Via Teldok

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av *Mats Lundeberg, Ingolf Ståhl och Mats Glader*

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Förord

Under slutet av 1986 och början av 1987 studerade tre lärare och forskare vid Handelshögskolan i Stockholm — professor Mats Lundeberg, professor Ingolf Ståhl och docent Mats Glader — med stöd från TELDOK hur ny informationsteknologi (särskilt persondatorer) kommer till användning inom ett visst slags högre utbildning i USA, nämligen vid "business schools", alltså närmast motsvarande handelshögskolor i Sverige.

De tre resenärerna hade alla olika resmål inom det gemensamma temat, deras erfarenheter är något olika om än samstämmiga i en del enskildheter. Deras reserapporter återges också var för sig, skrivna på olika sätt (inklusive med olika typsnitt) som de är, och med egen sidnumrering.

Dessutom bifogas ett särtryck av en rapport om användningen av persondatorer inom utbildningen vid UCLA (University of California at Los Angeles) Graduate School of Management.

Bertil Thorngren — Ordförande
P G Holmlöv — Sekreterare
TELDOK Redaktionskommitté

DATORANVÄNDNING VID HANDELSHÖGSKOLOR I USA

1 INLEDNING

Under tiden december 1986 - mars 1987 företog tre medarbetare från Handelshögskolan i Stockholm studieresor i USA enligt nedan:

Namn	Reseperiod	Besökta universitet, konferenser och företag
Mats Lundeberg	1986-12-13--21	University of California, Irvine, International Conference on Information Systems, San Diego, Stanford University, University of California, Los Angeles
Ingolf Ståhl	1987-01-12--30	MIT, Digital Equipment Corp, Wharton School, University of Pennsylvania, University of Pittsburgh, Carnegie-Mellon University, New York University, Columbia University, Yale University, Brown University, Harvard Business School
Mats Glader	1987-03-10--21	Apple, Stanford University, Execucom, University of Texas, Drexel University, Wharton School, New York University, Columbia University

Syftet med studieresorna var att studera hur datorer används i undervisning i ekonomi vid handelshögskolor i USA.

Ingolf Ståhl och Mats Glader har skrivit separata reserapporter från sina respektive studieresor, se bilaga 1 och bilaga 2. I denna rapport redovisas några huvudintryck från the International Conference on Information Systems. Detta är en årlig konferens inom området Information Management som samlar företrädare från flertalet av USA's handelshögskolor. Konferensen gav en fantastisk möjlighet att koncentrerat på ett par dagar bilda sig uppfattning var de olika skolorna står i sin användning av datorer just nu.

2 NÅGRA HUVUDINTRYCK

2.1 Ämnet informationsbehandling i MBA-utbildningen

Hur omfattande den obligatoriska undervisningen i informationsbehandling skall vara i MBA-utbildningen har ännu inte stabiliserat sig. Alla varianter finns, ifrån obligatoriska, genomarbetade "core" courses av stor omfattning till valfrihet. F. Warren McFarlan berättade inspirerande från Harvard Business School om deras nyliga satsning på en core course. Vid Harvard får alla nya MBA-studerande köpa ett datorpaket för USD 2700 innehållande en bärbar, batteridriven persondator, en extra monitor, en skrivare och tre programvarupaket (ordbehandling, kalkylering och statistik).

McFarlan framhöll att det var "oändligt" mycket bättre för studenternas inlärning att jobba med egen dator jämfört med att arbeta två och två. Han sa vidare att genom att de nya studenterna varje år köper den senaste persondatormodellen håller man jämna steg med den tekniska utvecklingen utan att låsa fast sig i gammal teknologi.

Bland andra universitet som satsat medvetet på undervisningen i informationsbehandling i MBA-utbildningen märktes:

University of Arizona

University of California, Los Angeles

Georgia State University

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Bilaga 1

Studieresa i USA 1987-01-12—30

Ingolf Ståhl

Anteckningar från en studieresa i östra USA rörande datoranvändning vid universitet 12 - 30 januari 1987

av Ingolf Ståhl
Handelshögskolan i Stockholm

Syftet med resan var

1) att studera den allra senaste utvecklingen vad gäller användningen av arbetsstationer för högskoleundervisning vid MIT och Carnegie-Mellon

2) att studera vilken typ av datorutrustning, särskilt persondatorer, som används vid olika handelshögskolor i USA

3) att studera vilken typ av programvara, som används vid dessa skolor.

Av praktiska skäl kom resan att begränsa sig till östra USA. Totalt besöktes ett tiotal institutioner. Nedan presenteras ett sammandrag av mina anteckningar från denna resa. En utförligare version på engelska, inklusive bl a namn på det hundratal personer som bidragit med information, kan erhållas från författaren, liksom en förteckning över den litteratur och mjukvara som hopsamlats under resan.

Redogörelsen nedan följer i hög grad de ursprungliga dagboksanteckningarna. De besökta institutionerna presenteras i den ordning, som de besökts. Det skall framhållas att den presenterade informationen baserar sig på intervjuer och kan således innehålla fel p g a feltolkningar osv.

MIT: Athenaprojektet

MITs syfte är att ta ett stort steg uppåt vad avser datoranvändning. Målet var att öka datoranvändningen i praktiskt taget alla ämnen som studeras vid MIT. Av kapitalet för detta projekt kom $ 25 M från DEC, $ 13 M från IBM och $ 20 M från MIT.

Utvecklingen koncentrerades på:

1) En arbetsstation, dvs en kraftfull en-personsdator

2) Ett nätverk, som sammanbinder alla arbetsstationer med varandra och med andra datorer på MIT's område, huvudsakligen via Ethernet.

3) System-programvara för arbetsstationer, framför allt fönsterhanterare.

4) Programvara för utbildning vid arbetsstationerna.

1. Arbetsstationen

Arbetsstationen har minst 3 Mbyte primärminne, en 30 Mbyte hårddisk och en 32 bitars processor som tillåter 1 - 2 miljoner instruktioner per sekund.

Arbetsstationens skärm är mycket större än på en persondator och medgav omkring en miljon punkter på skärmen. Detta tillät samtidig visning av en hel A4-sida text och på samma gång hjälpmenyer etc bredvid denna sida. Arbetsstationen var monokrom, ej färg. Arbetsstationen hade både ett tangentbord och en mus.

Alla studerande skulle så småningom bli tvungna att köpa sina egna arbetsstationer. För närvarande hade MIT 10 000 studerande, 5 000 som studerade för master eller doktorsexamen, 5 000 för bachelorsexamen och 1 000 fakultetsmedlemmar. MIT skulle förse alla fakultetsmedlemmar med arbetsstationer. 1987 kommer det att finnas 3 000 användare av Athenasystemet. 1988 beräknades 5 000 studerande att använda den; 1992 11 000 studerande.

I juni 1988 planerade man att ha 1 500 - 2 000 fungerande arbetsstationer ägda av MIT; hälften VAX-maskiner, hälften IBM RT.

Enligt planerna skulle priset för arbetsstationerna till slut bringas ned till $ 4 000, av vilket $ 1 500 var kostnader för nätanslutning och underhåll. Detta skulle innebära en årlig datorkostnad för den studerande om åtminstone $ 1 000, motsvarande ca 10 % av den årliga undervisningsavgiften.

2. Nätverk

Nätverket skulle täcka hela campusområdet, inkluderande utgångar i alla studenthem, med tillgång till centrala skrivare. MicroVAXarna skulle vara i ett "Token ring" fibernät på 10 MHz med 16 anslutningar till ett Ethernetsystem. VAX 2- och RT-maskinerna skulle anknytas till Ethernet.

