needed. Therefore, only the general steps or concepts will be given.

**<u>For PCs</u>**

- hook-up your printer and install the appropriate printer drivers.

- make sure both file and print sharing are turned on.

- open the Printers folder in My Computer and select the printer you wish to share.

- right mouse click and choose Properties.

- click on the Sharing.

- click Shared As and then name the printer for the network

- click OK, the printer is now a shared resource on the LAN.

**For Macs**

- hook-up your printer and install the appropriate printer drivers.

- open the Chooser and select the printer that you wish to share as.

- click the Setup button..

- select "Share this Printer" and then name the printer for the network.

- click OK, the printer is now a shared resource on the network.

4. Configure several computers on the peer-to-peer LAN to act as both servers and clients.

The steps needed for this procedure are just as described in topic 2 above. That is, a computer in a peer-to-peer network can act as both a server and a client. Both the server and the client software need to be configured.

## Unit 2B - Establishing a Client Server Network

**The student should:**

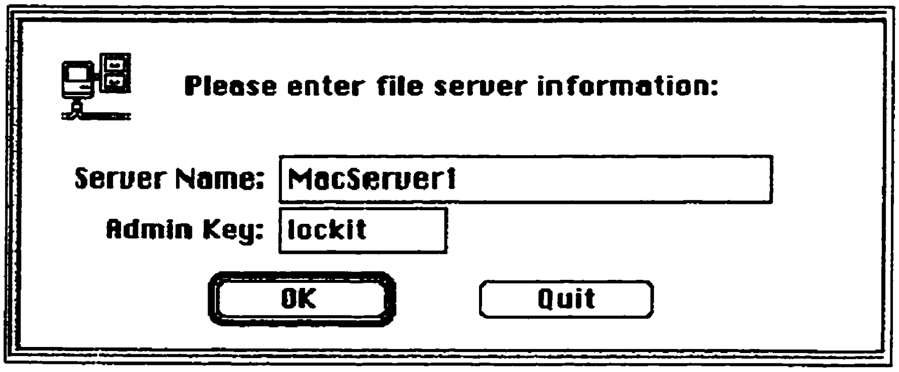
1. Setup and configure a server for a client server network using twisted pair cable, a hub, and ethernet.

For Macs (hookup cables and hub as in the peer_to_peer network unit and make sure the EtherTalk protocol is installed and activated)

i) Setup and Configure the Server using Appleshare.

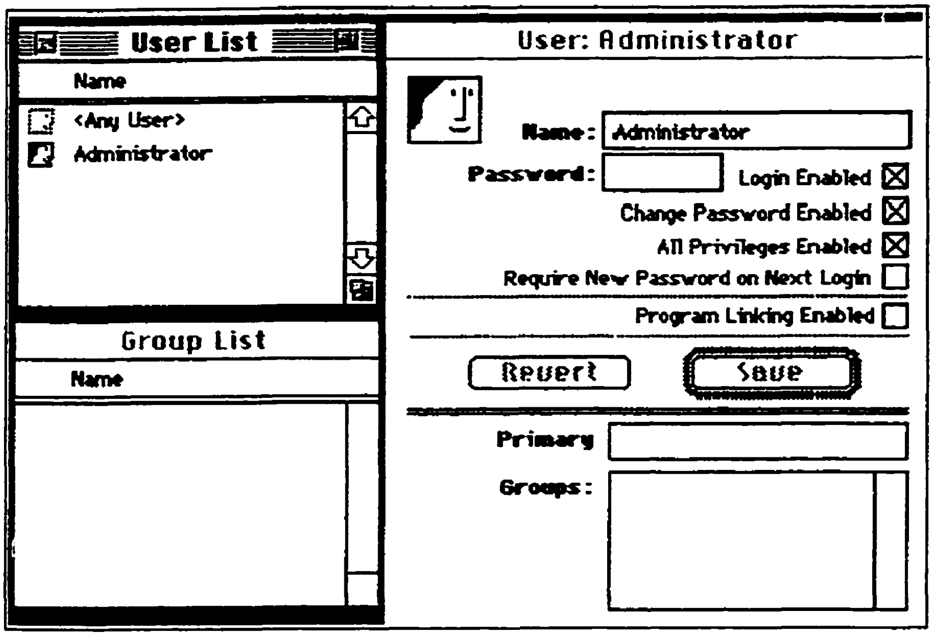
- run the installer to install Appleshare Server, and Print Server.

- open Appleshare Admin and the following window will appear.




- enter in the name you wish to use for the server and enter a password for the Admin Key.

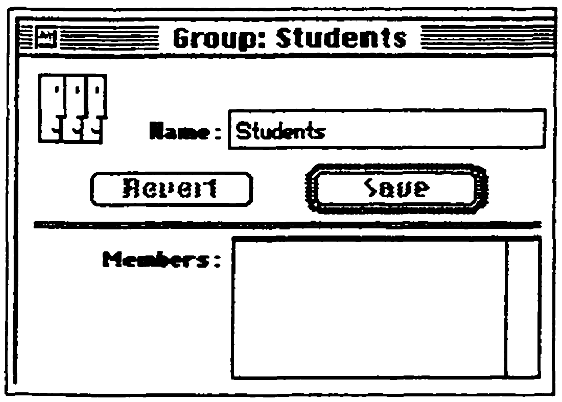
- click OK to get to the following window.




Note: set the Administrator Password and what ever privileges you would like for the Administrator. Since client/server environments are usually large (i.e. much larger than peer-to-peer networks) it is a good idea to create groups before creating users.

ii) Creating a new group.

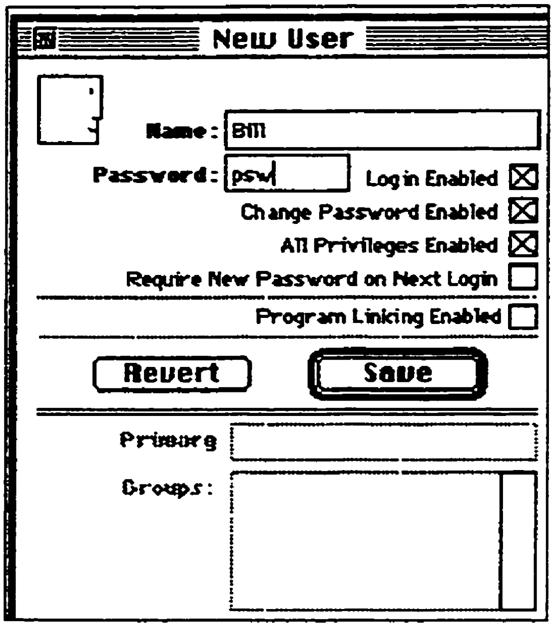
- Select "Create Group" from the "Groups" menu to get to the following window.



- enter a group name and click "save". Note: the "Students" group is now added to the group window.

iii) <u>Create a new user.</u>

- Select "Create User" from the "User" menu to get to the following window.

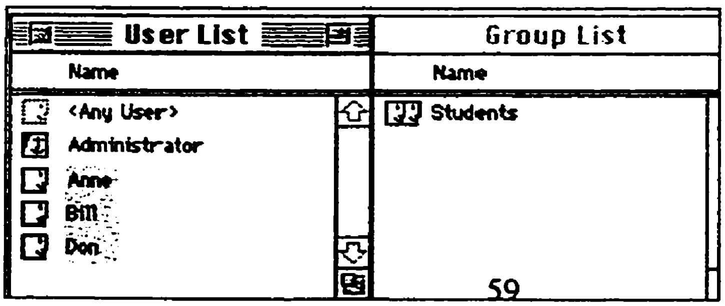



- give the user a name, and a password (if desired), and select the appropriate settings.

- click "save" and the user "Bill" will be added to the user list.

- add several more users (Anne, and Don) by repeating the steps above.

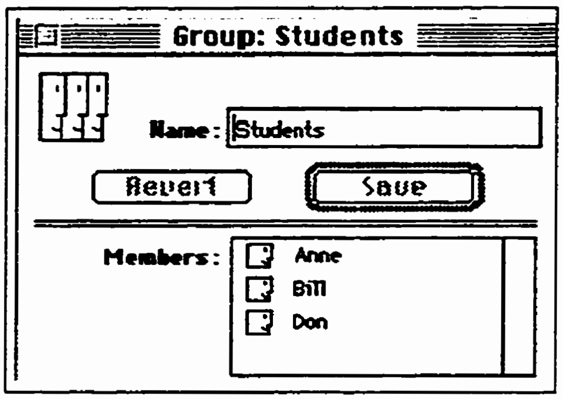
- open the following window.



iv) Adding Users to a Group.

- select the new users (Anne, Bill, Don) and drag them onto the "Students" group in the "Group List" window.

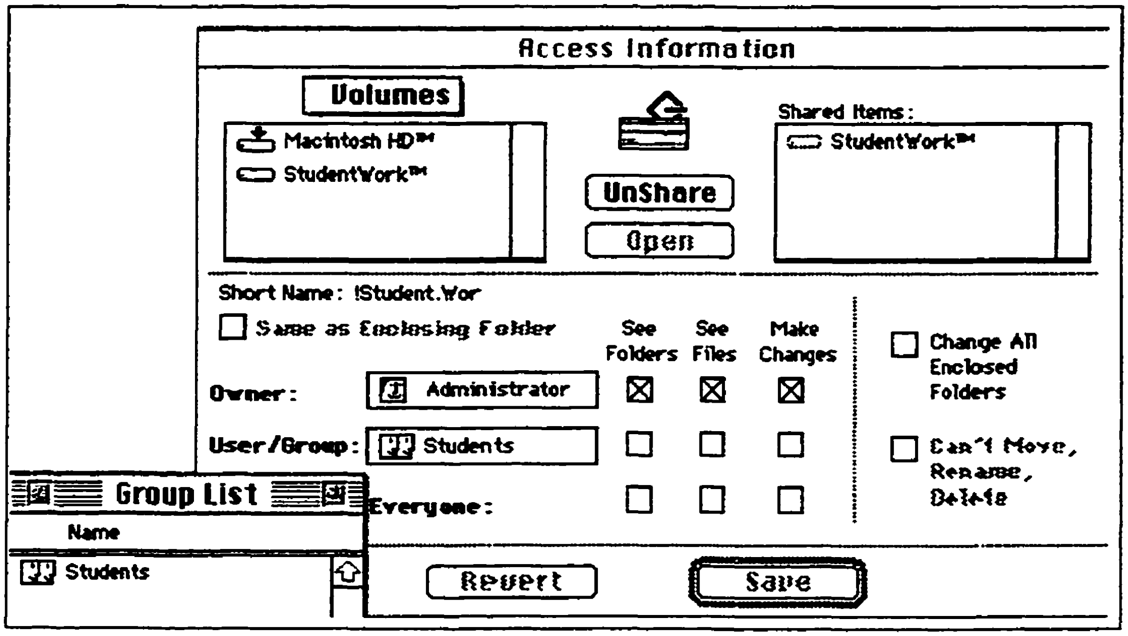
- open the "Students" group by double clicking on "Students". The following window will appear.




- click "Save". You have now created a group of "Students" that contains several users.

v) <u>Access Privileges.</u>

- select "Access Information" from the privileges window to get to the following window.




- select a drive that you wish to share and then click the "Share" button. The drive will now be added to the "Shared Items" window.

- add the "Students" group to this window by dragging it from the "Group List" window to the "User/Group" box in the "Access Information" window.

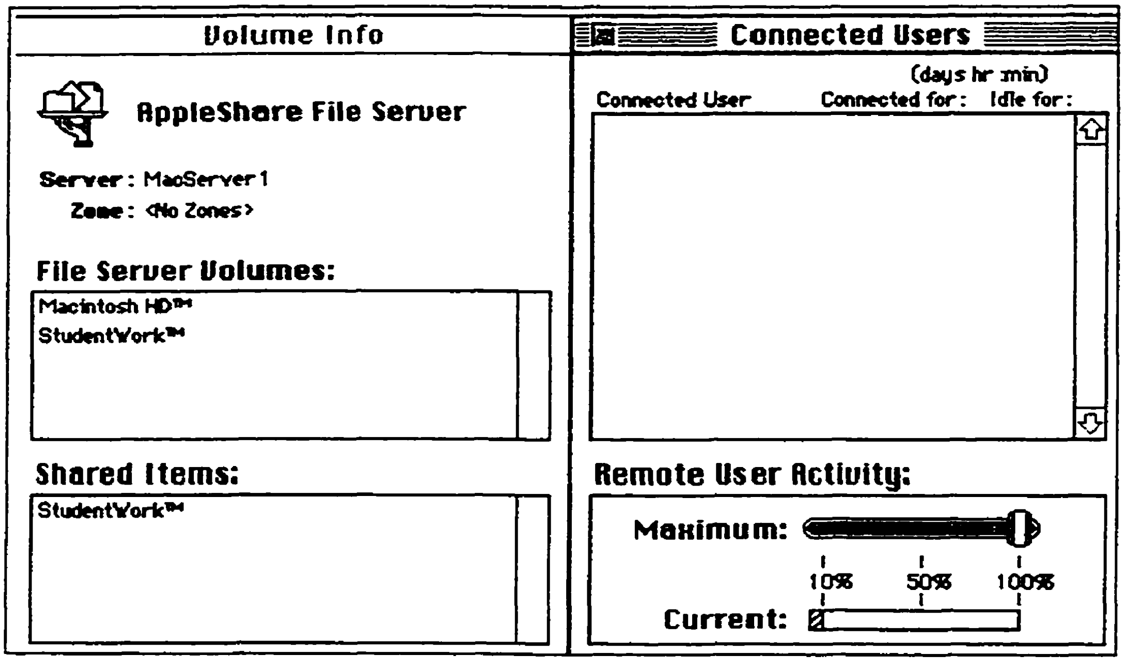
-select appropriate settings for the "Students" group. Note: Make Changes enables write privileges.

- click Save. The group "Students" now has access privileges to the "Student Work" drive.

- close Appleshare Admin.

vi) Run Appleshare File Server.

- open Appleshare File Server and then choose "Show connected users" and "Show Volume info" from the Server menu. The following window should appear.




- AppleShare is now configured and running with a shared item and a group of "Students". If you wish to set a logon greeting you may do so by choosing "Greeting Message" from the Server menu. A window will appear where you can type your greeting.

**For PCs** (hookup cables and hub as in the peer-to-peer network unit and make sure the appropriate protocols are activated)

i) <u>Setup and Configure the Server using Windows NT Server.</u>

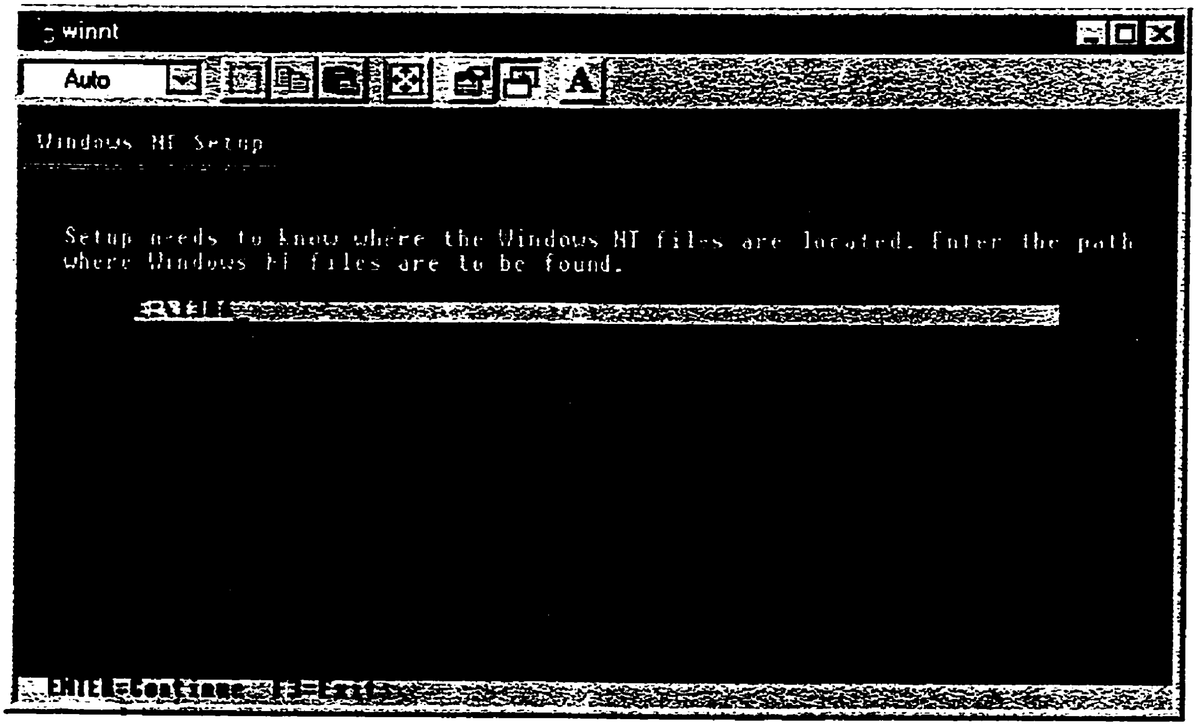
The notes for this section (i) are copied from the following web site:

http://web66.umn.edu/WinNT/CookBook/GettingStarted/Install/Default.html

- boot the computer from Disk #1 of the NT Server disk set and place the Windows NT Server CD-ROM in the drive when prompted.