Nätverkssystemet möjliggjorde att applikationer kunde köras på vilken processor som helst i systemet, men med outputen ledd till den speciella arbetsstationen. Sålunda kunde beräkningskrävande program köras på t ex en stordator som en virtuell del av arbetsstationen.

Athenasystemet siktade också på att introducera ett globalt informationssystem för MIT, dvs ett on-line dokumentationssystem med ständigt uppdaterad information om t ex kurser, fakultet, studerande etc (t ex betyg). Detta system med olika slag av "känslig information" krävde ett mycket sofistikerat användaridentifikationssystem med kodning, speciella passord etc, så att endast auktoriserade personer kunde nå vissa typer av information.

The Sloan School of Management var kopplad till nätverket, liksom alla andra avdelningar vid MIT, men hittills hade deras intresse för Athena varit mer begränsat. De koncentrerade sig för närvarande på IBM:s stordatorer och deras VAX:ar använde VMS, ej UNIX.

Ingen nätverksanslutning till Macintoshmaskiner planerades, men man rekommenderade mig att besöka Brown University.

3. Systemmjukvara

Utvecklingen av systemmjukvara är förmodligen den viktigaste sidan av Athenaprojektet.

Systemmjukvaran var UNIX-baserad och använde Berkely 4.2- eller 4.3-versionen. Systemmjukvaran koncentrerades på utvecklingen av X-Window-systemet, Toolkit-systemet och ett användaridentifikations- och säkerhetssystem.

Systemmjukvaran har fyra huvuddelar:

1) Fönsterhanterarsystemet X-Window

2) Toolkit-(=verktygslåde-)systemet

3) Det virtuella disk-servicesystemet, som innebar att varje arbetsstation tycktes ha en enorm diskkapacitet.

4) Användaridentifikationssystemet, inklusive passord, kodning etc.

Fönsterhanterarsystemet inom Athena (här definierat på ett annat sätt än för Andrew vid Carnegie-Mellon) bestod i själva verket av tre olika paket, alla skrivna i C, bestående av mycket allmänna kommandon för att hantera informationen på skärmen, och programmen kördes i en processmiljö, som möjliggjorde att flera uppgifter utfördes av CPU virtuellt samtidigt. På så sätt tillät systemmjukvaran att flera program kördes parallellt, t ex ordbehandling, grafik och simulering kunde utföras samtidigt. För kontakten med användaren, använde Athenasystemet Toolkit-systemet. Förhållandet kan förklaras med följande:

Användare   Toolkit-system   X-Window   C   Hårdvara

Athena tillät, i motsats till Andrew, fönstren att överlappa. Sofistikeringsgraden t ex vad beträffar antalet möjligheter stod på en högre nivå än hos Macintosh.

Fönsterhanteringssystem, X-Window, och Toolkit-systemet är skrivna i portabel C (Berkely 4.2 - 4.3) och kan därför arbeta på flera olika typer av arbetsstationer. X-Window-systemet, nu i version 10.4, var en helt mogen produkt. X-Window och Toolkit började nu erkännas som standards av flera dataföretag och var på väg att bli allmänt tillgängliga.

Fönsterhanteringssystemet X-Window ansågs vara ett mycket flexibelt system, och man trodde att utvecklarna av Andrewsystemet på Carnegie-Mellon skulle vara intresserade av att använda detta. Å andra sidan ansågs Andrewsystemet möjligen vara bättre vad avser anknytningen till slutanvändaren, och man skulle i framtiden eventuellt ha en sammanslagen produkt som nedan:

Användare   Andrew   Athena X-Window   Hårdvara

Som s k file servers, ifrån vilka arbetsstationer hämtade programvara och data ifrån databaser, användes vid MIT huvudsakligen ett antal VAX 750-maskiner, varvid varje dator betjänade 50 - 60 arbetsstationer.

Toolkitsystemet möjliggjorde användandet av en mus i ett system, som liknade Macintosh, men som i många avseenden var mera avancerat än detta.

Systemet för virtuell filservice använde delar av tre olika programbibliotek, utvecklade utanför MIT (Berkeley, HP och DEC). Toolkit bestod av ett urval ur dessa tre bibliotek.

Detta filservicesystem möjliggjorde läsning ifrån valfri arbetsstation i ett stort antal andra filer, såväl i VAX 750-maskiner som i anslutna stordatorer och andra arbetsstationer. På detta sätt kunde man från en arbetsstation ha tillgång till ett stort antal olika mjukvarusystem, databaser etc. Systemet tillät emellertid inte skrivning på centralt diskutrymme, utan man skulle spara sina egna data och program på sin egen hårddisk i arbetsstationen.

Systemmjukvaran medgav också ett decentraliserat databassystem, dvs med olika delar av databasen tillgängliga på olika ställen.

En personalstab på totalt 80 personer arbetade för närvarande med systemmjukvaran. Till en begränsad del arbetade man också med hårdvara (speciellt anknytning till yttre maskiner).

Den årliga kostnaden för denna systemdel av Athena uppskattades till $ 4 M. Detta betalades huvudsakligen av IBM + DEC ovanpå deras bidrag i form av hårdvaruanslag till de 1 500 - 2 000 arbetsstationerna.

I detta sammanhang bör nämnas att för s k generisk mjukvara, som arbetar på nivån mellan operativsystem och applikationsmjukvara, hade man valt:

a) S20/20 som kalkylspråk (spread-sheet)
b) RS1 som laborativt databassystem
c) GKS som grafikpaket
d) Ingres som relationsdatabas
e) Blox-systemet för "mänsklig anknytning"
f) EMAX som texteditor

4. Applikationsmjukvara

Applikationsmjukvaran, dvs mjukvaran specialgjord för undervisning, omfattade arbeten inom omkring 100 olika kurser.

Utveckligen gjordes i tre standardspråk - C, Fortran-77 och LISP (Franz Lisp). Ett fåtal projekt hade vid något tillfälle också använt Pascal. De flesta projekt använde C, naturligt i en UNIXmiljö. En stor del av arbetet gällde samhällsvetenskap och humaniora. Prolog användes knappast alls på MIT.

Användningsområden av intresse för handelshögskolor var bl a:

1. Fastighetsmarknadsanalys: ekonomi + stadsplanering.

2. Datoranvändning i grundläggande pristeori, inkluderande dataspel simulerande konsument- + producentbeteende.

3. Spel och analyser av s k fångarnas dilemmaspel, dvs grundläggande spelteori på dator.

4. Utveckling av databaserad analys av internationella processer.

5. Multi-robotspel. Genom att ha "robot"-program att deltaga i företagsspel, på samma sätt som datorer spelar schack, hoppades man få insikter i vad som utgör bra strategi i sådana spel.

6. Athena språkstudieprojekt, rörande undervisning i fem moderna språk, med användande av videodiskar, som skapar bilder på en arbetsstations skärm, beroende på elevens svar. Till exempel, på kursen i franska kunde eleven på skärmen promenera omkring i Paris och fråga olika personer om vägen etc, och kunde sedan se de aktuella platserna. Systemet är ännu mycket dyrbart.

Utvecklingen av mjukvara bekostades huvudsakligen av MIT, som bidrog, vilket redan nämnts, med totalt omkring $ 20M.

5. Klassrumsutrustning

För klassrumsanvändning av datorn användes bl a Hughes videoprojektor, monokrom och till ett pris av $ 27 000. Projektorn var mycket stark och kunde användas i stora lektionssalar för t ex mer än 300 personer. I något mindre lokaler använde man General Electrics färgprojektor.

MIT hade också ett elektroniskt lab med 21 arbetsstationer för 42 studerande och 1 lärararbetsstation. Tack vare nätverkssystemet kunde programmet som läraren körde visas på vilken arbetsstationsskärm som helst. Nämnas bör också att placerande av arbetsstationer i klassrummen hade lägre prioritet än Athenas andra delar.

II. Digital Equipments avdelning för universitetsrelationer i Marlborough utanför Boston

Jag fick först en introduktion till DECs position på universitetsområdet. Huvudstrategin var som följer: En enda arkitektur, ändå öppen att anknytas till andra system kopplade till OSI-systemet; ett operativsystem (VMS) för maskiner av mycket olika storlekar, och körning av VAXarna i grupper (clusters) med användandet av Ethernet, för att på så sätt ha möjlighet att tillhandahålla betydande datorkraft genom att använda flera maskiner.

Man nämnde att VAX var nummer 1 vad beträffar användning på handelshögskolor, tillgängliga språk, UNIX-användning och nätverksmöjligheter.

DEC hade lämnat betydande anslag till ett antal universitet, med inriktningen på olika områden vid olika skolor. Man hade 13 partners i ett forskningprogram:

Bland skolorna fanns University of Chicago, med inriktning på finansiella databaser. Wharton vid University of Pennsylvania (se mera nedan), University of Delaware med inriktning på elementära ekonomikurser, University of Rhode Island, med inriktning på Artificiell Intelligens och Expertsystem, samt Cambridge och Edinburgh, Storbritannien.

För kontakter med universitet som använder datorer rekommenderade man EDUCOM, ett årligt möte arrangerat för DEC-användande universitet, och IBSCUG, International Business School Computer Users Group. Information kunde också erhållas över BIT-nät i form av datakonferenser.

Därefter diskuterades vad man betraktade som intressant mjukvara. Vad beträffar ekonomi, framhöll man Chicagos databas över ekonomiska data. För marknadsföring framhöll man affärsspel såsom Tycoonspelet vid Dartmouth (som använder kalkylspråk för analyser) och det utökade INTOP-spelet. För LP framhöll man LINDO (University of Chicago) såsom det mest allmänt använda paketet.

DEC organiserade distributionen av tillämpad mjukvara både rent allmänt genom DECUS (Digital Equipment Corporation Users' Society) till distributionskostnad och speciellt för universitet genom ett clearinghus vid Iowa State University till mindre royaltyavgifter.

Jag fick sedan en presentation av DEC's system för datorstödd undervisning, i form av ett Pascalliknande bmasspråk DAL (Digital Author Language) och en mer användarvänlig applikationsgenerator, Courseware Design System. Med en passande kombination av de två systemen kunde man nå en balans mellan enkelhet och flexibilitet. Systemen innehöll också en grafisk redigeringsenhet - SIGHT. Systemen tillät även en samling av data över de studerande.

Jag erhöll också en hel del skriftligt material från DEC. Här skall jag bara nämna Jason Frands kartläggning av datoranvändning vid amerikanska handelshögskolor 1985. Där visades att förhållandet student/persondator för den övre kvartilen av de 125 undersöka handelshögskolorna var 15.

På kvällen besökte jag Datormuseet i Boston, nära South Station och Atlantic Avenue. Detta rekommenderas varmt varje Bostonbesökare. Av speciellt intresse för mig var utställningen av Whirlwinddatorn från MIT, ifrån vilken, mer eller mindre indirekt, DEC och större delen av Bostonområdets dataindustrier leder sitt ursprung.

III. Wharton School, University of Pennsylvania

Hårdvara

Whartons datorutrustning hade huvudsakligen donerats och därför hade Wharton en stor variation i utrustningen, t ex 1 VAX 8600, 1 VAX 11/750, 1 VAX 11/780, 8 Apollo arbetsstationer, 3 IBM RT, 40 Rainbow PC, 15 Burrough PC, 10 HP PC, 20 IBM PC, 20 Macintosh (128 k) etc. Detta innebar ett gott förhållande vad gäller antal studenter per persondator (grovt räknat 10). Man försökte så långt möjligt att nätverksansluta persondatorerna. På detta sätt var man också ansluten till områdets stordatorer. Man använde huvudsakligen Ethernet, men några IBM PC använde IBM PC-NET. Handelshögskolan Whartons datapolicy var i hög grad oberoende av Penn Universitetets centrala dataavdelning.

persondator-labben var öppna 24 timmar/dag. Datalabben användes inte för undervisning, utan var uppdelade i små hytter.

För att använda en dator i klassrummet hade man tidigare använt SONY-projektorer ($ 8 500, svagare än Barco). Nu höll man på att köpa ett antal av den nya Kodak Datashow plattskärmsmonitorn som placeras på en overheadprojektor ($ 1 200). Man var mycket nöjd med denna utrustning. I varje klassrum planerade man att placera en IBM AT med ett färgkort, kopplad till en sådan Kodakskärm.

Man hade också som policy att man <u>föredrog</u>, även om det <u>ännu inte</u> var obligatoriskt, att varje elev <u>skulle</u> ha sin egen persondator. Detta år hade omkring 75 % av studenterna på Mastersprogrammet sin egen persondator. Man var öppen i frågan om vilken persondator studenten skulle köpa, bara den var IBM-kompatibel. IBM, AT&T och HP erbjöd persondatorer till ett mycket nedsatt pris ($ 1 600 som lägst).

På hårdvarusidan kan också noteras att man i den nya byggnaden för företagsledarutbildning, i sov-"sviterna" höll på att introducera arbetsstationer med "Voice mail", dvs utrustning för digitalt ljud med möjlighet till lagring av talade meddelanden på datorn.

Mjukvara och kurser

De viktigaste mjukvarupaketen var Lotus 1-2-3 och WordPerfect. WordPerfect hade före valet noggrant jämförts med MS Word. För linjär programmering använde man SUPER-LINDO (såld till eleverna för $ 73.95). På kurser som krävde ett databasprojekt använde man huvudsakligen Oracle (på VAX), men också INFORMIX och INGRES (från Relational Technology Corp) med möjlighet att knyta Lotus 1-2-3 till SQL.

För statistik använde man EasyStat från Harcourt & Brace och ett delvis eget paket, som byggde på APL.

Datorn användes (förutom för ordbehandling) i följande grundläggande kurser på Masterprogrammet:

1. Introduktion till ekonomi: Lotus 1-2-3 + användning av ekonomiska databaser, t ex CRISP, en stor ekonomisk databas från Chicago.

2. Marknadsföring: Lotus 1-2-3 för fallstudier.

3. Redovisning: Lotusmallar i vissa övningar, t ex för att introducera redovisningsbegrepp.

4. Mikro + makroekonomi: Spreadsheetmallar för att simulera en makromodell (ISLM). Grafik spelade stor roll.

5. Kvantitativa beslutsmodeller: Lindo + Lotus 1-2-3.

6. Statistik: EasyStat + användning av APL-paket.

Det bör nämnas att Wharton hade erhållit ett anslag på $ 2 milj från IBM, som en del av IBM Management of Information Systems Program, av vilket $ 1 milj var avsatt till fakultetsmedlemmarnas tid för att utveckla användandet av datorerna. Arbete var på gång i 41 olika projekt.

På Masternivån undervisades inte i något dataspråk; bara en kurs i Lotus 1-2-3 makrokommandon. Alla ekonomistuderande för bachelorgraden måste emellertid ta en kurs i Pascal.

Man hade upprättat planer för ett nytt 5 terminers kombinerat Master of Business Administration/Master of Science program. Alla valfria kurser i MBA-delen av programmet skulle vara inom MIS-sektorn. Detta skulle tillåta eleverna att ta de flesta baskurserna i MIS, såsom Introduktion till MIS, Databashantering och Systemanalys och Design. I kursfordringarna skulle under tredje terminen ingå några månaders arbetsplatspraktik inom MIS-området under lärarhandledning.