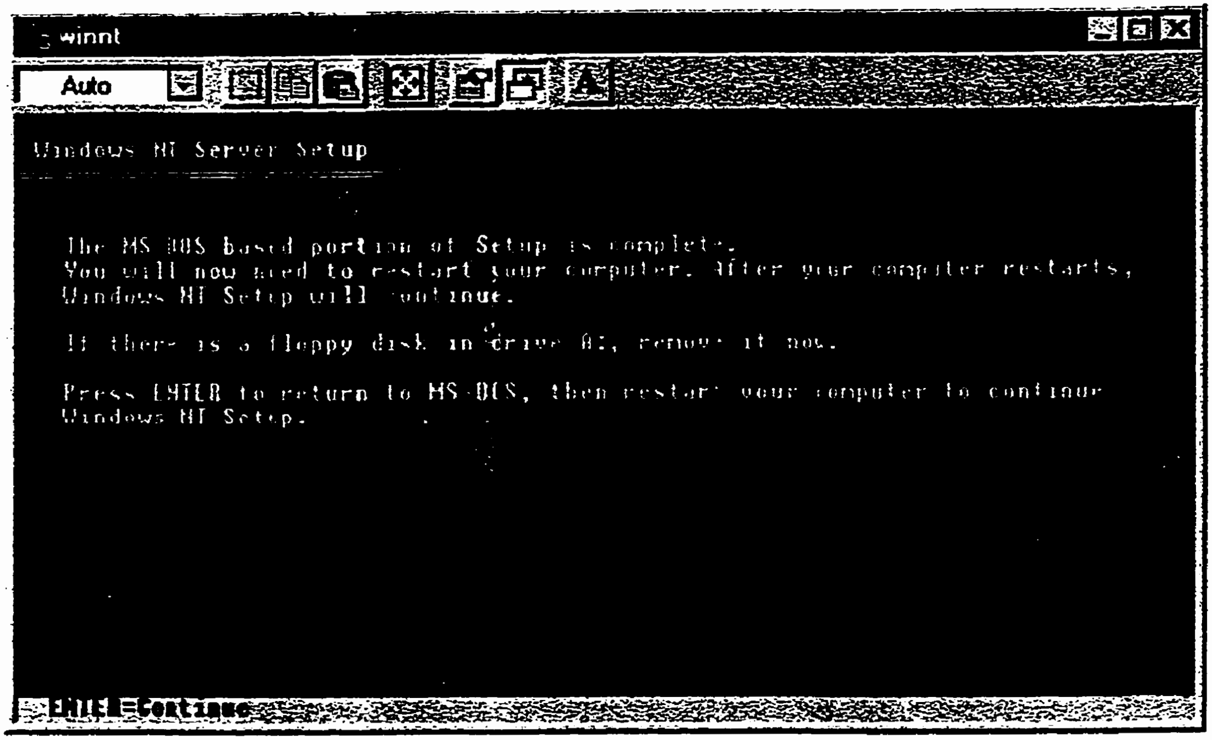
- when you insert the Windows NT CD ROM, it will automatically bring up the setup window. Press the Windows NT Setup button.

- you must confirm the location of your Windows NT setup files. On the example machine, the CD ROM is in drive D.



- press Enter to continue.

- setup will take quite a while to copy files to your hard disk (Ten minutes or more).




- once it is complete, press enter to leave setup and then restart your computer.

- when the computer restarts, you will be in a dual-boot configuration and it will allow you to select which system to start. Use the arrow keys to select Windows NT 4.0 Installation/Upgrade.

- the setup process will continue and you will be asked to confirm a number of hardware-related settings.

•be sure to select the proper drive letter for the installation. In our case, drive C.

•you should convert to NTFS during the installation.

•to save yourself a lot of headaches, let NT install into the \WinNT directory.

- when the computer restarts, you will again be allowed to select which system to start. Use the arrow keys to select Windows NT Server Version 4.0

- you will be placed in Windows NT Setup and asked to finish setting up the remainder of the Windows NT configuration.

a) Part One is information about your computer.

•License and registration information

•Computer Name

•Type of server: select Primary Domain Controller for your first server.

•Password

•System Components

b) Part Two is information about your network.

•Install the Internet Information Server.

•Select and set the settings for your ethernet adapter.

•Network Protocols: This subject is open to debate, but I suggest selecting only TCP/IP (at least for now, it can be changed later).

•Network Services: Keep it simple for now, and leave at the defaults.

•Select that you do not wish to use DHCP.

•TCP/IP Properties: set your IP Address, subnet mask, and gateway. Click on the DNS tab, set your Host Name and Domain and Add the IP address of your DNS service. Press OK, and you will get an error message about noWINS address. Select to continue.

•Domain: Set the Domain name for your NT Network (example Newnet).

Note that this is not the same as your DNS domain name.

c) Part Three is the configuration of your computer.

•Time zone, date, and time.

•Monitor settings.

- finally, setup will copy more files, complete the configuration, and ask you to restart your computer.

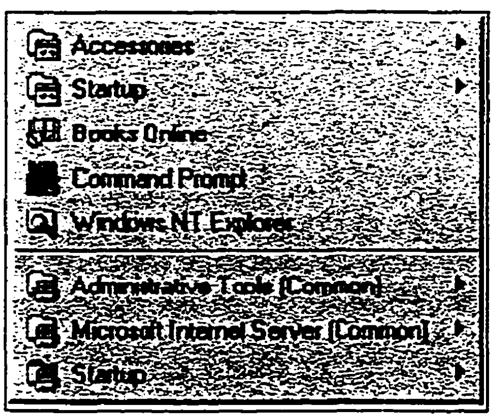
- windows NT Server is now installed.

Since client/server environments are usually large (ie. much larger than peer-to-peer networks) it is a good idea to setup groups before creating users.

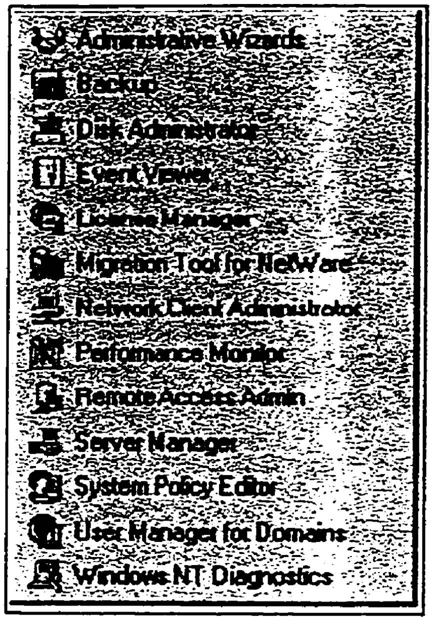
ii) Creating a new group.

- click on the "START" button and then choose Programs.

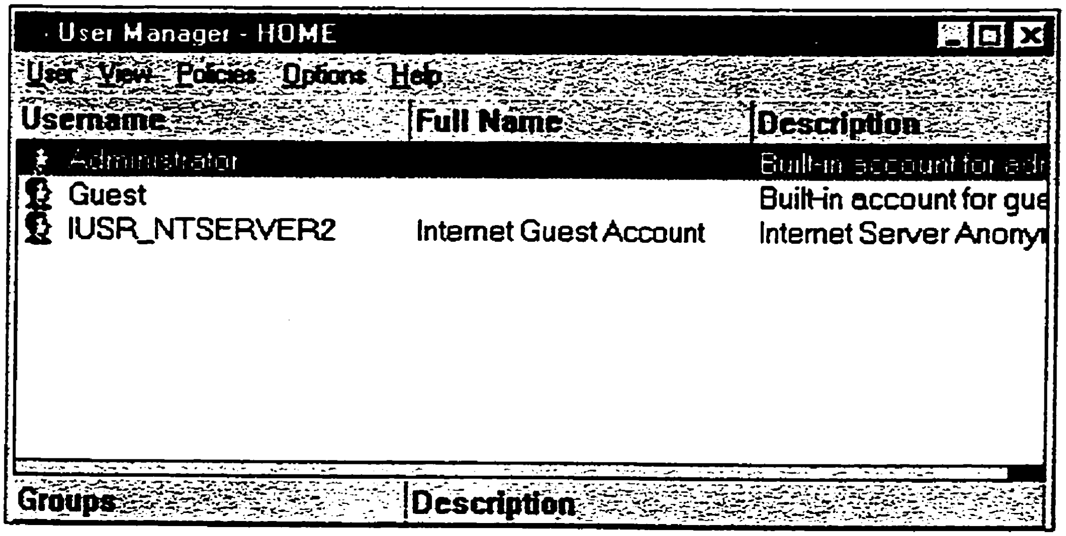
- another menu similar to Windows 95 will open, but with a very important addition: the Administrative Tools menu as shown below.



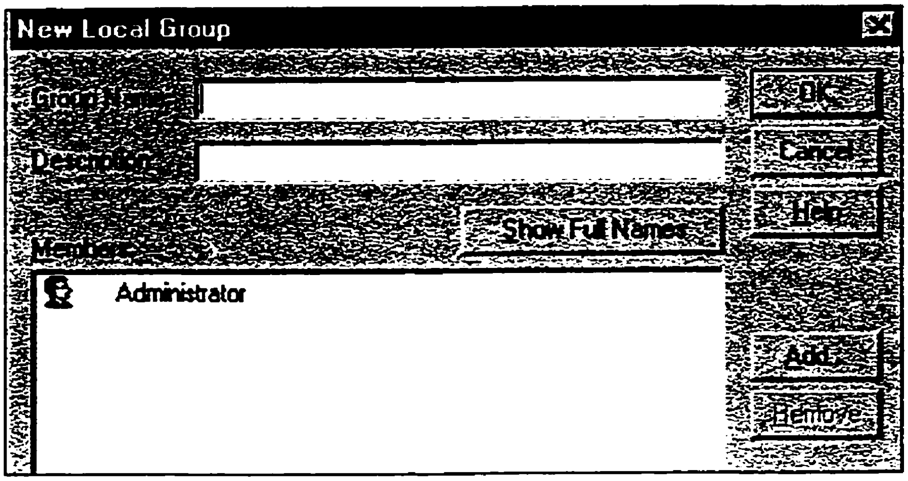

- select the Administrative Tools option to get to the following menu.




- open User Manager for Domains and the following window will appear.

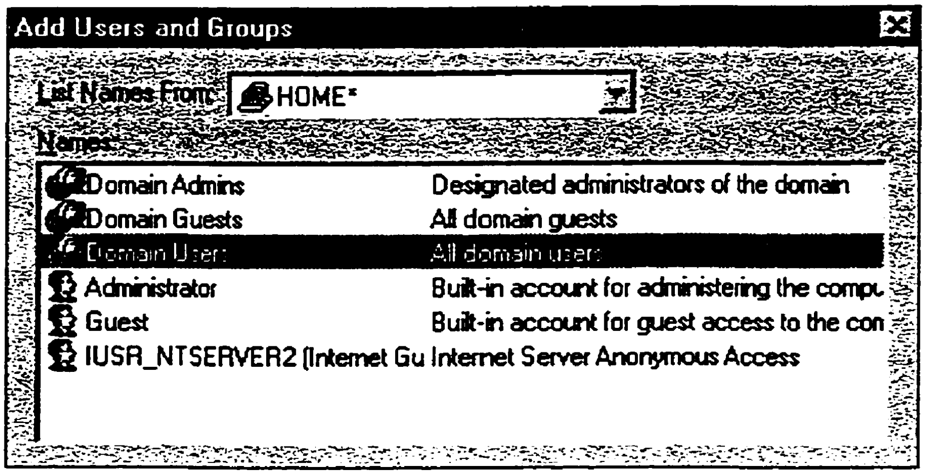



- open "New Local group" from the user menu and the following window will appear.




- enter a group name (in this case Students) and click the Add button.

- the following window will appear.




- select Domain users as in the window above.

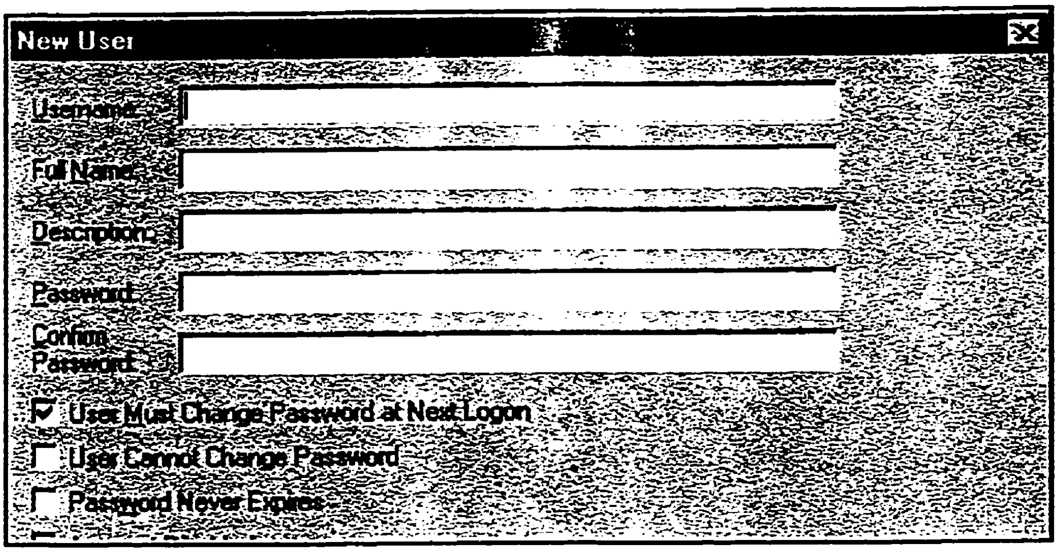
- click Add at the bottom of this window (you have now created a group named "Students" which is added to the Domain Users.

- repeat the above steps to create another group named Teachers.

Note: the bottom part of the User Manager window displays the groups. Scroll through this list to make sure that both the Students and Teachers groups are present.

iii) Create a new user.

- Open the user Manager for Domains window (as described above) and choose New User from the User menu. The following window should appear.



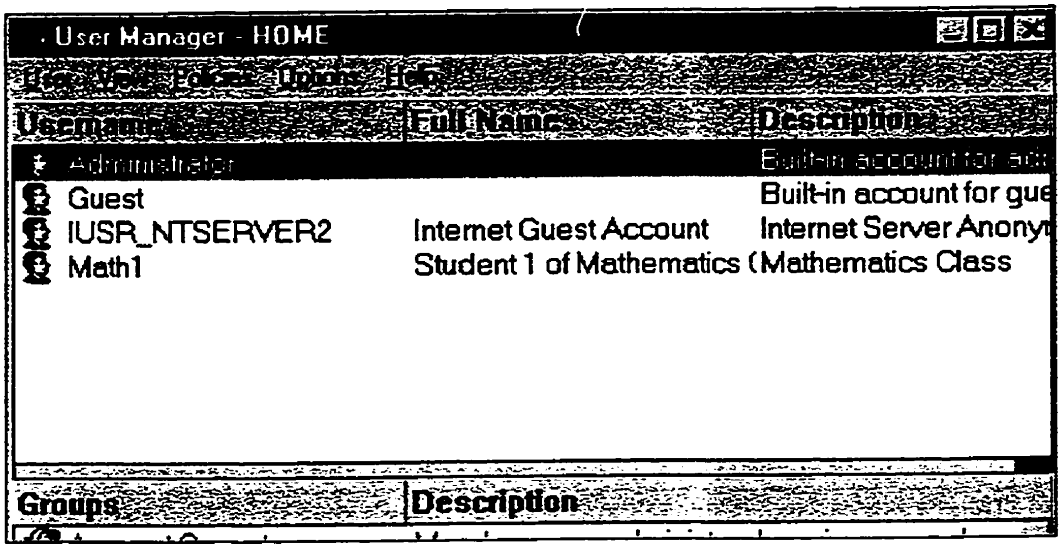

- enter a user name (example math1).