Specialiserade MIS-kurser som lades till för MS-delen av programmet var bl a:

- Telekommunikationer
- Informationssystem
- Intelligenta managementsystem
- Beslutsstödssystem

I doktorandkurser inom beslutsvetenskap användes GAMS (General Algebraic Modelling System), kopplad till MINOS, och utvecklat vid världsbanken. Planer fanns vidare att på Wharton integrera GAMS med ett standarddatabassystem, t ex FOCUS.

För simulering av produktionsplanering användes XCELL-systemet.

En gästforskare vid Wharton arbetade på ett projekt för användning av Macintosh i grundläggande pristeori. Projektet använde en animationsteknik, som omfattade Mac Paint, för att steg för steg bygga upp olika mikroekonomiska kurvor. Detta projekt liknade det projekt, lett av David Friedman (Miltons son), som syftar till en textbok om mikroekonomi med en floppy disk. Båda projekten inriktade sig på persondatorns grafiska möjligheter att ge en bättre förståelse av mikroekonomi.

Inom nationalekonomiska undervisningen var även användning av laborativa marknadsexperiment av betydelse i både mikro- och makrokurser.

Wharton använder också ett spel, The Master Scheduling Game, för att simulera ett företags produktionsplanering, samt Saaty's Multiattribute Expert Choice.

IV. University of Pittsburgh

Hårdvara

The Graduate School of Business vid University of Pittsburgh tillhörde de 13 skolor, som får $ 1 milj av IBM i anslag till hårdvara. De hade en IBM 4381 med 8 M primär- och 5 G sekundärminne, och en IBM persondator för var och en av de 65 fakultetsmedlemmarna.

Ytterligare anslag kom från AT&T: några 3315 minidatorer + 20 persondator AT&T + 35 terminaler. Man hade också en VAX 750. Dessutom hade man 30 IBM persondatorer för studenterna (av vilka 15 var en del av anslaget). Alla persondatorer var IBM-kompatibla.

Studenternas persondatorer var kopplade i ett Starlan nätverk, som i sin tur, tillsammans med fakultets-persondatorer och IBM 4381, var hopkopplat med skolans hela nätverk, vilket delvis använde Ethernet. Därigenom var man ansluten till Pittsburghs superdator. Hela universitetet hade spenderat $ 20 M i enbart nätanslutningskostnader. Det fanns inga fristående persondatorer.

Man arbetade på ett system för handelshögskolans administration och använde sig av IBM PROFS, Professional Office System, med elektronisk post, elektroniska förslagslådor, nyhetsbrev, resurs + rumsscheman, personkalendrar etc etc. Detta system använde Easy Access och SQL.

Handelshögskolan hade 250 heltidsstuderande på ett tvåårsprogram + några kvälls- + fredag/lördagsstudenter. Där fanns 30 persondatorer i ett PC-lab; några ställda utefter väggarna, några i mitten av rummet. Man hade 1 (AMPEX) skrivare per 2 persondatorer; PC-labbet var öppet 7.30 - 23.00 på vardagar, 10.00 - 17.00 eller 19.00 lör/söndagar. Under 7 veckor på höstterminen var förhållandet 250 studenter på 30 persondatorer inte tillräckligt. Man var därför i färd med att utforma en policy som innebar att man förväntade att varje heltidsstuderande skulle se till att skaffa sig tillgång till en IBM-kompatibel PC utanför skolan.

Mjukvara

Som mjukvara använde man huvudsakligen Lotus 1-2-3 och GW-BASIC, men användningen av BASIC var under omprövning. Javelin hade av leverantören offererats helt kostnadsfritt men hade likväl ej kunnat ersätta Lotus 1-2-3. För ordbehandling användes WordStar och DisplayWrite. Som ekonomisk statistik-paket TSP. För OR använde man LINDO och Expert Choice (för beslut i situationer med många mål) och i ekonomi FAIR:s ekonometriska modell. I många kurser, där man använde fallstudier, önskade lärarna att studenterna skulle använda dator, men läraren specificerade inte vilken mjukvara studenterna skulle använda. I nationalekonomi använde man CRISP ekonomiska databas, och använde ett IBM SQL-system (del av IBM Application System) för analyser av detta datamaterial. Man ville att eleverna skulle arbeta på ett realistiskt sätt med stora datamängder. Inom nationalekonomi användes vidare bl a GAUSS' statistikpaket.

I PC-labbet hade eleverna många paket att välja bland, inklusive paket såsom APL, LISP, Knowledgeman, IFPS, Final Word, SLAM II, Slide graphics etc.

På nationalekonomiska institutionen utvecklades under ledning av professor Arnold Kats mjukvara för Computer Aided Instruction, The Intelligent tutor, för grundläggande undervisning i nationalekonomi. Denna mjukvara utnyttjar AI för att utveckla optimala inlärningsstrategier. Undervisningen sker i form av marknadsspel, där datorn innehåller marknadsuppgifter, vilket uppmuntrar studenten att använda en systematisk metod för att söka information. Programmet var skrivet i LISP (Texas Instrument PC-Scheme-versionen).

Man hade fått ett "obegränsat" mjukvaruanslag från IBM, med uppskattat värde av ca $ 4 M. Syftet med anslagen var att utveckla kursvara med speciell inriktning på en ny MBA + MS-examen (Master of Information Systems), liknande den som ovan diskuteras för Wharton.

V. Carnegie-Mellon University

1. GSIA (Graduate School of Industrial Administration)

Hårdvara

Vid GSIA fanns 190 Master heltidsstuderande samt 130 deltidsstuderande på kvällstid. GSIA hade omkring 35 IBM persondatorer och ungefär 35 Macintosh för dessa studerande, dvs ett mycket gott förhållande vad avser antal studenter per PC, och för närvarande behövde eleverna inte köpa sin egen PC. Man hade ett stort lab med 17 IBM persondatorer samt 6 små rum med 3 IBM persondatorer i varje, med ett litet angränsande diskussionsrum utan PC.

Alla IBM persondatorer vid GSIA var anslutna till Andrewsystemet (se nedan) och använde ett virtuellt filsystem liknande DOS (men UNIX-baserat), vilket innebar att man kunde definiera ett diskutrymme på Andrewsystemet som D och sedan kalla på det med D:. Macintosharna var alla fristående. GSIA hade dessutom en IBM 3083 och 2 VAX-datorer.

Mjukvara

I undervisningen i OR användes LINDO med möjlighet att koppla till FORTRAN program. För grundläggande inlärning av LP användes ett av professor Gerald Thompson utformat mjukvarupaket SML, som står för Self Managed Learning of LP.

Inom GSIA användes som statistikpaket bl a GAUSS från Applied Technical Systems, och TSP.

2. Andrew-projektet

Hårdvara och systemprogramvara

Andrewprojektet har stora likheter med MIT's Athenaprojekt. Båda använder kraftfulla arbetsstationer, som arbetar i ett nätverk med mycket användarvänliga fönstersystem. Inom Andrewsystemet har man också siktet inställt på att arbetsstationen skulle kosta omkring $ 4 000 inom några år. Då skall varje elev kunna köpa en, men man hade åtminstone inte ännu beslutat att det skulle vara obligatoriskt. Med en uppskattad servicekostnad för arbetsstationen på grovt räknat $ 300 per år skulle den årliga kostnaden bli i storleksordningen $ 1 000 - 1 500, motsvarande 10 - 15 % av den årliga undervisningsavgiften.

Liksom i Athena använde man MicroVAXar och IBM AT, men Andrew använde dessutom även SUN. Arbetsstationerna hade processorer med 2 MIPS kapacitet, och 2 - 4 Mbytes primärminne och 30 Mbyte hårddiskar för användarens egna program.

Inom Andrew var IBM den enda bidragsgivaren tillsammans med CMU. Andrew är, liksom Athena, baserad på UNIX (4.2), men här siktade man på att komma bort från att vara helt beroende av UNIX. Arbetsstationerna hade, liksom hos Athena, en hög upplösning med omkring 1 miljon punkter, vilket gjorde det möjligt att på skärmen samtidigt presentera en hel sida text plus hjälpmenyer och systeminformation.

Beträffande mjukvaran koncentrerar Andrew sig på kopplingen till användaren, medan Athena betonar det grundläggande fönstersystemet. Som nämnts ovan under MIT, kan det i framtiden bli en sammansmältning, där man använder Athenasystemet för den grundläggande fönsterkopplingen till UNIX och använder Andrewsystemet för kopplingen mellan människan och det grundläggande fönstersystemet.

Arbetsstationerna var sammankopplade med hjälp av två slags nätverk:

a) Ethernet b) IBM Token Ring

Totalt planeras ett system med omkring 10 000 utgångar, där en arbetsstation kan kopplas in, till en totalkostnad av $ 6 M, dvs ca $ 600 per utgång. För närvarande var bara 50 arbetsstationer tillgängliga för elever och 350 för fakultetsmedlemmar. 3 500 inloggningsnamn var registrerade.

Arbetsstationerna var kopplade till ett system med 15 st file servers. Som file server använde man SUN-2 och IBM RT-datorer. Tidigare hade man använt VAX 750, men de ansågs för kostsamma för detta ändamål. Nätverket kopplade samman arbetsstationerna i sista hand till en stor IBM 3083 och en ännu större Cray XMP.

Grovt räknat 60 % av eleverna skulle ha sin arbetsstation i sitt studenthem med direkt koppling. De återstående skulle kopplas över telefonnätet. Man skulle då i dessa fall få problem med att de normala överföringshastigheterna (1 200 - 2 400 bits per sekund) skulle upplevas som långsamt. På särskilda linjer ansågs överföring av 64 000 bits per sekund vara möjlig, men inga kostnadsberäkningar kunde lämnas för detta.

All applikationsmjukvara, som skulle användas, skulle läsas från någon file server eller möjligen hårddisk i en annan arbetsstation, som arbetade som en virtuell del av en arbetsstation. 400 - 500 Kbyte systemmjukvara (fönsterhanteringssystem etc) skulle alltid finnas i minnet.

Demonstrationen av Andrew arbetsstationen framhävde möjligheterna hos fönsterhanteringssystemet, när man arbetade i en multiprocessmiljö. Detta tillät t ex samtidig ordbehandling, konstruktion av diagram via grafikpaketet i mitten av texten och körning av ett simulationsprogram i bakgrunden, vilket gav siffrorna till diagrammet.

De olika lagren av system-mjukvara kan beskrivas som följer:

CMU-tutor-språket
Andrews hjälpprogram inkl textbehandlare och kalkylspråk
BE-2 (Basic Environment version 2)
Fönsterhanterare
UNIX

CMU-tutor-språket kommer att diskuteras nedan. Andrews hjälpprogram inkluderade dess egen textbehandlare med bl a enkel formelhantering och kalkylspråk (spread sheet), för närvarande likt Visicalc. Tanken bakom att skriva egna textredigerare + kalkylspråk var att möjliggöra ett helt integrerat paket (liksom Macintosh) för att förenkla både inlärning och användande.

Demonstrationen fick mig att upptäcka en befintlig svaghet, vilken jag också hörde andra tala om senare, nämligen tidsfördröjningen, när man skall hämta en fil från file servern. Eftersom många användare delar på en file server kan fördröjningar liknande den i en time-sharing-miljö uppstå, men här avser det endast läsning av central mjukvara och datafiler. Man arbetade emellertid hårt på att få ned dessa tider.

Tre grupper arbetade med Andrew-systemet:

1. ITC (Information Technology Center), utvecklarna av den grundläggande system-mjukvaran, som sysselsatte 35 personer och använde en budget om $ 35 M över 5 år, med slut 1987.

2. CDEC, Center of Design of Educational Computing, som byggde särskild mjukvara för undervisningsbruk, speciellt CMU-tutor-språket.

3. Andrews Systems Administration, den CMU-organisation, som ansvarade för utvecklingen av arbetsstationer på universitetsområdet.

Mjukvara

Förutom ovanstående tre grupper hade man ett stort antal fakultetsmedlemmar som utvecklade särskild applikationsmjukvara för konkreta undervisningssituationer med användning av t ex CMU-tutor-språket.

CMU-tutor-språket utvecklades bl a av personer som tidigare arbetade med Platoprojektet vid University of Illinois. CMU-tutor måste ses i ljuset av avsikten med Andrewsystemet, nämligen att förbättra inlärningen inom den grundläggande undervisningen vid Carnegie Mellon genom att ta hänsyn till helt nya inlärningsmetoder - t ex nya slag av bibliotekssökning, simulering etc, etc.

Detta gjorde det mycket viktigt att ha ett mycket enkelt, men ändå kraftfullt, språk, i vilket lärare kunde utveckla särskild mjukvara för undervisningen; ett språk, som helt kunde utnyttja kraften i Andrew-systemet. I CMU-tutor-språket kunde man i princip skriva allting man kunde göra i Pascal, men man hade mycket bättre grafikmöjligheter.

Det var emellertid mycket enklare att skriva program i CMU-tutor än t ex i Pascal, eftersom man i CMU-tutor kunde arbeta huvudsakligen genom att peka med musen på en meny. Demonstrationen imponerade speciellt på mig genom det mycket enkla sätt på vilket man kunde bygga upp de grafiska delarna av ett program.

CMU-tutor förbättrades ständigt, men var redan i bruk bland vissa lärare. Dock framgick det av en katalog över CMU:s datorprojekt för undervisning att de flesta projekten var programmerade i traditionella språk som C, Turbo-Pascal, FORTRAN och Lotus 1-2-3 och bara en mindre del i CMU-tutor. Detta berodde förmodligen på tidsfaktorn.

Bland de program, som skrivits i traditionella språk, kan nämnas ett paket som kombinerade Lotus 1-2-3-mallar med ett Pascal-program för att undervisa i LP-metoden steg för steg.

VI. New York University, Graduate School of Business Administration

90 % av studenterna arbetar. Det finns inget krav på eget PC-innehav, men detta kan komma om 3 - 4 år. Det fanns 3 PC-lab med vardera 20 Zenith PC, alla fristående. Ett PC-lab hade också några terminaler kopplade till 2 VAX:ar. I ett lab fanns en skrivare per PC, i ett annat fanns inga skrivare.

Ett klassrum hade en PC kopplad till 8 monitorer (Zenith 28 tum), ett annat hade en PC kopplad till en Sonyprojektor. Det fanns inga Macintosh-lab.

VII. Columbia University

Hårdvara

Columbia University är känt för "det elektroniska klassrummet" med 24 persondatorer för 48 elever och 1 lärar-PC. Läraren hade dessutom en särskild låda med 24 tangenter, en för varje PC. Med detta tangentbord kunde läraren styra utdata från en valfri PC till en annan PC eller till videoprojektorn. Denna utrustning var specialgjord, och kan köpas genom Columbia Information Technology Project.

Den största kostnaden för det elektroniska klassrummet var, emellertid, förmodligen själva klassrummet. Där fanns fyra bänkrader, var och en på en högre nivå så att man från varje plats kunde se projektorduken. Det fanns speciella lampor i taket. Alla kablar var inbyggda i de speciella bänkarna. Trots att rummet var 100 kvm stort, var luftkonditionering nödvändig, när alla 25 PC + projektorn användes.