- set the rest of the options as you need for this particular user. Note: at the bottom of this screen are several buttons (Groups, Profile, Hours, Logon To, Account, and Dialin), you do not need to set these at this time.

- click the Add button to add the user.

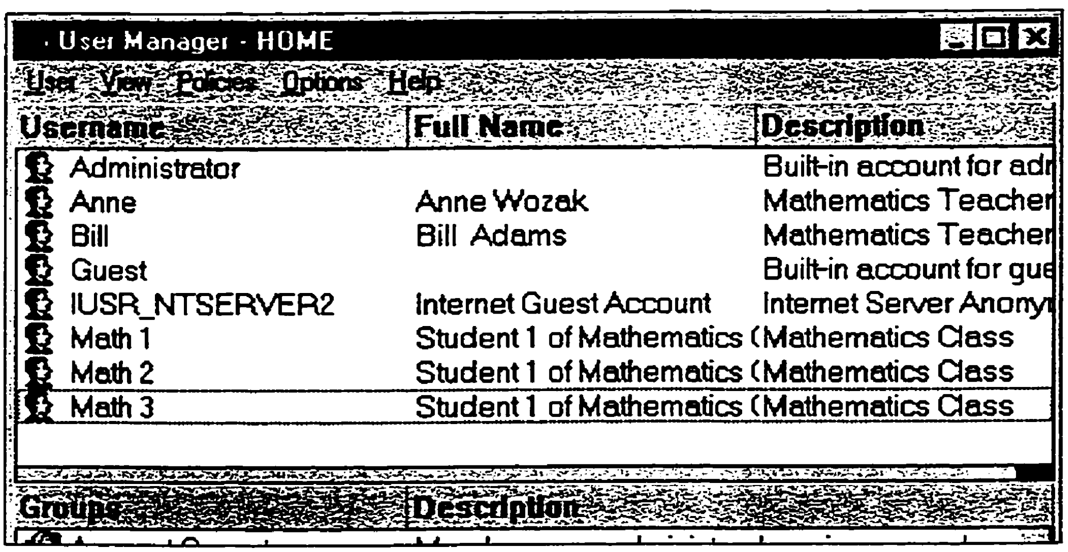
- the following window should appear.

Note: Math1 is added as a user of this network.



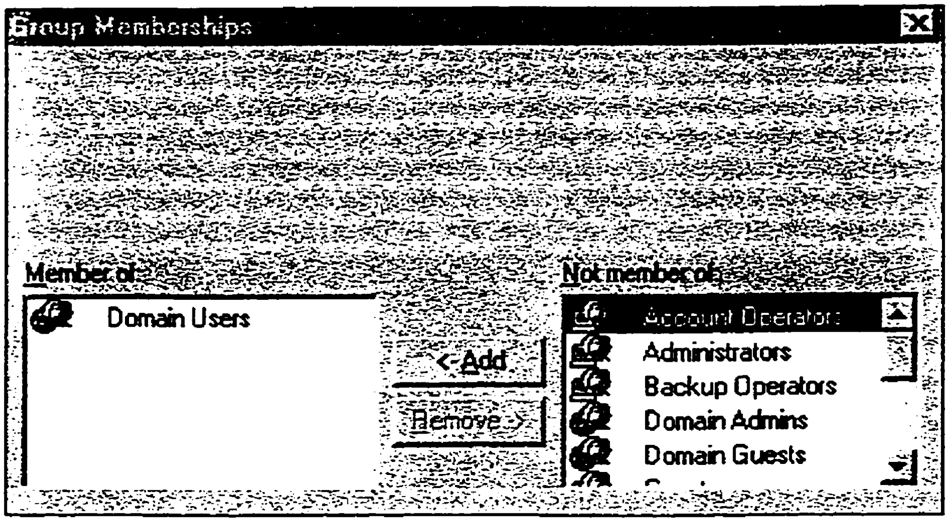

- create several new users (math2, math3, Bill and Anne) using the steps above.

- after these new users are created, NT will automatically assign them to be members of the Domain users group, however, you may create your own groups as well.



iv) Adding Users to a Group.

- double click on Math 1 (in the above window) and the User Properties screen will open. Click on the Group button at the bottom of this window to get to the following screen and then scroll through the window on the right side till you see the Students group.




- select Students and then click the Add button in the center of the window.

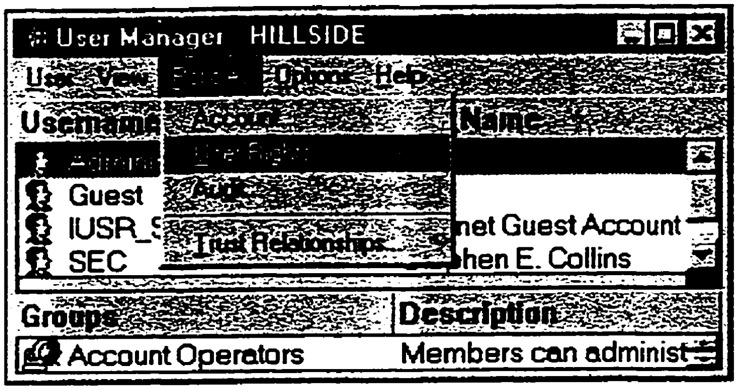
- the Math 1 user has now become a member of both the Domain Users group and the Students group.

- repeat the above steps to add Math 2 and Math 3 to the Students group.

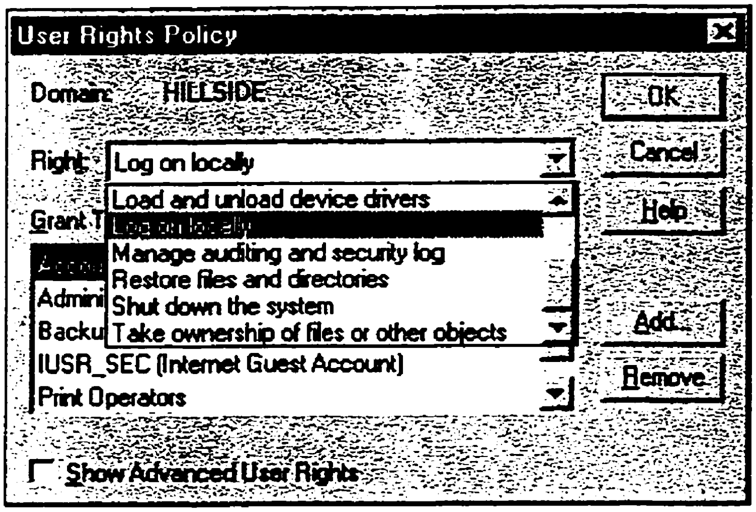
- add Bill and Anne to the Teachers group.

v) Access Privileges.

- new users will normally not be allowed to log in on the server itself. If you want to use an account on the server, you'll have to give it the right to Log on Locally. Pick User Rights from the Policies menu as below.




- the following window will appear.




- press the drop-down Rights menu and scroll until you find Log on Locally. You will see all the users and groups with this right. To grant this right to our new account, press the Add button.

- you will then see all of the groups in your domain. Press the Show Users button to see all the users. Scroll down below all the group names and you will see the users. Pick the new account just created (Math 1, Math 2, Math 3, Bill, and Anne) and press the Add button.

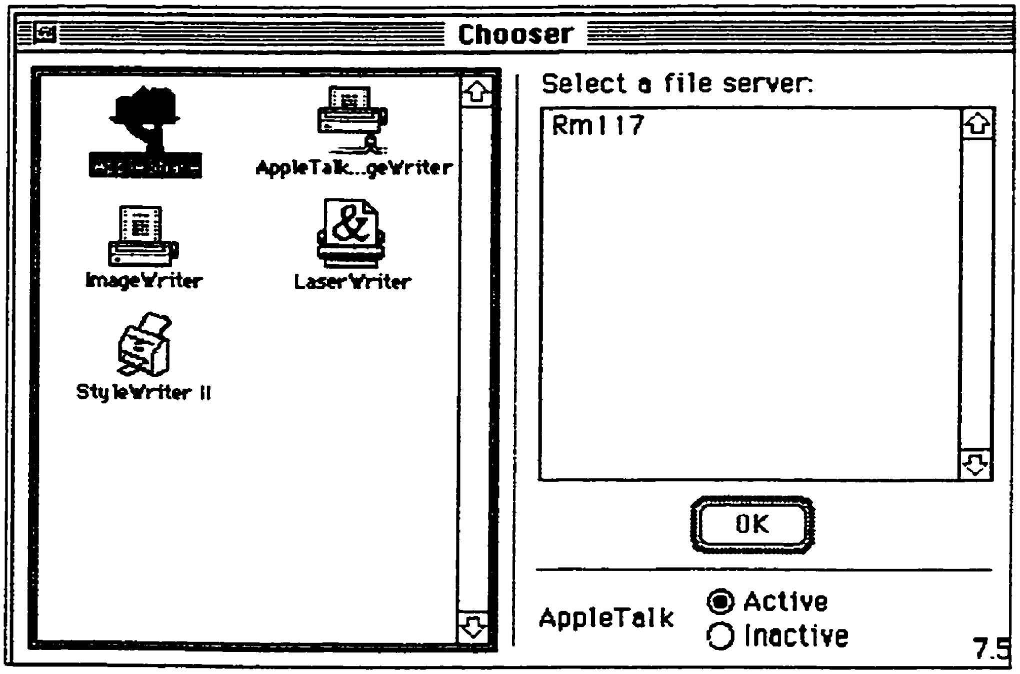
- press OK to add this right, and then close the User Manager window. You will now be able to log into your server from these new account.

- you are now ready to Logon to this server as Math 1, Math 2, Math 3, Bill, Anne, and Administrator.

2. Setup and configure a client for a client server network.

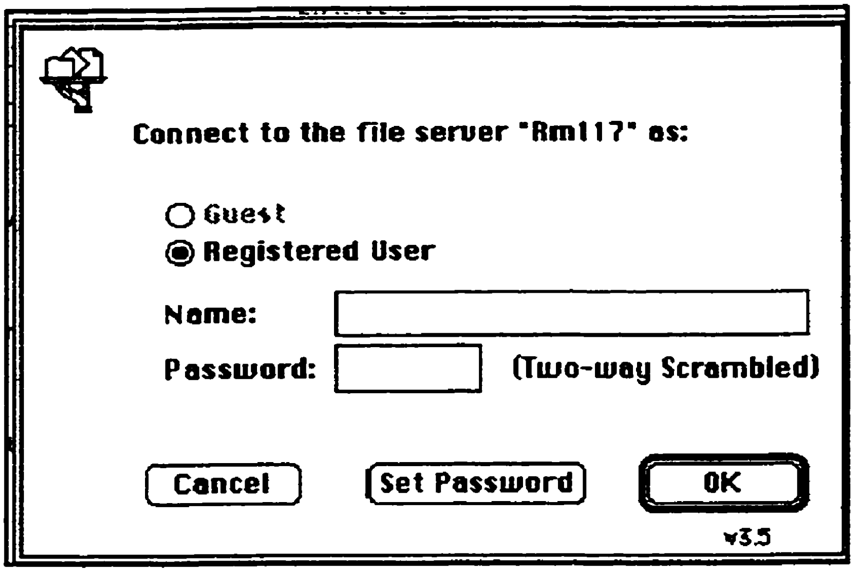
<u>**For Macs**</u> (hookup cables and hub as in the peer_to_peer network unit and make sure the EtherTalk protocol is activated).

- open the chooser to get to the following window.

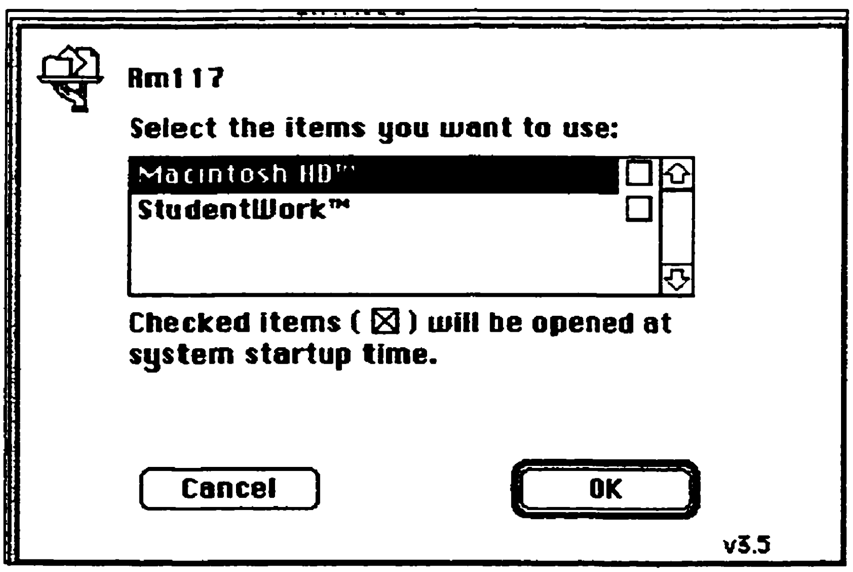



- click on Appleshare to see the available mac servers on the LAN. In the above case, Rm117 is available.

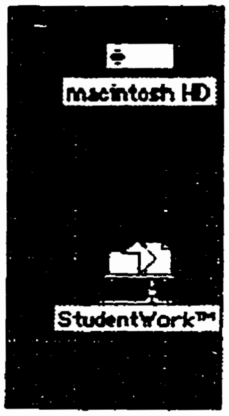
- select the server you wish to log onto and click OK to get to the following window.




- enter a User name and password (if necessary) and click OK. The following window should appear.



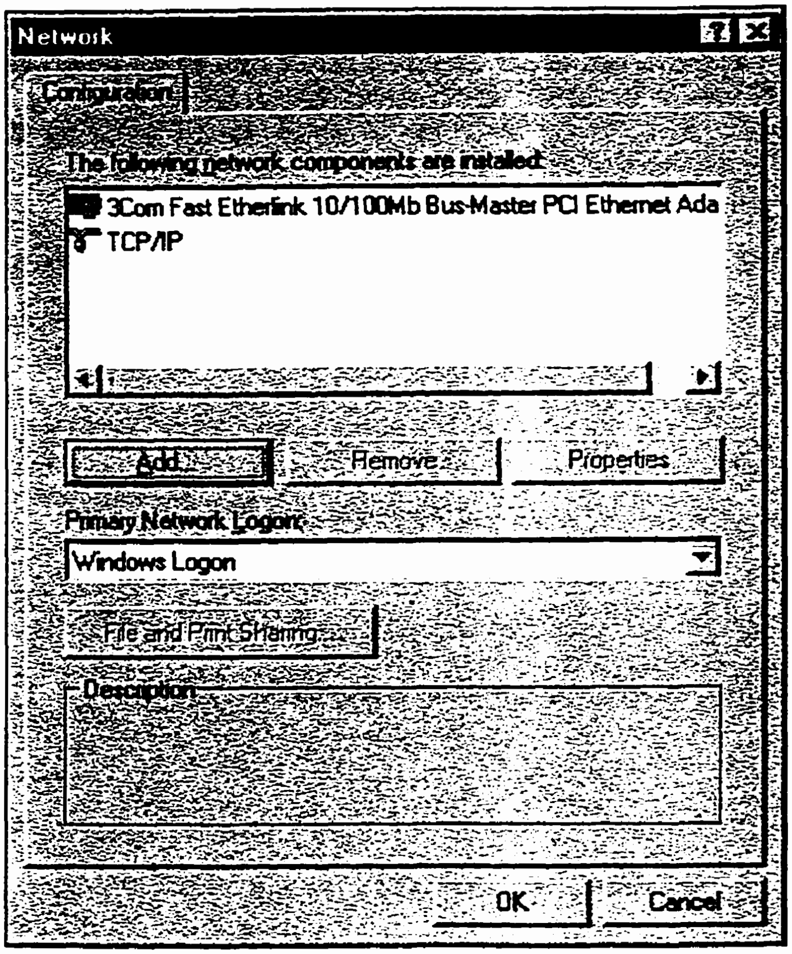
- select the drive you wish to have access to and click OK. You will now see the server drive appear as a shared drive on your desktop.



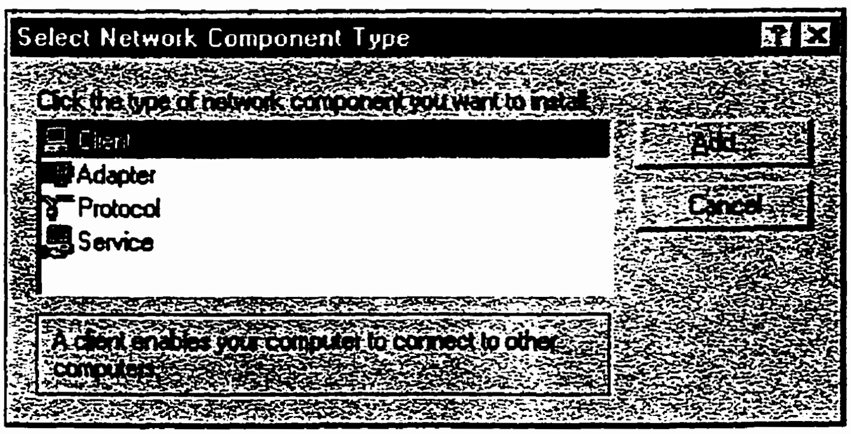

- you have logged on successfully.