Columbia Business School hade dessutom ett PC-lab med 55 IBM-kompatibla persondatorer.

Mjukvara

Columbia Information Technology Project (ITP), till största delen bekostat av IBM, omfattade även utveckling av kursspecifik mjukvara. Den mjukvara som föreföll mig mest intressant var i Nationalekonomi, bl a specialprogram för prisfluktuationer på råvarumarknaden och för terms-of-trade-förändringar.

Mjukvarupaketen till Information Technology-programmet kommer att säljas genom Irwin. Det bör nämnas att ITP centralt har flera professionella programmerare anställda på heltid som tar hand om den mjukvara som lärare utvecklat och gör den felfri och användarvänlig.

I marknadsföringskurserna vid Columbia användes datorn främst för marknadsföringsspel som Markstrat och statistikpaket som SAS och SPSS-X.

VIII. Yale University, Yale School of Management

Hårdvara

Denna handelshögskola med 360 elever hade 55 persondator, dvs ett förhållande 6,5 studenter/PC, 2 lab (1 med 43, 1 med 12 PC), alla kopplade till ett IBM PC nätverk. Fakultetsmedlemmarna + personalen hade tillsammans 60 PC, kopplade till skolans egen VAX och, över universitetets allmänna nätverk, till en central IBM 3083.

Yale hade sin egen kommunikationsmjukvara, Y-term, vilken man ansåg vara bättre än Kermit. Över nätverket kunde stora databaser som t ex Compustat föras till persondatorerna. Nätet hade en lokal file server om 60 Mbyte.

24 av persondatorerna var AT, 5 XT och resten enkla PC. Alla persondatorer hade 640 Kbyte. AT- och XT-maskinerna hade ko-processorer (80287 och 8087). Så småningom planerade man att uppgradera alla PC till AT. Det fanns en skrivare per PC. En var kopplad via modem till Dow Jones.

20 % av eleverna hade nu sina egna persondatorer. Man förutsåg att om 2 - 3 år skulle alla eleverna vara tvungna att köpa sina egna. För närvarande krävde man ej att studenterna köpte sina egna persondatorer, utan i stället tog man ut en speciell PC-avgift på $ 300 för att finansiera PC-utbyggnaden. Det fanns inga persondator i klassrummen.

Alla persondatorer var, tillsammans med monitorerna, fastlåsta med en låsanordning av märket Anchor Pad (kostnad $ 200), fastlimmade ovanpå borden.

Mjukvara

Vad beträffar mjukvara använde man huvudsakligen Lotus 1-2-3. För att undervisa i detta använde man boken Philip Dyborg: Personal computing for managers with Lotus 1-2-3. För ordbehandling hade man valt WordPerfect. En utvärderande jämförelse hade gjorts med Word. Man använde en nätverksversion av WordPerfect. För att undervisa i Lotus 1-2-3 och WordPerfect hade man en 12-timmars kostnadsfri orienteringskurs.

För LP använde man Lindo och Lindo's 1-2-3 interface What's best?, vilken tillåter eleven att ha Lotus 1-2-3 som in- och utgång till LP-paketet.

I statistik använde man tidigare MINITAB; nu används EXECUSTAT, en delmängd av Statgraphics, orienterad mot företagsledningsperspektivet. Den är skriven i APL och därför mycket långsam utom på AT:n. På databassidan provade man Oracle, Reflex, Rbase:5 och Dbase III, men man hade ännu inte gjort något slutgiltigt val.

I en förhandlingskurs använde man mjukvara skriven i APL av Peter Cramton, vid Yale, för förhandlingar med datorn, t ex rörande oljekontrakt. För körning av denna mjukvara krävdes emellertid att man har Keyworks (från Alpha Software).

Man använde även professor Martin Shubiks managementspel för både undervisning och forskning. I detta spel kan spelledaren via en meny först välja antal spelare, beslutsvariabler etc. Datorn kan sedan beräkna olika spelteoretiska lösningar, i linje med Shubiks senaste bok Market Structure and Behavior. Dessa lösningar kan sedan jämföras med verkliga spelets utfall.

IX. Brown University

Den främsta anledningen till att jag besökte Brown var att på en lista över universitet med Macintosh-användning verkade Brown vara den mest intressanta Macintosh-platsen i den del av östkusten, till vilken jag begränsade min resa. Jag kom dock att se mycket annat också.

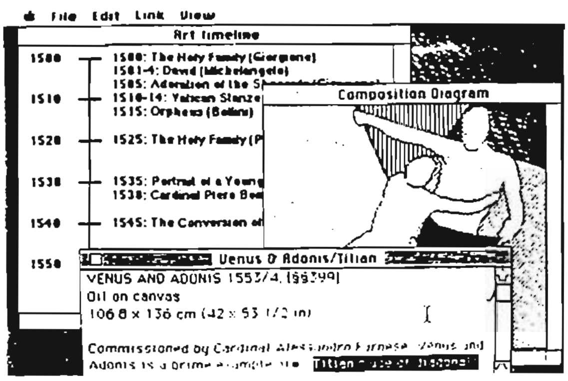
1. Gould lab, ett stort datorundervisningsrum, som även användes som datalab, med 65 Apollo arbetsstationer (som använde en version av UNIX 4.2), hopkopplade i ett Ethernet nätverk, med dessutom en TV-projektor. Från lärarens arbetsstation på podiet kunde innehållet på lärarens arbetsstation visas antingen via TV-projektorn eller på alla studenternas arbetsstationer; men inte tvärtom (som i Columbias elektroniska klassrum, se ovan). Arbetsstationerna var till en del en gåva från Apollo. Det fanns också 6 HP arbetsstationer med färgskärmar i nätverket. Lektionssalen, med varje bänkrad på en högre nivå, var byggd särskilt för detta ändamål. Lab-klassrummet, använt främst för undervisning i datalogi, var för närvarande långt ifrån fullt utnyttjat.

Studenterna undervisades i Pascal, och sedan, som tillvalsämne, C och 68000 Assembler. I AI undervisade man i Lisp och Prolog; nästa år endast Prolog.

Studenterna var inte tvungna att köpa en PC, men många köpte Macintosh (ibland i ett kooperativ; se nedan) främst för textbehandling.

2. IRIS, the Institute for Research on Information and Scholarship, där man arbetade på det s k Hypermediaprojektet. Detta är ett långtidsprojekt för att utveckla system, som skall tillåta författare att skapa länkar i dokument till olika slags media såsom text, diagram, videoreportage och musik. Detta är tänkt att bli ett stort genombrott för användandet av datorer i t ex konst- och musikhistoria etc. Hypermedia är en teknik, som är helt beroende av en effektiv fönsterhantering och avancerad grafik. Den tidigare utvecklingen hade gjorts på Macintosh, men för närvarande görs det huvudsakliga arbetet på IBM RT arbetsstationer, men man arbetar med en mus och med en Macintoshtyp av användarvänlig skärmhantering. Steve Jobs kommande NeXT-dator ansågs vara en dator, som skulle vara särskilt passande för denna typ av hypermediaarbete.

Följande bild ur MacWorld 1986 illustrerar hypermediaidén.



Intermedia
In a corpus of art history materials, for example, links can be created between historical timelines, diagrams, reference texts, and even video or laser disk images. The program places bullet markers at both the source and the destination points to indicate the existence of a link.

3. Harknessprojektet: Studenterna i ett stort studenthem hade bildat ett kooperativ med Macintosh-datorer för att hålla kostnaderna nere.

Med användande av Appletalk-systemet, hade en serie Macintoshar kopplats i ett nätverk till en vanlig Apple (Laser) skrivare, en 20 Mbyte file server och en länk till en centralenhet. Projektet sköttes helt och hållet av studenterna i studenthemmet. Macintosharna används huvudsakligen till ordbehandling och tack vare Appletalk-nätverket kunde studenterna klara sig med de billigaste typerna av Macintosh.

X. Harvard Business School

Den allmänna Harvardfilosofin för dess datoranvändning är en betoning av det integrerade användandet i kurser och användningen, på ett pragmatiskt sätt, av den mest passande tillgängliga teknologin.

Hårdvara

Under de senaste tre åren har de 750 studenter, som har börjat vid HBS, starkt rekommenderats att köpa en specifik persondator. 1984 och 1985 köpte de stationära eller "transportabla" IBM persondatorer. 1985 blev de rekommenderade (i praktiken tvingade) att köpa IBM:s batteridrivna, bärbara persondatorer.

Anledningen att kräva batteridrivna, bärbara persondatorer var att de kunde användas under tentamen. På grund av de stora administrativa svårigheterna med att handskas med alla disketter vid tentamina, skulle man från hösten 1987 kräva att studenterna också hade en batteridriven, bärbar skrivare, så att alla studenter vid slutet av tentamen kunde skriva ut alla svar.

Alla studenter som började vid HBS i september 1987 skulle till en kostnad av $ 2 700, den första juli erhålla ett paket innehållande en IBM bärbar dator, med 512 Kbyte minne och 2 x 720 3,5 tums disketter, en monitor att användas hemma (eftersom LCD-skärmen på datorn var tröttsam för ögonen), en bärbar batteridriven skrivare, vikt 1/2 kg (utskriftshastighet 180 karakt/sekund); antingen en direkt nätanslutning i studenthemmet inom universitetsområdet (för 60 %) eller ett modem (för resterande 40 %); två års teknisk service; 2 års elektronisk post service etc; Lotus 1-2-3, WordPerfect och Robert Schleifer's statistikpaket (se nedan).

De $ 2 700 ingick i studielånet och eftersom det uppgick till mindre än 15 % av kursavgiften, var det få protester från studenterna. På så sätt spenderade HBS praktiskt taget inga pengar alls på persondatorer. De enda som HBS tillhandahöll för studenter var 20 gamla "transportabla" IBM PC, vilka huvudsakligen användes till att konvertera gamla 5 1/4 tums disketter till de nya 3,5 tums disketterna. Några var också kopplade till skönskrivare, som användes för utskrift av platsansökningshandlingar.

Som centraldator användes en DEC 1091, vilken kunde nås via direkta ledningar från studenthemmen på campusområdet eller telefonledningar via modem, från andra studentrum. Studenternas användande av detta var inte så betydande.

Datorserviceavdelningen hade en reparationsverkstad där studenterna kunde lämna in deras trasiga bärbara IBM-datorer på morgonen och få tillbaka dem efter kl 15.00. Reparationskostnaden var inkluderad i de $ 2 700.

Alla fakultetsmedlemmar måste köpa sina egna persondatorer. Det fanns ett PC-lab med 16 persondatorer för forskningsassistenter. Sekreterarna hade alla AT:s. Genom denna introduktion av persondatorer hade man minskat antalet sekreterare per fakultetsmedlem från 0,5 till 0,4.

För klassrumsanvändning hade man hittills använt några Barcoprojektorer. Nu planerade man att köpa antingen Kodak eller Sharps QA-25 LCD-skärmar att placera på overheadprojektorer.

Mjukvara och kurser

Mer än $ 1 milj per år spenderades på utveckling av mjukvara, i form av avgifter till fem programmerare (kostnad $ 600 000) på ett fristående konsultföretag, som arbetade heltid med att tillsammans med HBS-lärare utveckla kursvara (kostnad mer än $ 400 000). I var och en av första årets obligatoriska kurser utsågs en lärare som kontaktperson med konsultföretaget. Denna kursutveckling fokuserades på Lotusmallar.

Undervisningen i Lotus 1-2-3 var en 2,5-dagskurs ledd av lärarna i marknadsföring, kursen baserade sig helt på praktikfall. Tanken var att visa Lotus 1-2-3 som ett praktiskt, inte tekniskt, verktyg. Eftersom dessa 2,5 dagar kanske inte skulle vara tillräckligt för några av studenterna, skulle nu datorn med mjukvara sändas ut två månader i förväg så att studenterna skulle kunna börja öva Lotus 1-2-3 på egen hand.

Mer än 150 fallstudier under första året använde Lotus 1-2-3-mallar eller liknande program och det slutliga målet var att varje praktikfall med en siffertabell skulle utnyttja en Lotus 1-2-3-mall.

Det fanns ingen betoning på att få studenterna att använda Lotus 1-2-3 på ett strukturerat sätt; därav inget intresse för Symphony med fönsterhantering.

Valet av WordPerfect var inte så medvetet som valet av Lotus 1-2-3; valet av ordbehandlingspaket hade ändrats varje år under de senaste åren.

Datorn spelade en stor roll i alla obligatoriska kurser (på det första året), utom kursen i Organisationsbeteende. Framgångsrik användning av datorn kunde noteras, inte bara på traditionella OR-områden, utan också inom marknadsföring, kontroll och redovisning.

Vad beträffar undervisningen i Informationsbehandling, hade man detta år för första gången bland de obligatoriska kurserna inkluderat en kurs med ett antal praktikfall rörande hur datorteknologin "kunde användas som ett strategiskt offensivt vapen".

På en tillvalskurs, given under det andra året, rörande Datamodeller och beslutsfattande, lades större vikt vid modellkonstruktion än på användandet av modeller, och man undervisade i ett modellspråk. Man sökte skapa en motvikt till den mindre strukturerade modelluppbyggnaden i Lotus 1-2-3. Tidigare hade man i denna kurs använt IFPS. Man ville nu koncentrera sig på Javelin, som av läraren i denna kurs ansågs vara vida överlägset Lotus 1-2-3. Javelin hade offererat ett obegränsat antal kopior, kostnadsfritt, för HBS-studenter. Den position Lotus 1-2-3 hade var dock alltför väl etablerad för att ändringar i det första årets program skulle vara möjliga.

I många kurser använde man Schleifers statistikpaket, som gjordes tillgängligt för alla studenter vid HBS. Detta paket ansågs på HBS vara unikt på grund av dess många funktioner, dess höga grad av interaktion, dess skärmhanteringssystem och dess snabbhet vad beträffar handhavandet av stora datamängder. Under första året användes den bl a för regressionsanalyser. Den kunde kopplas till Lotus 1-2-3.

I andra årets valfria statistikkurser användes bl a två program, också specialgjorda vid HBS: PROPFIT, vilket tillåter anpassning av punktestimat till sannolikhetsfördelningar, och PREF, vilket tillåter uppbyggnad av en preferensfunktion.

I marknadsföring användes bl a olika typer av simuleringar, bl a baserat på kursboken: John R Hauser: Applying Marketing Management: Four persondator simulations.

Kursen Production Operations Management, var fokuserad på produktionsstyrning och använde även en hel del simulering. Man använde huvudsakligen Lotus 1-2-3-schabloner, men bland andra mjukvaror, som användes, kan nämnas: 1) PLANETS, ett program för nätverksplanering, utvecklat vid HBS och 2) XCELL Factory Modelling System (utvecklat vid Cornell)

Företagsspel spelar också en stor roll vid HBS. Under det första året hade man tidigare använt ett femdagarsspel, fokuserat på administrativa problem, med ett stort antal studenter i varje lag. Nu gick man ned till ett tredagarsspel (WISE), fokuserat på strategiska frågor på en internationell marknad.