**For PCs**

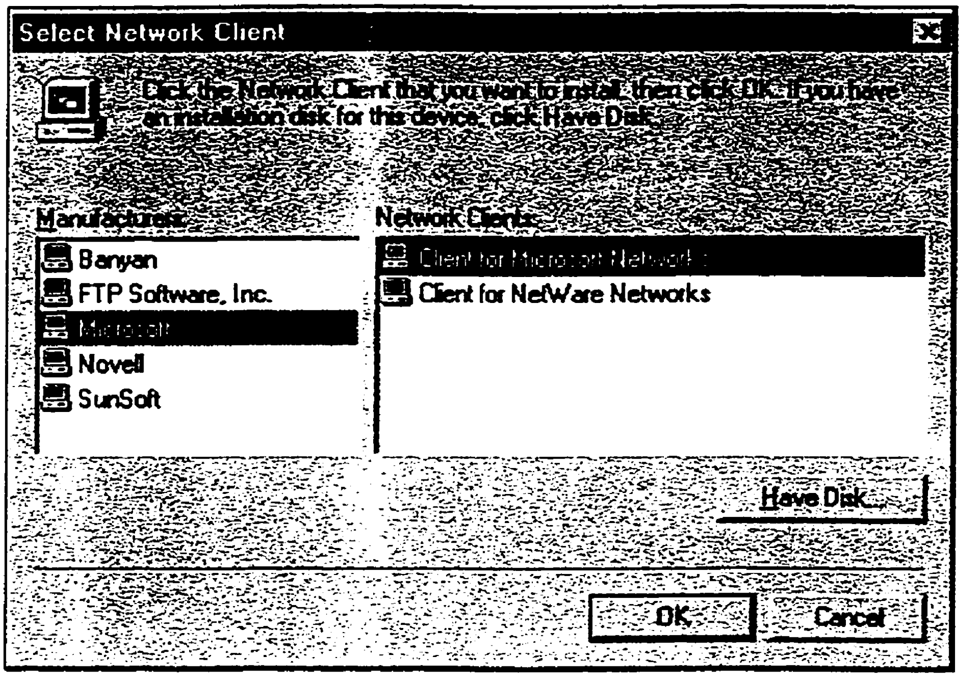
- bring up the Network control panel as below.




- press the Add button to get to the following window.

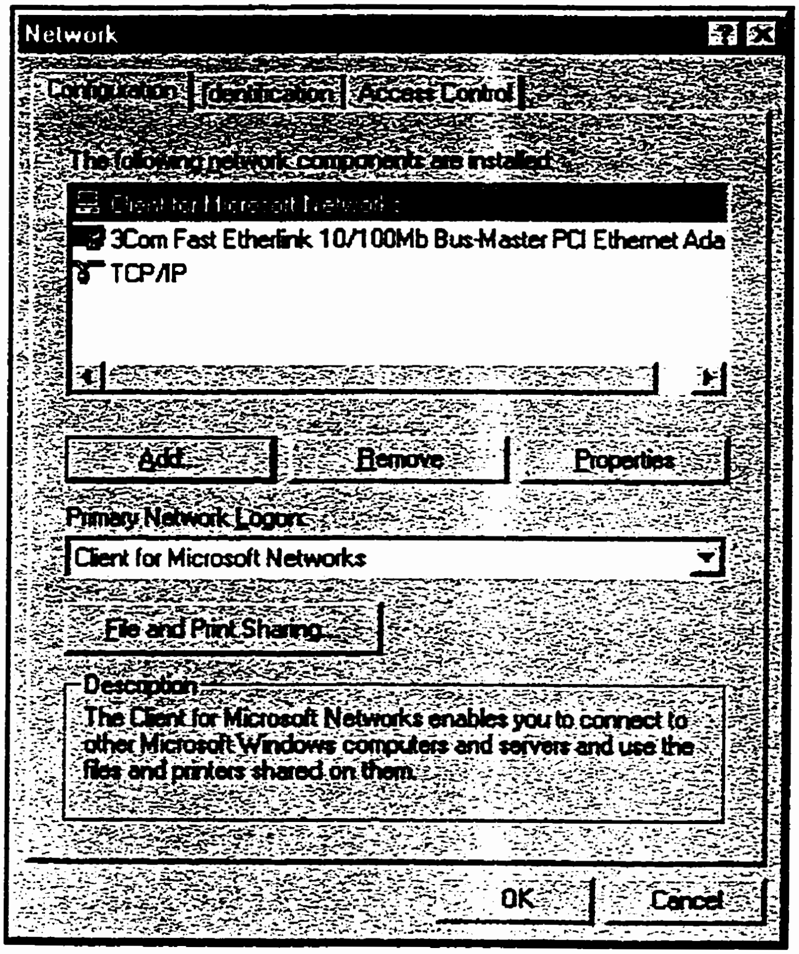


- select Client and press the Add button to get to the following window.

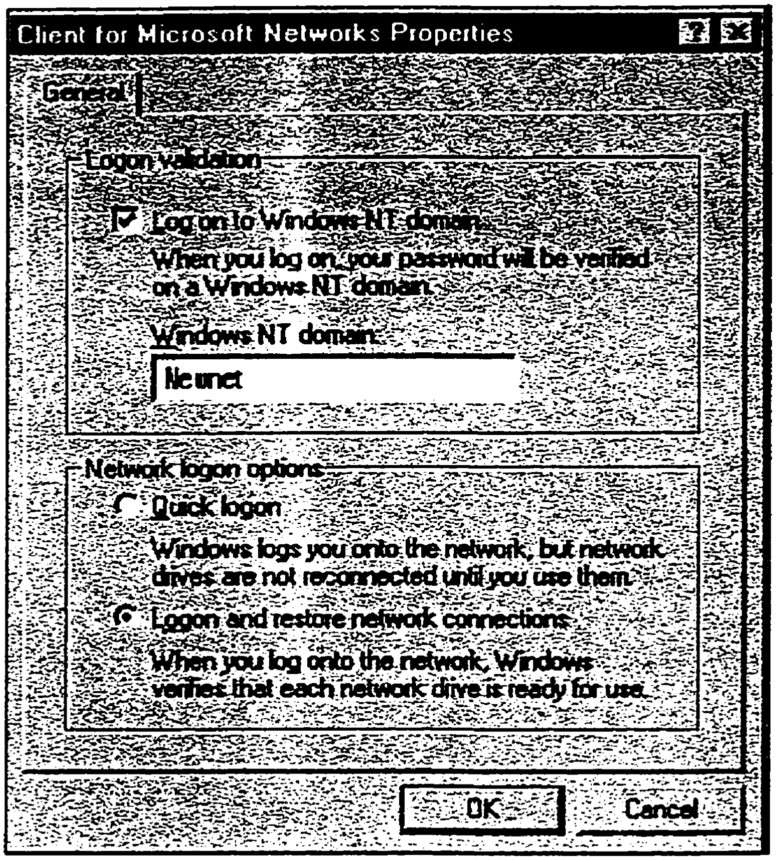



- select Microsoft in the left window above and then Client for Microsoft Networks from the right window above.

- press the OK button and Windows will install the client software and return you to the Network control panel as shown below.



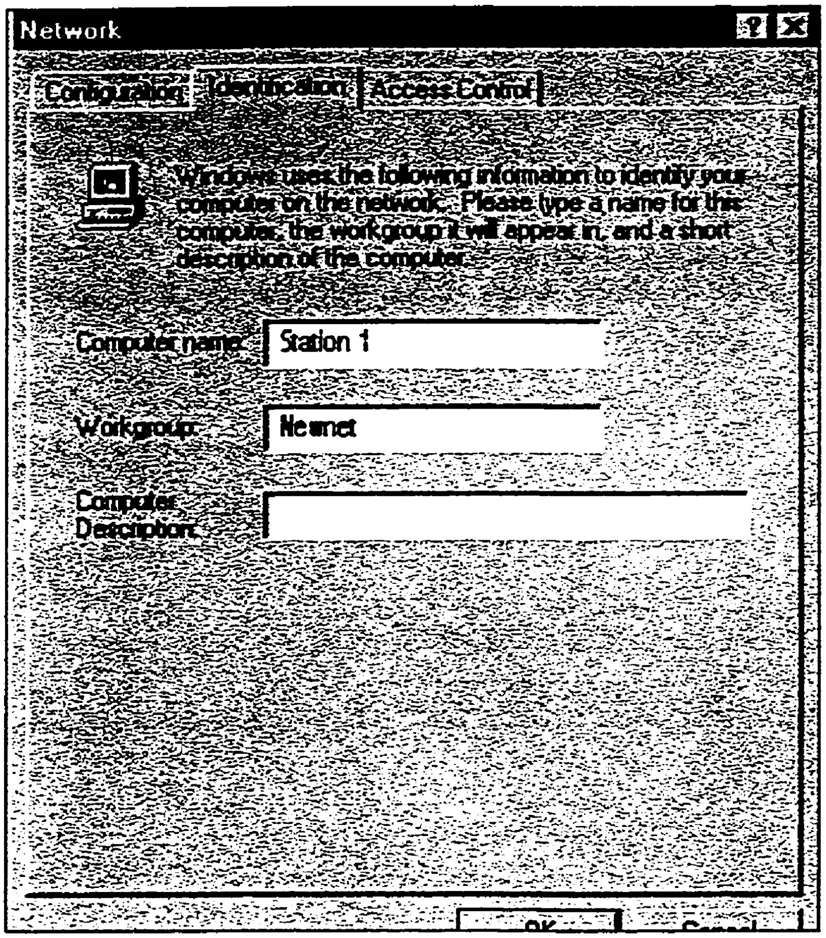
- select Client for Microsoft Networks and press the Properties button to get to the following window.




- check Log on to Windows NT domain and enter the name of your Windows NT Domain. This must match exactly the domain set on your NT Server.

- press the OK button.

- bring up the Network control panel (below) and select the Identification tab.




- enter your client Computer name (Station 1) and the name of your Windows NT domain as the Workgroup (Newnet).

- you can put anything into the Computer Description.

- press the OK button and then you will need to restart.

- after restarting, a dialog box will appear. Enter your user name and password (if it is required). You have now logged into an NT network. Double click on the Network Neighborhood icon to see the NT server.

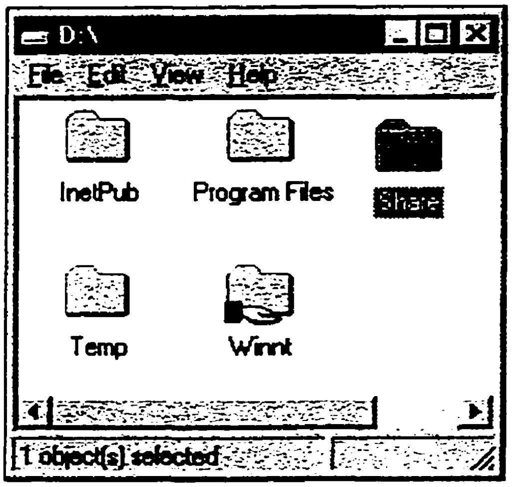
# Unit 2C - Establishing Resources on Client Server Networks

**The student should:**

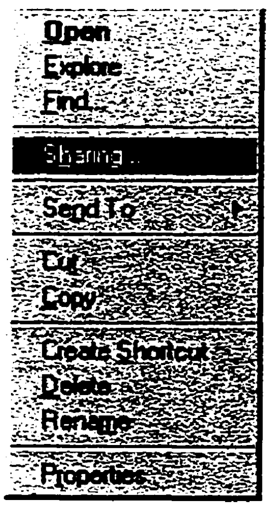
1. Create a shared folder on the server and set access privileges for the clients.

<u>**For PCs**</u>

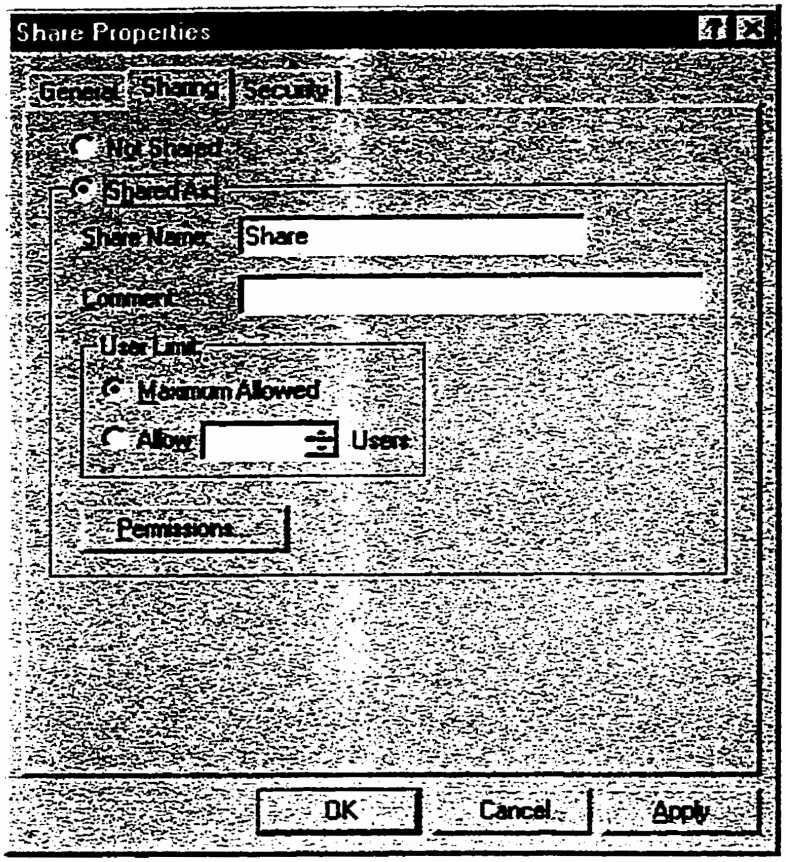
- create the folder Share on the hard drive of the NT Server as below.




- right click on the folder to bring up the context menu. Pick Sharing from the context menu.

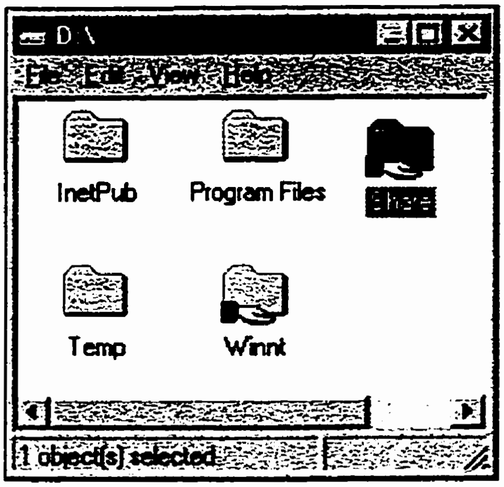


- the following window should appear.

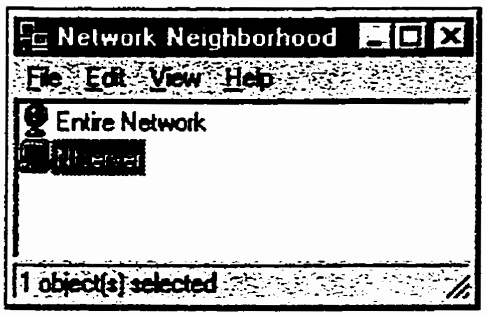



- click on the Share As button. It will automatically use the folder name as the share name, but you could use any name you wish. The Share Name doesn't have to be the same as the folder name itself. This is the name that will show up in the Network Neighborhood.

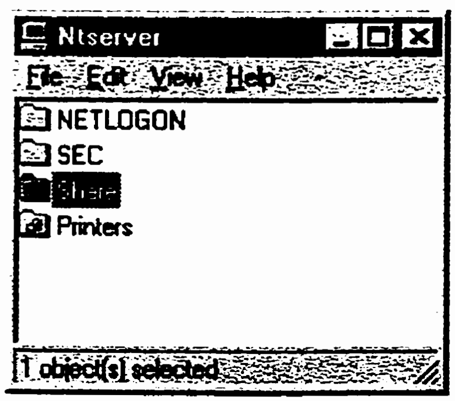
- press the OK button. The Share folder now has a hand offering it to show that it is shared (as shown below).



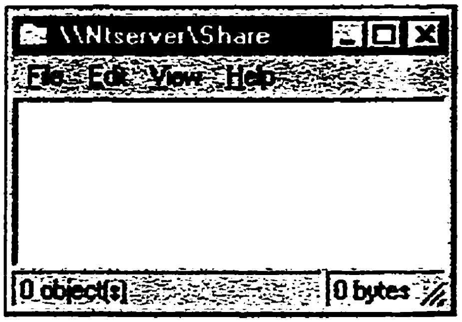

- this folder will now appear as a folder inside the NT server when viewed by a client. From the client, open the Network Neighborhood and select your server as below.




- Open the NT server (double click) and you should see the following window.

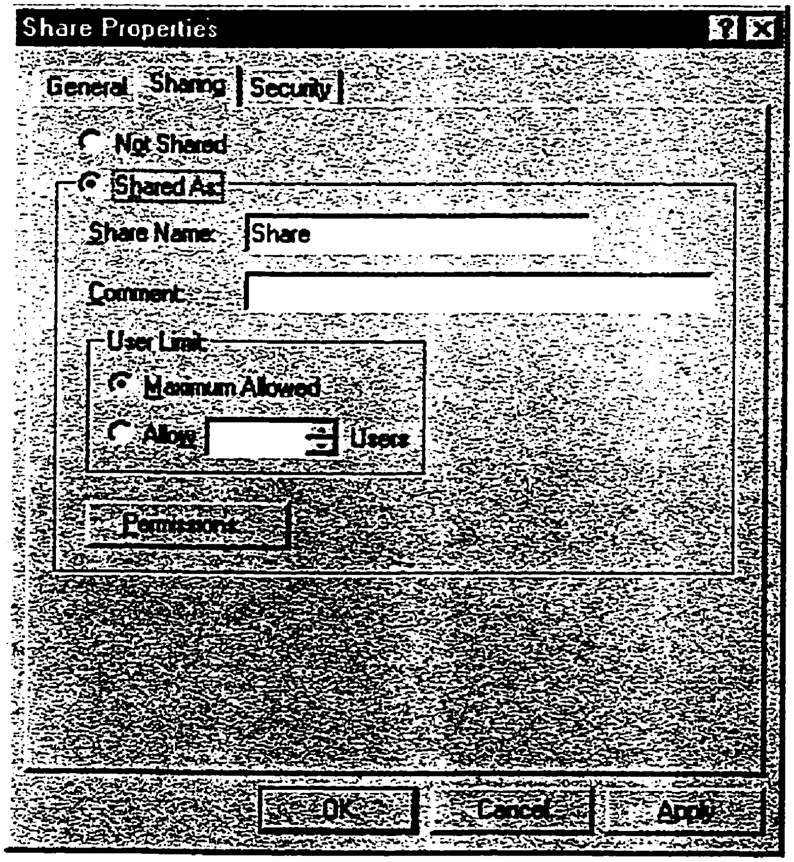


- if you double click on the folder, you will open a window showing the content as below.

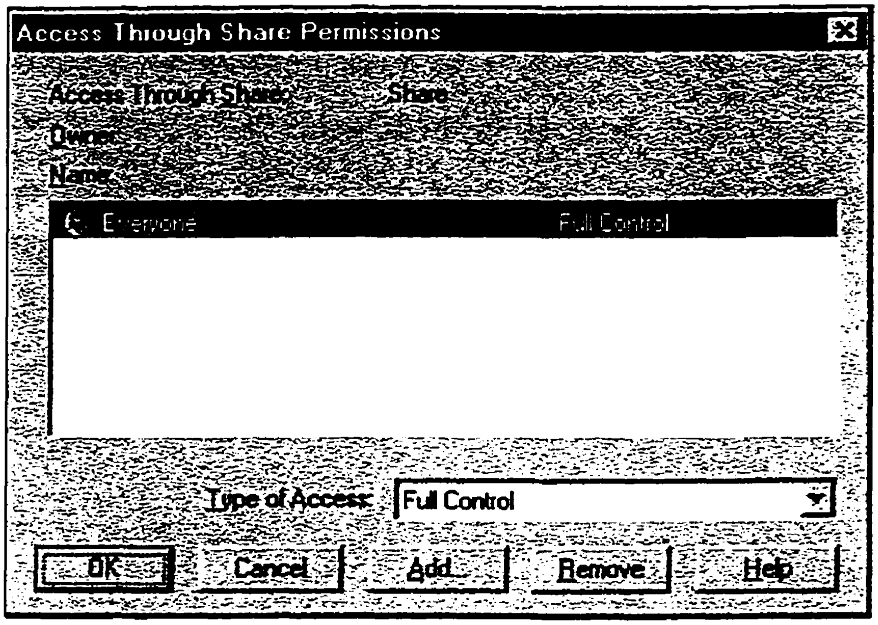



- any files, applications, or folders placed inside the Share folder on the server will appear in the above window.

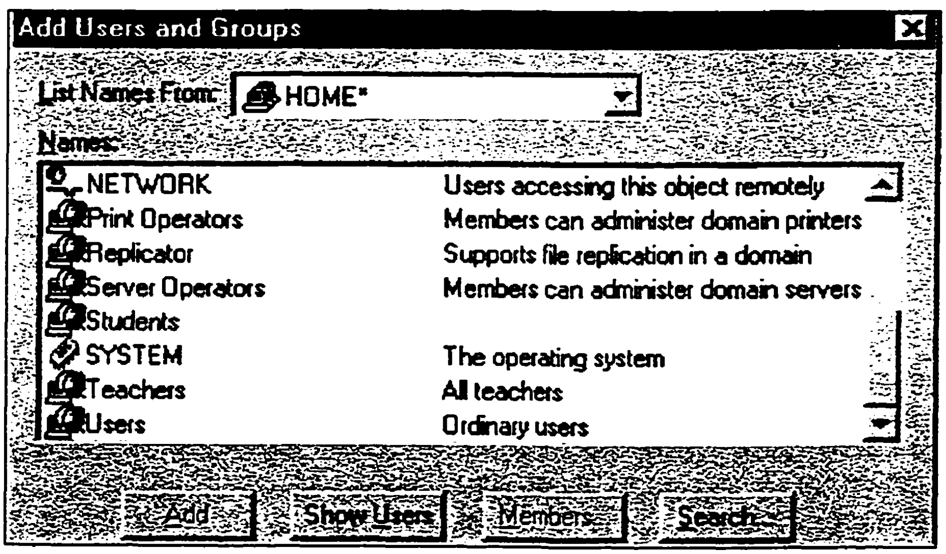
- right click on the folder Share to bring up the context menu again. Select Sharing from the context menu and the following window will appear.



- press the Permissions button. This will show the Share permissions. The share permissions are the access rights when this folder is accessed over the network.

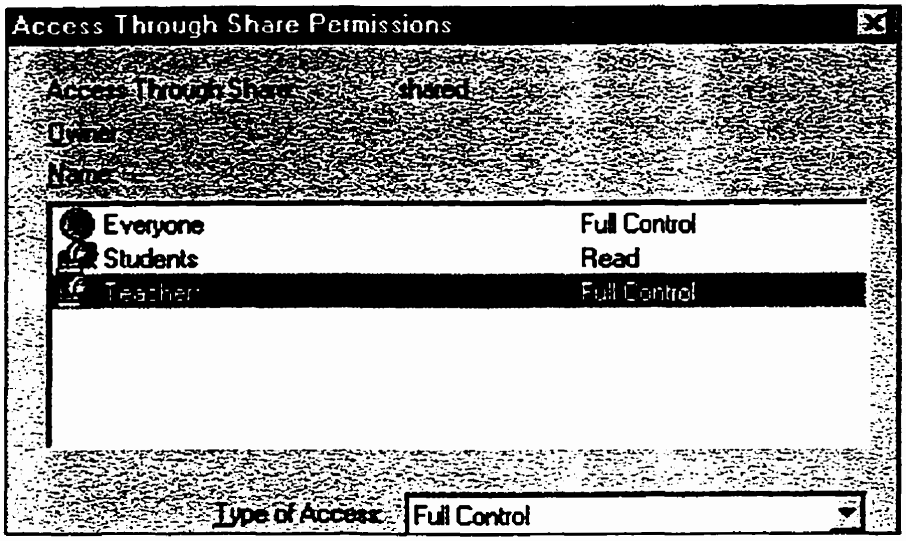



- click the Add button to see the following window.




- scroll down till you see the two groups created in the Server client unit (Students, Teachers), and select Students and then click OK. Do this for

Teachers as well and then click OK. You should now return to the following window.




- In the above window choose the type of access you wish to grant to the groups by selecting the groups and then choosing the access rights from the pop up window shown below.

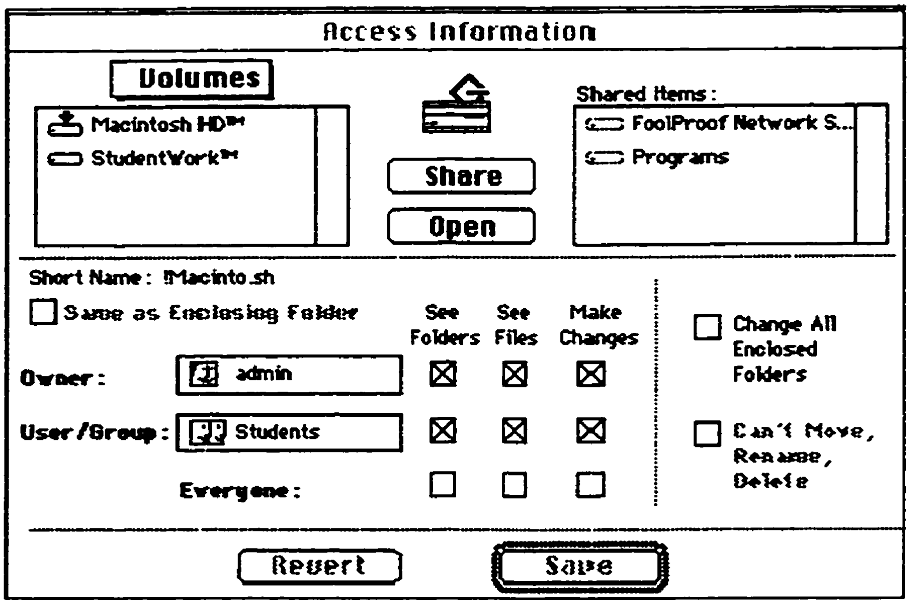

- press the OK button.

NOTE: it is a good idea to remove the "Everyone" group from the list. If everyone has full access to the computer than security becomes a real problem.

**For Macs**

- create a folder on the server's hard drive (Example Shared Images).

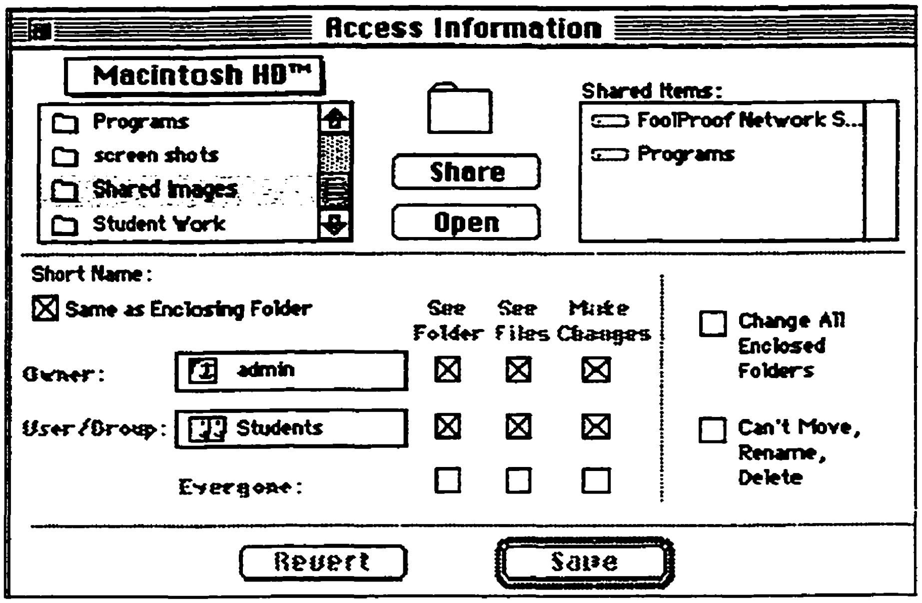
- open Appleshare Admin and choose "Access information" from the Privileges menu to see the following window.



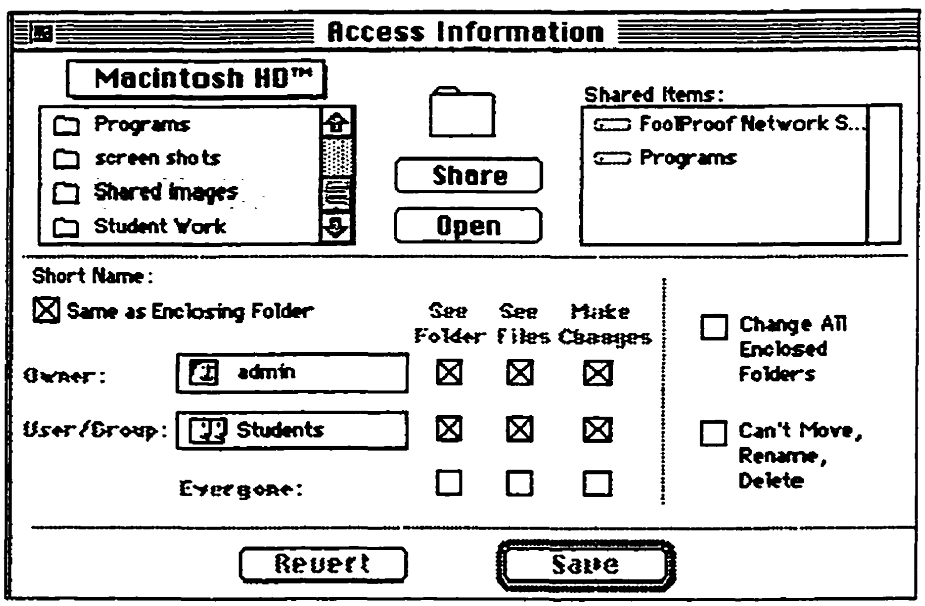

- currently the "Students" group has read/write privileges to these "Shared Items": "Foolproof Network" and "Programs".

- open the Macintosh HD in the Volumes window (i.e.. double click on it).

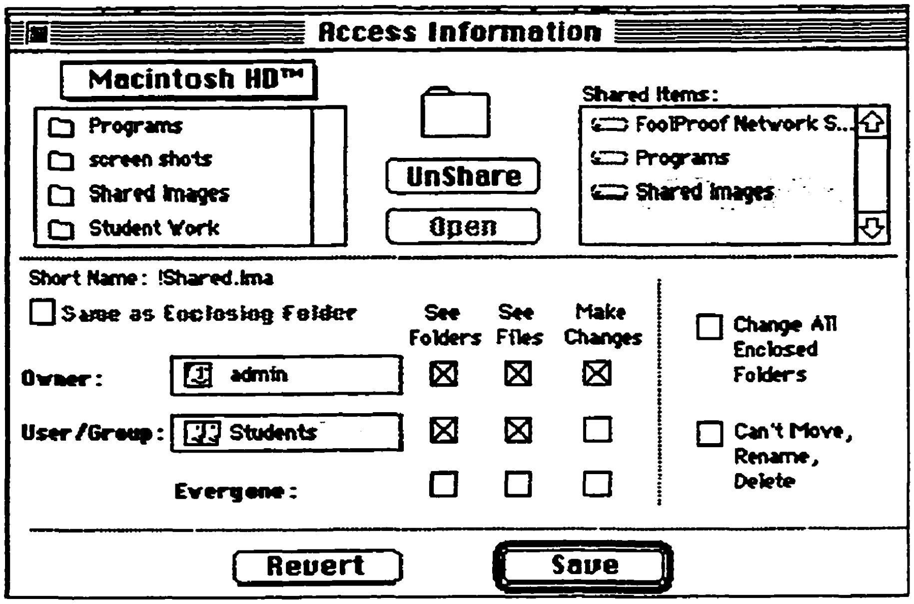
- scroll through the Macintosh HD window (as below) and select the folder created on the server hard drive (in this example "Shared Images").




- click the "Share" button in the middle of the screen to add the "Shared Items" folder to the "Shared Items" window.




- select the "Shared Images" folder in the "Shared Items" window and set the appropriate rights for the "Students" group.

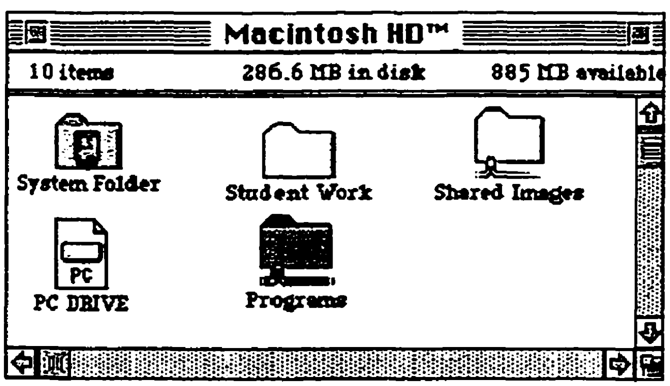



- in the above window, the "Students" group does not have write access to the "Shared Items" folder. That is, the option "Make changes is not selected".

- click save and close Appleshare Admin.

- open Appleshare File Server to startup the network.

- the folders "Programs" and "Shared Images" should now be networked folders as below.

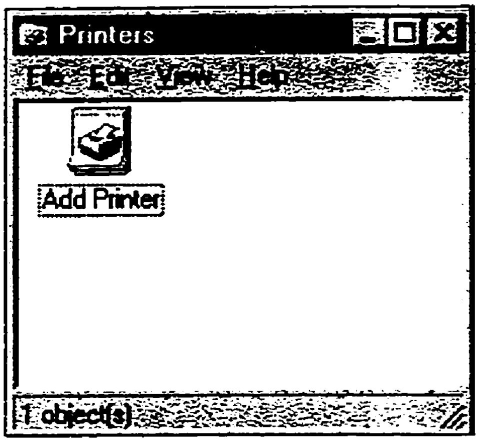


2. Create shared printing resources on the server.

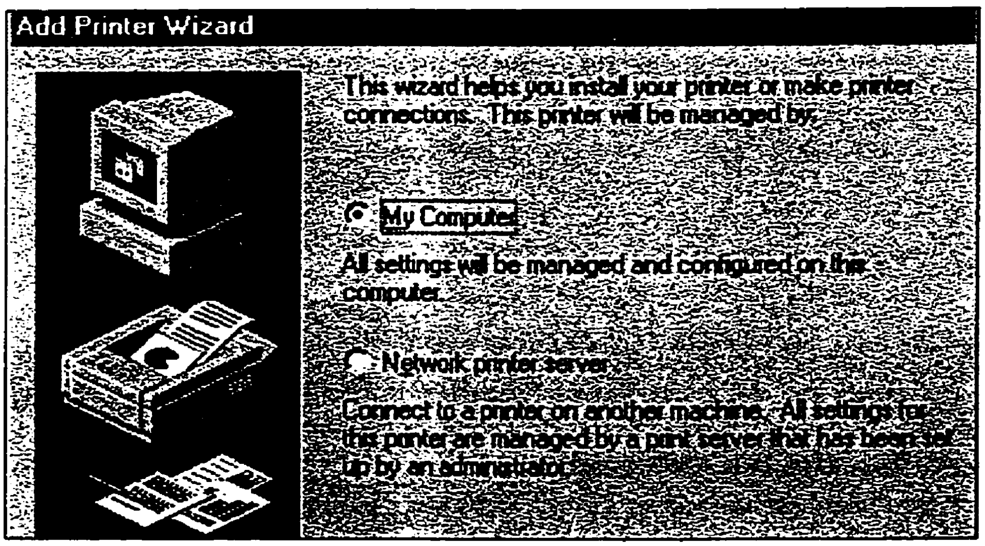
<u>**For PCs**</u>

- physically attach the printer to the server.

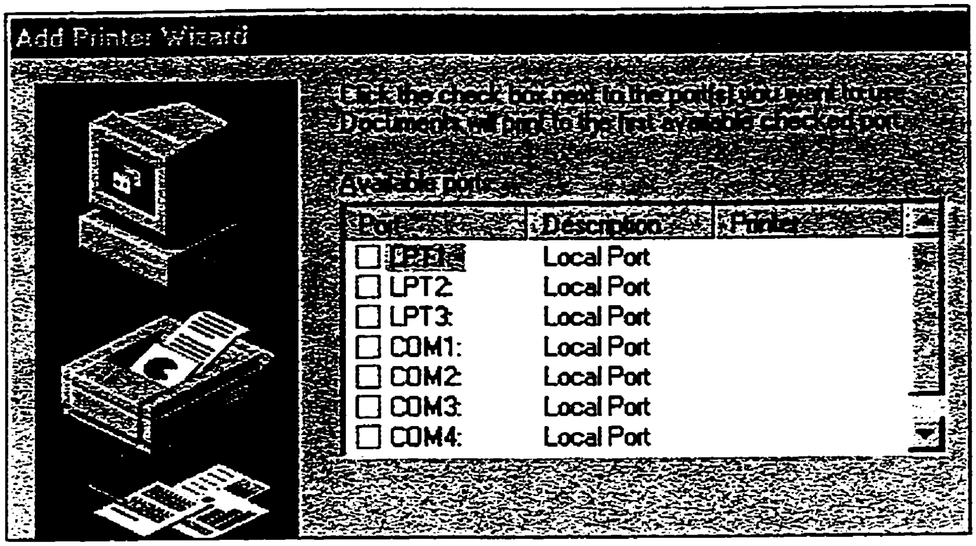
- on the NT server, open the Printers folder as below.



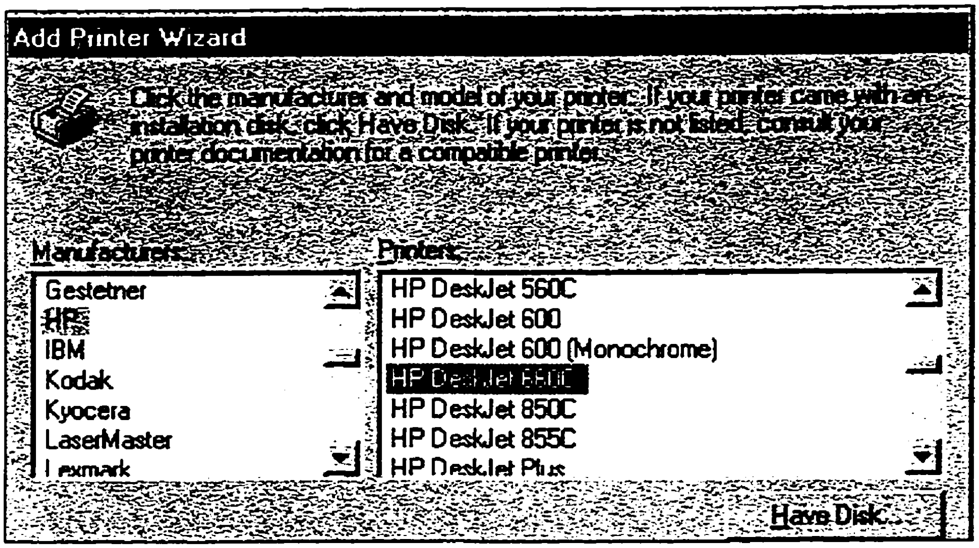

- double click on the Add Printer icon to see the following window.



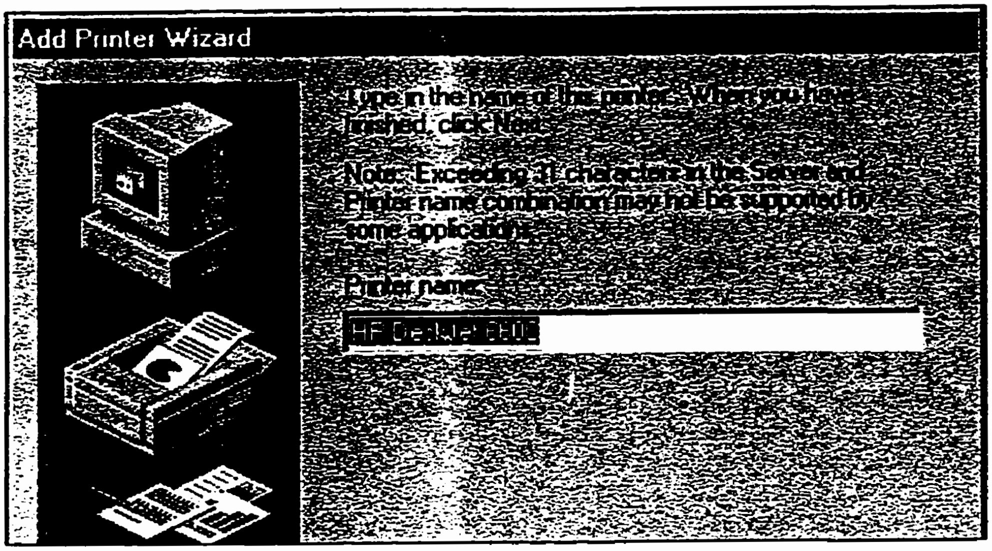

- since you are configuring the printer from the server, select My Computer as above and click Next to see the following window.



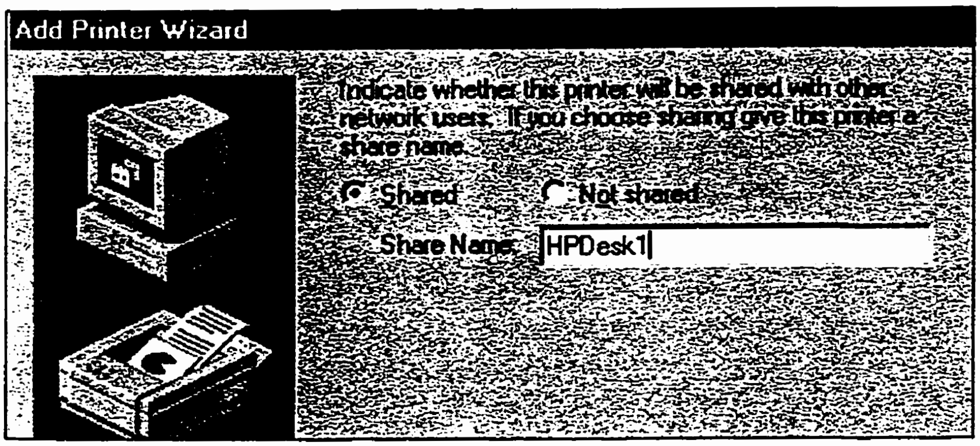

- select LPT1 and click Next.




- in the above window, select the Manufacturers (in our example HP) and then the Printer Model (in our case HP DeskJet 660C) and click Next.




- name the printer and click Next.



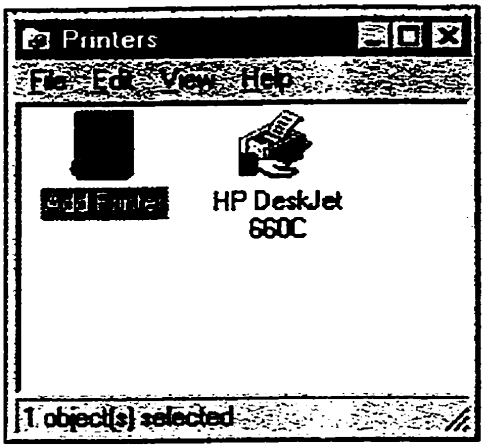

- in the above window, select Shared and give the Share Name for the printer (this is the name that the clients will see).

- click Next.

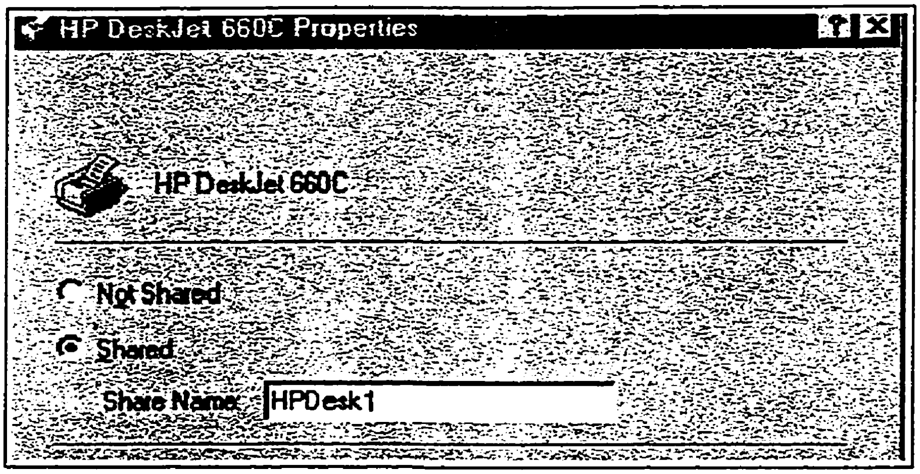
- you will now be prompted for a print test.

- at this point you will need to insert the Windows NT server CD-ROM.

- NT will now install the drivers it needs. After the install is finished, you should see the following window.




- right-click on the newly added printer (HP DeskJet 660C) and then choose Sharing from the pop-up menu to see the following window.




- click the Sharing tab at the top of this window and then select Shared and enter a share name (the name here is what will be seen by the clients).

- click OK. The printer is now a shared printer on the NT network.

**For Macs**

In early versions of Appleshare each printer was named by a program called the Namer. This program came with the purchase of the network card that needed to be installed in printers (ImageWriters). Other printers such as the LaserWriter came with a Localtalk port and even an Ethernet port. The printers that came with Ethernet ports simply need to be connected to the LAN and identified. The client then selects the appropriate printer driver from the Chooser. All available printers show up in the right hand window (of the Chooser). Simply select the one that you wish to connect to and close the window. Appleshare 5.0 IP File Server (for Power PCs and newer) allows you to establish a print server (that is, a computer that manages the requests for printing). This print server can support up to 30 printers, 10 queues, and 32 simultaneous print sessions. Although each version of Appleshare includes different features and slightly different ways of configuring printers, the bases of establishing printers as resources on a server/client network are much the same as on Apple's peer-to-peer networks.

## Unit 2D - TCP/IP

**The student should:**

1. Give a brief history of TCP/IP by gathering information from the Internet and other sources.

TCP and IP were developed by a Department of Defense (DOD) research project to connect a number different networks designed by different vendors into a network of networks (the "Internet"). The Army puts out a bid on a computer and DEC wins the bid. The Air Force puts out a bid and IBM wins. The Navy bid is won by Unisys. Then the President decides to invade Grenada and the armed forces discover that their computers cannot talk to each other. The DOD must build a "network" out of systems each of which, by law, was delivered by the lowest bidder on a single contract. To insure that all types of systems from all vendors can communicate, TCP/IP is absolutely standardized on the LAN.

(used by permission, http://pclt.cis.yale.edu/pclt/comm/tcpip.htm)

- Search the Internet for more information about the history of TCP/IP.

Example sites:

http://info.isoc.org/guest/zakon/Internet/History/Brief_History_of_the_Internet

http://www.unizar.es/isocara/historia/History.html

http://www.davesite.com/webstation/net-history.shtml

http://www.cs.rochester.edu/u/leblanc/internet-course/history.html

http://www.tectrix.com/links/internet.html

2. Define TCP/IP.

TCP/IP is a protocol for sharing information between different computers. TCP/IP includes a whole suit or set of protocols for communication. TCP/IP consists of:

- TCP: Transmission Control Protocol. Ensures that connections are made and maintained between computers.
- IP: Internet Protocol. Handles computer addresses.
- ARP: Address Resolution Protocol. Relates IP addresses with hardware (MAC) addresses.
- RIP: Routing Information Protocol. Finds the quickest route between two computers.
- OSPF: Open Short Path First.
- ICMP: Internet Control Message Protocol. Handles errors and sends error messages for TCP/IP.
- BGP/EGP: Border Gateway Protocol/Exterior Gateway Protocol.
- SNMP: Simple Network Management Protocol.
- PPP: Point to Point Protocol. Provides for dial-up.
- SMTP: Simple Mail Transport Protocol. How e-mail is passed.
- POP3/IMAP4: Post Office Protocol. Setup for client to connect to severs to collect e-mail.

(1998, Teach Yourself Networking in 24 hours, Matt Hayden)

3. Explain IP addressing and Class.

TCP/IP assigns a unique number to every workstation in the world. This "IP number" is a four byte value that, by convention, is expressed by converting each byte into a decimal number (0 to 255) and separating the bytes with a period. For example, the REC server is 204.112.17.8.

(used by permission, http://pclt.cis.yale.edu/pclt/comm/tcpip.htm)

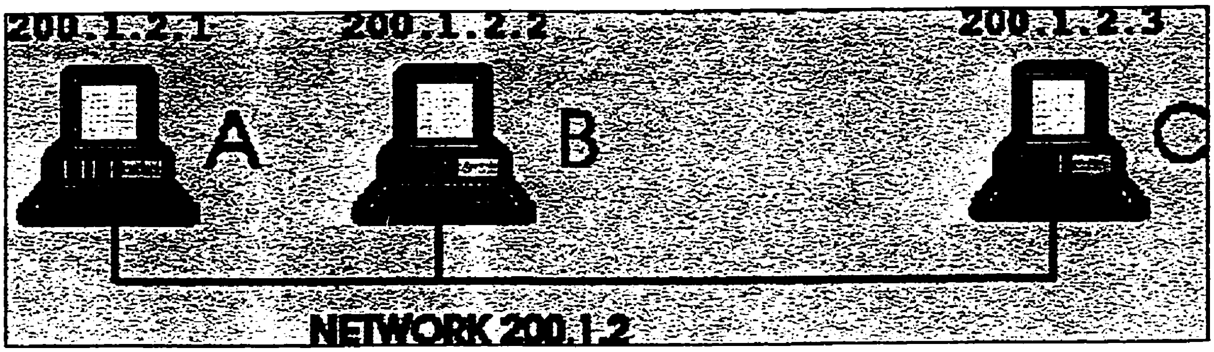
By convention, TCP/IP is expressed as a four decimal numbers separated by periods, such as "200.1.2.3" representing the decimal value of each of the four bytes. Valid addresses thus range from 0.0.0.0 to 255.255.255.255, a total of about 4.3 billion addresses.

There are five classes of address in this system. These are classes A through E and are used to represent groups of IP numbers as given below.

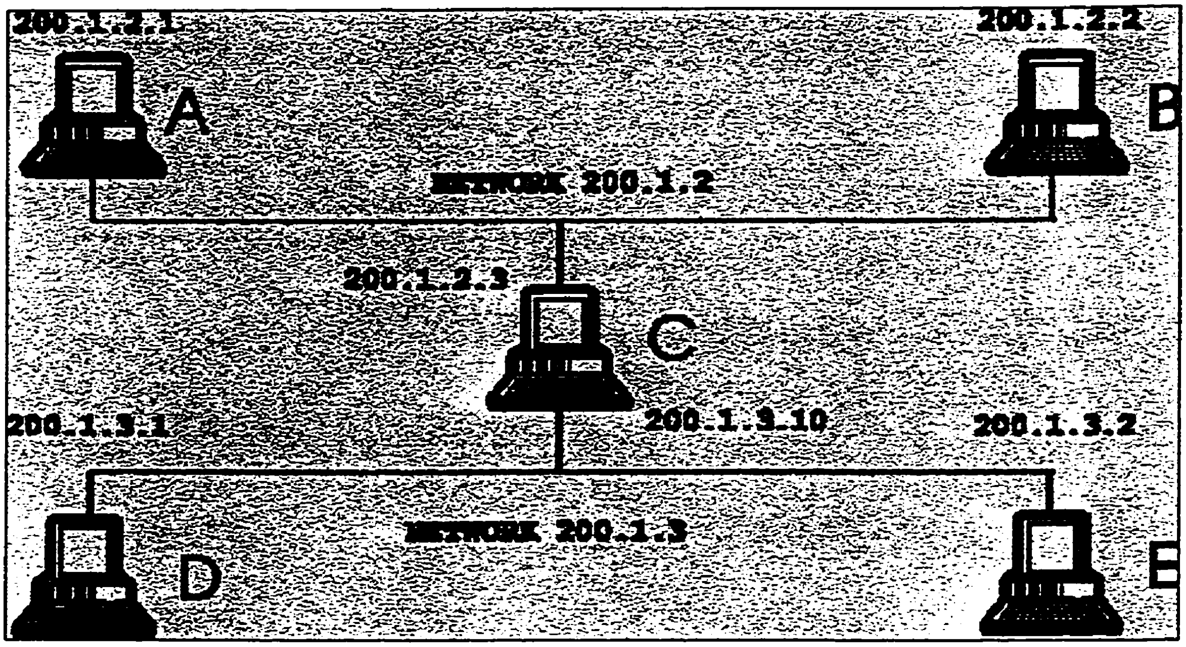
| Class | Range of Net Numbers | Range of Host Numbers |
|---|---|---|
| A | 0 to 126 | 0.0.1 to 255.255.254 |
| B | 128.0 to 191.255 | 0.1 to 255.254 |
| C | 192.0.0 to 233.255.255 | 1 to 254 |

Any address starting with 127 is a loopback address and should never be used for addressing outside the host. A host number of all binary 1's indicates a directed broadcast over the specific network. For example, 200.1.2.255 would indicate a broadcast over the 200.1.2 network. If the host number is 0, it indicates "this host". If the network number is 0, it indicates "this network" [2]. Class D addresses are multicast, and Class E are reserved.

Consider a small internal TCP/IP network consisting of one Ethernet segment and three nodes. The IP network number of this Ethernet segment is 200.1.2. The host numbers for A, B, and C are 1, 2, and 3 respectively. These are Class C addresses, and therefore allow for up to 254 nodes on this network segment.




In the diagram above and subsequent diagrams, we have emphasized the network number portion of the IP address. Suppose that computer A wanted to send a packet to computer C for the first time, and that it knows C's IP address. To send this packet over Ethernet, computer A would need to know computer C's Ethernet address. The Address Resolution Protocol (ARP) is used for the dynamic discovery of these addresses [1]. ARP keeps an internal table of IP address and corresponding Ethernet address. When computer A attempts to send the IP packet destined to computer C, the ARP module does a lookup in its table on C's IP address and will discover no entry. ARP will then broadcast a special request packet over the Ethernet segment, which all nodes will receive. If the receiving node has the specified IP address, which in this case is computer C, it will return its Ethernet address in a reply packet back to computer A. Once A receives this reply packet, it updates its table and uses the Ethernet address to direct A's packet to C. ARP table entries may be stored statically in some cases, or it keeps entries in its table until they are "stale" in which case they are flushed. Consider now two separate Ethernet networks that are joined by a PC, C, acting as an IP router (for instance, if you have two ethernet segments on your server).



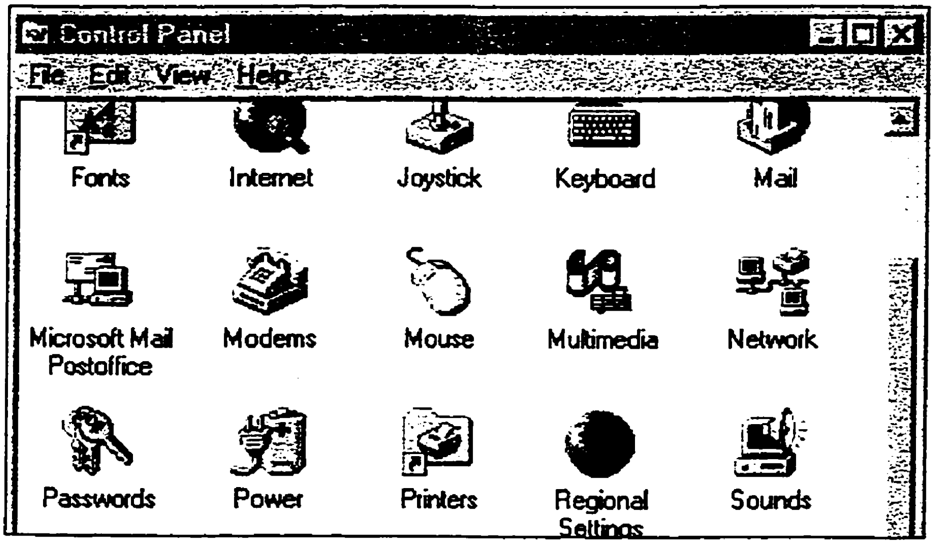

Device C is acting as a router between these two networks. A router is a device that chooses different paths for the network packets, based on the addressing of the IP frame it is handling. Different routes connect to different networks. The router will have more than one address as each route is part of a different network. Since there are two separate Ethernet segments, each network has its own Class C network number. This is necessary because the router must know which network interface to use to reach a specific node, and each interface is assigned a network number. If A wants to send a packet to E, it must first send it to C who can then forward the packet to E. This is accomplished by having A use C's Ethernet address, but E's IP address. C will receive a packet destined to E and will then forward it using E's Ethernet address. These Ethernet addresses are obtained using ARP as described earlier.

(used by permission, http://www.sangoma.com/fguide.htm)

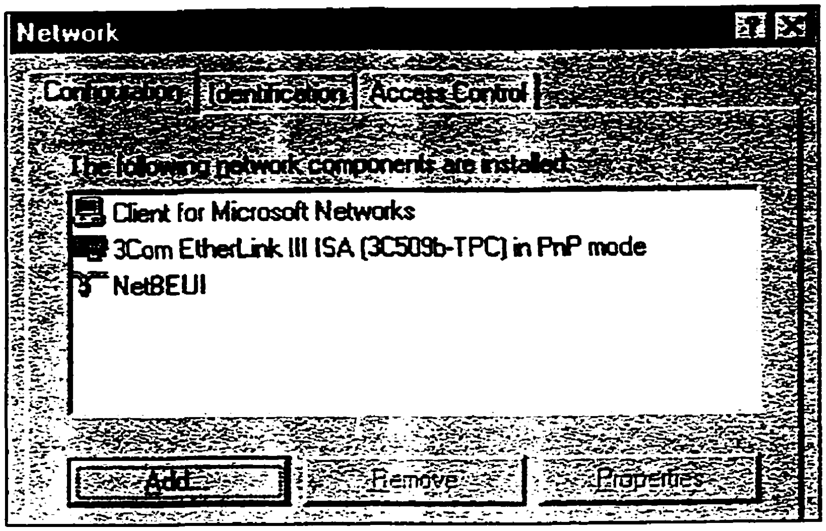
4. Configure TCP/IP.

__For PCs.__

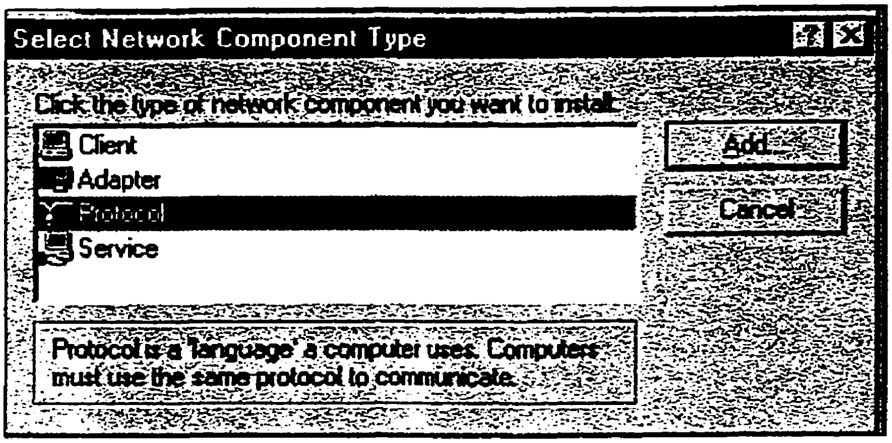
- open the Control Panel.



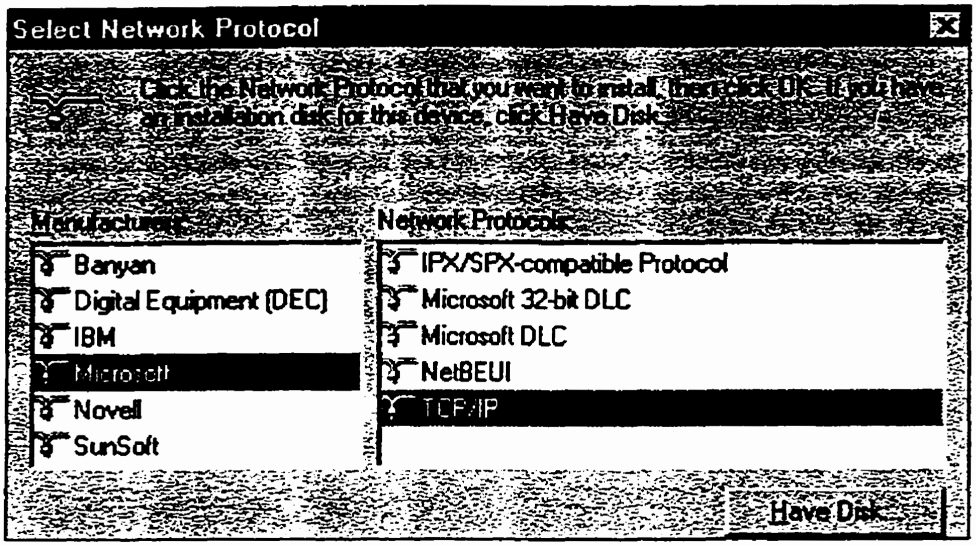
- open Networks and the following window will appear.



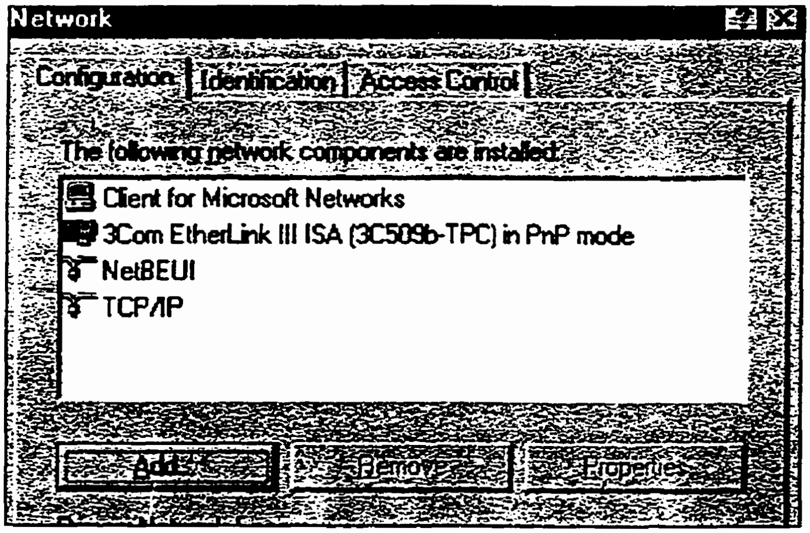

- click the Add button to see the window below.



- select Protocols and click Add. The following window will open.

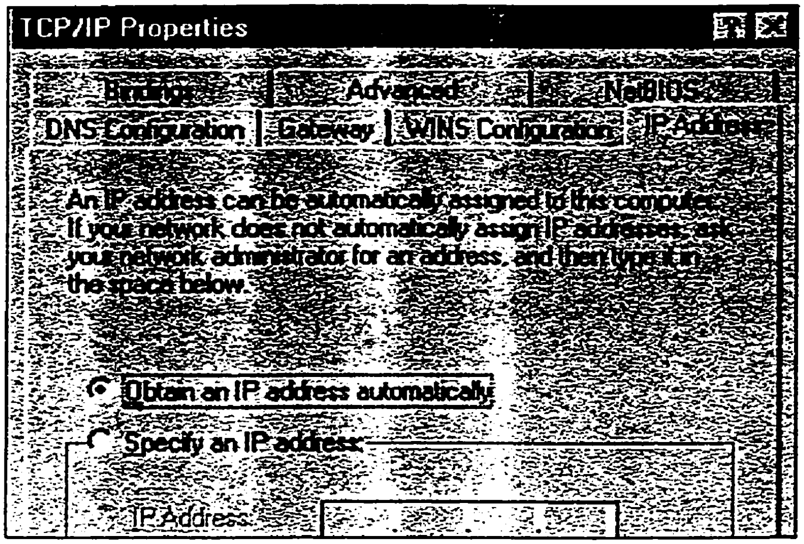



- select Microsoft from the Manufacturers window and TCP/IP from the Networks Protocols window and click OK. The following window should appear.




- TCP/IP is now added to the original Network window. You now need to configure the settings for TCP/IP.

- select TCP/IP and click Properties to see the following window.




- there are several things that need to be configured in this window. First, set the IP number for the machine.

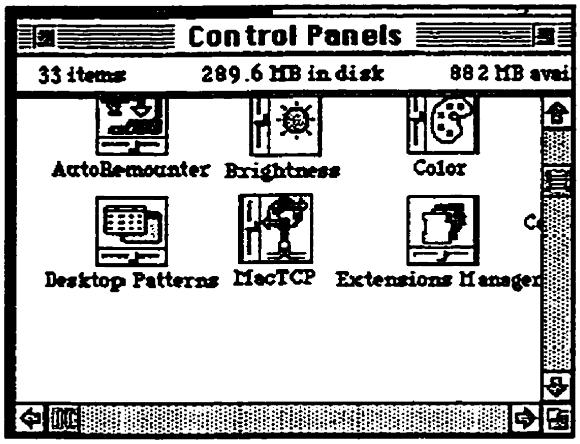
- select "Specify and IP address:" and enter an IP address as discussed in the above section on Classes and IP numbers (example 204.112.17.155).

- set the Subnet Mask (typically 255.255.255.0).

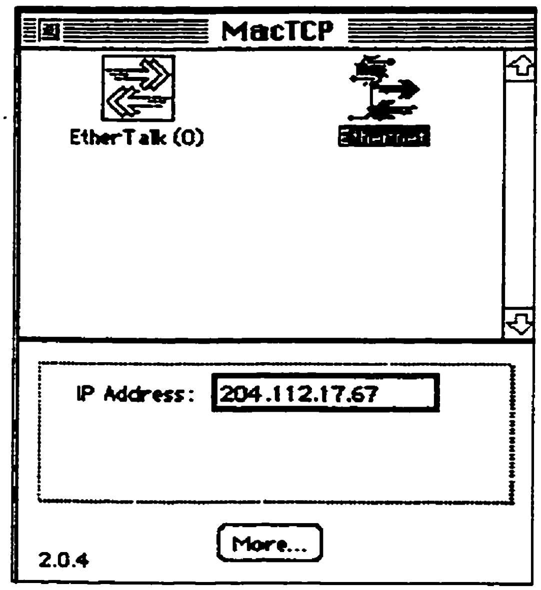
NOTE: IF you DO NOT plan to go on the Internet click OK and TCP/IP will be set. However if you plan to go on the Internet you will need to set the DNS configuration and the Gateway. Since the Gateway and DNS configurations are dependent on your access to the Internet (your Internet Provider, router number, Dialup or LAN) they will not be discussed.

**For Macs**

- install/copy MacTCP into the Control Panel of the System Folder as below.

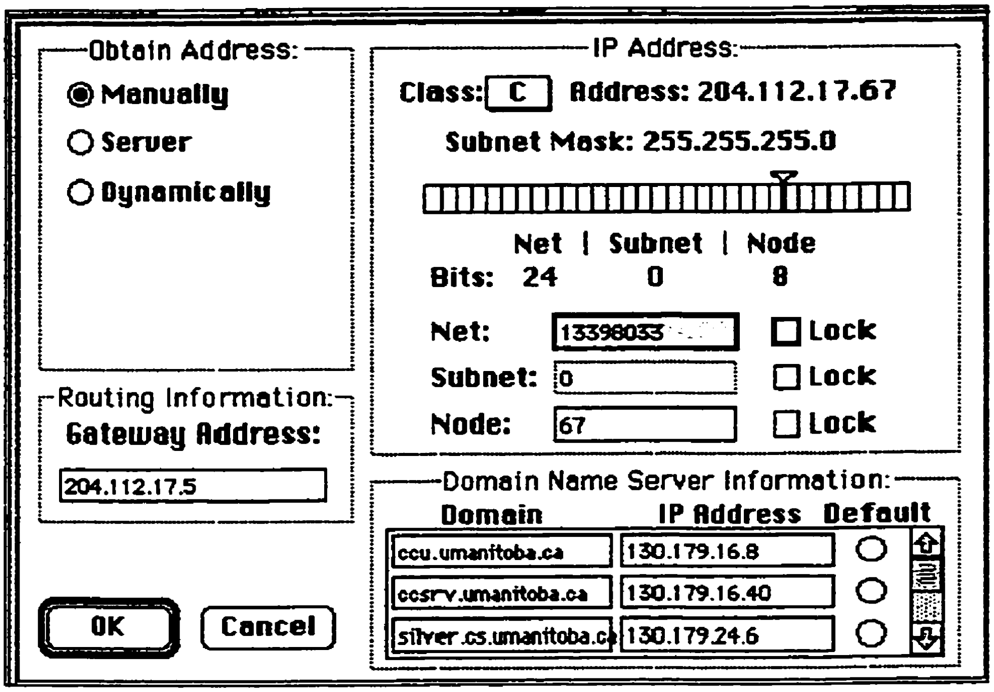



- open MacTCP. The following window will appear




- enter your TCP number as described in the IP Addresses and Classes section above (example 204.117.112.67 Note: this is a class C address).

- click on the more button to see the following window.




- set the "Obtain Address" box as needed. That is, in case you will do a manual configuration. The "IP Address" box should indicate that the previously entered IP address is a Class C address (204.112.17.67). In this example the Subnet Mask is set to 255.255.255.0. From the above discussion of Classes, this denotes that all of the computers on our LAN are on the same Subnet. That is, we have less than 255 computers attached to this LAN and therefore only need to set the last bit of the 4 bit address. All of our IP address are between 204.112.17.0 and 204.112.17.255. With the settings as given, any computer wishing to talk to another computer on the LAN will not be routed out of the building.

NOTE: if you wish to connect to the Internet then you must set routing and Domain Name information. Otherwise click OK and your computer is now ready to use TCP/IP.

- restart if necessary.

5. Explain Internet Provider and make a list of all local Internet Providers and their rates.

## Unit 3 - Thinking Critically about Networks

**The student should:**

1. Evaluate and contrast peer_to_peer networks and client/server networks given the following scenarios:

   a) a small network of 5 or 6 computers in a classroom that require a shared printer and shared folders.

   b) a medium sized network of 50 or 60 computers for two high school labs that require several printers and some network security.

   c) a large network of 150 computers that require several printers, several shared applications, access to a common database, and stringent security.

   Use the following criteria in your evaluations:

   i) feasibility of the different topologies

   ii) cost of network operating system

   iii) difficulty of installation and configuration

   iv) maintenance of the network

2. Plan and implement a network solution for a network need in your school using the following outline.

   a) Planning:

      i) define the problem

      ii) set the goal

      iii) formulate questions (such as; what resources are to be provided by the network, how much security is needed, how should the logon activity be structured, which applications are to be run across the network)

iv) identify the main components necessary for their network solution (types of cabling, hubs, computers, network cards, printers, protocol, network operating system, platform)

b) Presenting solution for debate:

i) compare plausible topologies

ii) use a diagram to sketch or map out a solution

iii) orally discuss (with appropriate technical language) a chosen solution

c) Implementation:

i) install and configure network cards for the computers

ii) install the appropriate cabling (ethernet, coax, etc)

iii) install and hook up the hub(s)

iv) connect the computers to the hub

v) configure the network operating system

vi) logon or connect the clients to the network

vii) establish the shared resources (printers, folders, applications)

viii) provide some security (logon scripts, or access rights and privileges)

d) Maintenance:

i) maintain the network for a given period of time (1 or 2 weeks) by managing the resources, adding new clients, adding new users (accounts), and installing any new applications

3. Plan an Internet solution for:

a) a small school that wants to have a WWW Web server (for its homepage) with Internet access for a lab of 25 computers.

b) a school that wants Internet access for its entire LAN comprised of 100 computers.

Use the following criteria in your plan:

i) list all of the required hardware and associated costs

ii) operating system with associated costs including licensing fees for the clients

iii) registering a domain name (if applicable) and all appropriate TCP/IP numbers.

iv) security of the network

4. Present the above (topic 3) solution to the class using a diagram (topology layout), price quotes from actual dealers for the hardware and software, and the timeline for implementation.

5. Plan an Intranet solution for:

a) a school that has 50 or 60 computers.

b) a school division that has several schools with 50 or 60 computers in each school.

Use the following criteria in your plan:

i) list all of the required hardware and associated costs

ii) operating system with associated costs including licensing fees for the clients

iii) protocol choice and reason for choice

iv) users and groups (logon accounts)

v) access rights and privileges

## Reflections

As is customary, several issues arose in this construction of a protocol for authoring generalizable technology education curricula. At least three issues call for reflection.

First, there may be a need for further analysis and research concerning developing generalizable technology education curricula. Second, strengths and weaknesses of my protocol emerged during the development of the curriculum. And third, it can be asked how well this protocol will work in authoring other technology education courses.

Procedures for developing generalizable technology education curricula will be in greater demand as students and teachers are drawn into the field of technology. School systems are having an increasingly difficult time finding the resources (human and monetary) needed to properly equip students with the technological skills of today's work force. Further, the Department of Education itself is not able to keep up with current technological changes. As a result, technology education teachers are, by default, largely responsible for curriculum development and the standards associated with their curricula. This is troubling when one considers that most classroom teachers have very little, if any, formal training in curriculum development.

Further investigations are needed to guide technology teachers in creating curricula. Technology education teachers will need protocols and exemplary curricula in order to meet the demands of their tasks. The eclectic protocol used in this thesis seems appropriate for creating some generalizable technology education curricula, but some courses such as those concerning graphic arts or multimedia may need a different approach than was laid out here.

The choice of models incorporated into my protocol for authoring Networking Technology 40S were the academic, the technical, and the intellectual (see pp. 14-17). These seemed to be good choices for the authoring of this curriculum, but they presented certain challenges that were not apparent at the onset.

The academic model is well suited to the development of the introductory unit. This model focuses on the content as a body of knowledge with its own terms, and attention to educational opportunities and jobs. Technology education courses should probably incorporate aspects of the academic model into the curriculum. Thus, by setting the tone, respect for the content is enhanced. As students realize the need for the language associated with a particular field of study, they are encouraged to accept and use it. This makes students more technically literate as both their attitude to a field of study becomes more positive, and their use of technical language increases. This approach is generalizable to other technology education curricula.

The technical model was used to author the hands-on units of the curriculum. Although this model is perhaps the easiest model to use when authoring curriculum, it proved to be challenging for the purpose of developing generalizable curriculum. By its nature, this model guides a curriculum developer to incorporate behavioral objectives or performance skills. This forces the curriculum to focus on specific tasks. It is then easy to fall into the trap of prescriptively describing expected behaviors, behaviors that are all-too-often tied to existing technology (hardware and software), making the curriculum non-generalizable.

The sample curriculum in this thesis attempted to maintain generalizability by incorporating two scenarios for each hands-on task. The intent was to show how specific tasks such as configuring a peer-to-peer network for file sharing on a Macintosh is similar to that in Microsoft's NT. Although the steps are different between the two platforms, the concept of what is needed to be done in order for file-sharing to occur is the same. Describing these kinds of generalizable concepts in terms of specific technical instructions turns out to be a challenging task when using the technical model. This is not to say that the model was a poor choice; technology courses need to have students get their hands "dirty" in order to become technically literate, and the same problems are apt to arise no matter what model is adopted.

The intellectual process model was used in the last unit of the sample curriculum and proved to be well suited for the task of bringing the entire course together by focusing on thinking critically about networking technology. Many of the suggested activities (planning a network, evaluate and contrast various plausible solutions) for problem solving came together nicely when using the intellectual model. This concept or approach is generalizable to technology education curricula. Today's view of technical literacy will likely force all curriculum developers to seriously consider incorporating this model into curricula construction.

Overall, then, the eclectic process used in authoring the sample curriculum in this thesis seems to be well suited to creating technical courses. Courses dealing with operating systems, configuring systems, and exploring hardware would also be good candidates for this process. A large part of the content of these courses deals with general concepts that are linked to prescriptive behaviors. Like Networking Technology, these courses need to emphasize language, further education, and job opportunities. Further, these types of courses need to place a heavy emphasis on problem solving and critical thinking.

However, not all courses considered to be technology education courses are of this nature. Courses such as Multimedia and Desktop Publishing should probably emphasize more creativity and freedom of expression than courses such as Networking Technology and Exploring Hardware. The model used in this study would need to be modified so as to incorporate some aspects of the personal or learner-centered model if it were to be used to author such curricula as graphic arts courses.

Another possible approach to developing generalizable technology curricula is to use the eclectic process described in this paper in a different way. Instead of developing each unit using one model at a time, authors could integrate many of the models into each unit. That is, critical thinking topics could be integrated into each unit of the curriculum so as to encourage students to think critically from the start. Similarly, hands-on activities that focus on specific technical skills could be integrated into the introductory unit. Thus each unit would contain aspects of many of the models. Although this approach would be different from what has been suggested by this thesis, it may have potential for authoring generalizable technology education curricula.

In conclusion, more work is needed to help technology teachers author technology curricula. Various other approaches need to be described and exemplified via sample curricula in order for technology teachers to better understand the process of curriculum development. As technology changes at an increased rate, it becomes increasingly important for teachers to learn how to author generalizable technical curricula.

## References

Chinien, C. A., Oakes, M. M. & Boutin, F. (1995). A national census on Technology Education in Canada. Journal of Industrial Teacher Education, 32(2), 76-92.

Choo, E. (1997). The key to achieving true computer literacy. IT ON-LINE [On-line], Available: http://www.bangsar.com.

Clark, S. C. (1989). The Industrial Arts paradigm: Adjustments, replacements, or extinction? Journal of Technology Education, 1(1). Available: http://borg.lib.vt.edu/ejournals/JTE/jte.html

Derflerr, F. J. (1995). PC Magazine: Guide to connectivity. (3rd ed.) Emeryville: Ziff-Davis Press.

Florida Center for Instructional Technology. (1998). An educator's guide to school networks: Solving the networking puzzle. [On-line]. Available: http://fcit.coedu.usf.edu/network/

Frey, R. E. (1989). A philosophical framework for understanding technology. Journal of Industrial Teacher Education, 27(1), 23-35.

Gallaghar, J. V. (1993). Improve or perish revisited. The Technology Teacher, 52(4), 28-32.

Gilbert, H. (1995). Introduction to TCP/IP. [On-line]. Available: http://pclt.cis.yale.edu/pclt/comm/tcpip.htm

Gradwell, J., & Welch, M. (1991). Technology Education should focus on basic concepts. Canadian Vocational Journal, 26(3), 22-27.

Hansen, R. E. (1995). Five principles for guiding curriculum development practice: The case of technological teacher education. Journal of Industrial Teacher Education, 32(2), 30-50.

Hayden, M. (1998). Teach yourself networking in 24 hours. Indianapolis: Sams Publishing.

Herschbach, D. R. (1992). Technology and efficiency: Competencies as content. Journal of Technology Education, 3(1), 17-28.

Johnson, S. D. (1992). A framework for Technology Education curricula which emphasizes intellectual processess. Journal of Technology Education, 3(2), 29-40.

Kincheloe, J. L., & Steingberg, S. R. (1993). A tentative edscription of post-formal thinking: The critical confrontation with cognitive theory. Harvard Educational Review, 63(3), 296-320.

Lowe, D. (1996). Network for dummies. (2nd ed.) Foster City: IDG books Worldwide.

Orstein, A. C. & Hunkins, F. P. (1993). Curriculum: foundation, principles, and theory. (2nd ed.) Boston: Allyn and Bacon.

Pucel, D.J. (1992a). Technology Education: A critical literacy requirement for all students. Presented at the 1992 Mississippi Valley Industrial Education Conference, Chicago, Il.

Pucel, D.J. (1992b). Technology Education: Its changing role within general education. Presented at the 1992 American Vocational Association Convention, St. Louise, Mo.

Rogers, G. E. (1995). Technology Education curricular content: A Trade and Industrial Education perspective. Journal of Industrial Teacher Education, 32(3), 59-74.

Sanders, M. E. (1996). Scenarios for the "Technology Standard". Journal of Technology Education, 7(2).
Available: http://borg.lib.vt.edu/ejournals/JTE/jte.html

Sangoma Technologies Inc. (1998). TCP/IP and IPX routing Tutorial. [On-line].
Available: http://www.sangoma.com/fguide.htm

Schatt, S. (1993). Understanding local area networks. (4th ed.) Indianapolis: Sams Publishing.

Web66: A K12 World Wide Web Project. (1998). Installation of Windows NT Server. [On-line].
Available:
http://web66.umn.edu/WinNT/CookBook/GettingStarted/Install/Default.html

Wicklein, R. (1996). Curriculum focus for Technology Education. Presented at the 1996 Technology Issues symposium, Maui, Hawaii.

Wright, R. T. (1992). Building a defensible curriculum base. Journal of Technology Education, 3(2), 67-72.

Zuga, K. F. (1989). Relating Technology Education goals to curriculum planning. Journal of Technology Education, 1(1), 34-58.

Zuga, K. F. (1993). A role for alternative curriculum theories in Technology Education. Journal of Industrial Teacher Education, 30(4), 48-67.

Zuga, K. F. & Bjorkquist, D. C. (1989). The search for excellence in Technology Education. Journal of Technology Education, 1(1). Available: http://borg.lib.vt.edu/ejournals/JTE/jte.html

# IMAGE EVALUATION TEST TARGET (QA-3)

150mm

6"

APPLIED IMAGE, Inc
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989