Sammanfattande intryck

1. Den tekniska utvecklingen går mycket snabbt. Om några år kommer arbetsstationer med flera miljoner teckens arbetsminne och storbildsskärmar med samtidig plats för hel A4-sida och menyer att bli standardverktyg inom undervisningen. Kostnaden för dessa kommer ej att väsentligen överstiga dagens kostnader för PC.

2. Trenden är stark mot att all PC- och arbetsstationsutrustning knyts i nätverk, som i sin tur kopplar den enskilda arbetsplatsen till såväl universitetets centrala datorer som till andra universitets datorsystem. På sikt knytes alla arbetsplatser på de bästa universiteten därigenom samman.

3. En trend finns mot att studenterna skaffar sig egna persondatorer. Ett krav på detta tycks dock först bli aktuellt när utnyttjandet blir mycket intensivt, mycket grovt uppskattat en timmes PC-användning per dag. De flesta skolorna håller f n med ca en PC per tio studenter.

4. På centraldatorsidan finns tydlig tendens till att VAX blir en typ av standardmaskin på amerikanska handelshögskolor.

5. På persondator-sidan dominerar IBM-kompatibla datorer, men på många universitet har Macintosh en stark ställning vad gäller ordbehandling.

6. Vad gäller mjukvaran finns tydliga tendenser till standards. Vad beträffar kalkylspråk (spread sheet) är Lotus 1-2-3 en mycket klar standard. Vad gäller ordbehandling förefaller WordPerfects ställning stark. På PC-databassidan förefaller Dbase III+ ställning i universitetsvärlden ej vara lika stark som i affärsvärlden.

7. Vad gäller statistisk mjukvara är inget program klart dominerande. Vissa skolor satsar på egna statistikprogram.

8. Vad gäller LP har Lindo, med olika anknytningar till Lotus 1-2-3, en stark ställning. Många skolor har dock tagit fram egna program för att lära ut Simplex-metoder.

9. Simuleringar och företagsspel intar en stark ställning i handelshögskolornas datoranvändning, men inga program förefaller ha nått en position som standard.

10. Väsentligt arbete krävs för att få datoranvändningen integrerad i undervisningen. Förutom ren teknisk driftspersonal, har flertalet handelshögskolor ett väsentligt antal "datorstödskonsulter", som aktivt hjälper lärarna att utveckla datorstödda undervisningspaket, inklusive mjukvara, dokumentation praktikfall m m.

Via Teldok
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Bilaga 2

Studieresa i USA 1987-03-10—21

Mats Glader

1 SLUTSATSER I SAMMANDRAG

Studieresan genomfördes under perioden 10—21 mars 1987. Resan startade i San Francisco med besök vid Apple Computer, Berkeley, och Stanford. Därefter besöktes Execucom Systems Corporation, IC^2 och University of Texas i Austin. I Philadelphia gjordes besök vid Drexel University och The Wharton School. Resan avslutades i New York med besök vid New York University och Columbia University.

Studieresans syfte

Syftet med studieresan var att närmare studera hur datorer används i undervisning och utbildning i företagsekonomi. Avsikten var att försöka få ett "samlat grepp" över hur man angripit frågan om datorstödd undervisning i ekonomi. Av intresse var att få en bild över vilka datorer, programvaror och systemlösningar, som främst kommer till användning. Intresset inriktades också mot de ämnesområden och kurser, där datoranvändningen är mest utbredd. Frågan om hur utvecklingsarbetet för att få fram lämpliga programvaror och undervisningsmaterial — courseware — bedrivs var likaså av särskilt intresse. Avsikten var även att försöka "täcka in" flera olika datormiljöer, dvs miljöer uppbyggda kring IBM, VAX och Apple.

Datorernas roll

Mer övergripande kan konstateras att på samtliga besökta universitet och business schools har man på ett eller annat sätt byggt upp en miljö, där datorer integrerats i studieordningen. Graden av omfattning och integration varierar dock. Vid några universitet och skolor menar man att datorer är mycket betydelsefulla och att det är nödvändigt att studenterna på olika sätt i sin utbildning får arbeta med och utnyttja datorstöd. Det är emellertid "upp till" varje enskild lärare eller grupp av lärare att i förhållande till sina egna kurser bedöma och själva se till att det mest relevanta "verktyget" används. Universitetet stödjer alla sådan ansträningar och tillhandahåller den kapacitet som erfordras. Men datorerna har inget egenvärde utan utgör ett av flera "verktyg". Med hänsyn till den nuvarande snabba utvecklingen inom informationsteknologiområdet blir det alltmer naturligt att integrera datorinslag i utbildningen.

Vid andra universitet och skolor har användningen av datorer en högre prioritet. Det tycks vara en avsikt , och en mycket medveten strävan, att inom ramen för ett helt utbildningsprogram genomdriva en "bred datorisering". Användningen av datorer och inriktningen mot informationsteknologi utgör ett kännetecken — ett "varumärke" — för hela utbildningsprogrammet. I dessa sammanhang har också frågan om utveckling av programvaror och undervisningsmaterial på olika sätt formaliserats i olika organisatoriska former, vilket bl.a. innebär att ett stort antal personer fortlöpande arbetar med att ta fram programvaror, courseware, annat undervisningsmaterial och lämpliga datortekniska miljöer.

Den "datoriseringsmodell" som vanligtvis används innebär att en persondator tjänstgör som en fristående arbetsplats och som en arbetsplats i ett lokalt nätverk. Persondatorn är också ansluten till "omvärlden" genom modem. Studenten använder datorn för eget arbete, t.ex. ordbehandling, modellarbete och statistiska beräkningar. Genom det lokala nätverket får man tillgång till undervisningsmaterial och annan programvara, vilken behövs för de olika kurserna. Dessutom kan man dela dyrare kringutrustning som laserskrivare med andra användare. I nätverket kan studenten antingen själv välja mellan olika programvaror eller också kan man koppla in sig på "en snitslad bana" för t.ex. speciella undervisningsprogram. Med hjälp av modem kan man nå ut till t.ex. externa databaser.

Vid Drexel University finns information om studieordning, kursplaner och annan för studierna nödvändig information upplagd på en särskild diskett — The Drexel Disk. Varje nyinskriven student får vid studiernas början en sådan diskett till sin persondator.

Programvaror

Datorerna kommer huvudsakligen till användning inom följande områden:

* Ordbehandling
* Modellverktyg — spread-sheet, modellspråk
* Statistiska beräkningar
* Grafik
* Databaser — file management
* Idea processing — outlining
* Komunikation — filöverföring

När det gäller ordbehandling används vanligtvis WordPerfect. Lotus 1-2-3 och Symphony förefaller mest vanliga när det gäller modellverktyg. På stordatorsidan utnyttjas IFPS i stor utsträckning.

När det gäller de kommande åren talar många om utvecklingen vad gäller:

* CD-ROM
* videodisc
* interaktiv video
* expertsystem och AI.

CD-ROM förväntas innebära stora förändringar inte minst vad gäller integrationen mellan programvaror, courseware och databaser. Interaktiv video förekommer på vissa ställen, men tycks inte ha nått någon mer omfattande spridning. Vad gäller expertsystem och AI har ett flertal programvaruleverantörer för närvarande lanserat "skal", med vars hjälp mer ovana användare skall kunna skapa egna expertsystem-tillämpningar. I och med tillgången till ännu mer kvalificerade "skal" förväntas tillämpningarna också inom detta område komma att öka. Rent allmänt kan konstateras att inom de "framtida områdena" finns för närvarande inte några mer konkreta illustrationer och tillämpningar att tillgå. Många arbetar med dessa frågor men när det gäller idag fungerande programvaror för undervisning, courseware och annat utbildningsmaterial tycks det inte finnas så mycket att hämta.

Problemområden

Många olika problem och svårigheter uppkommer i samband med att datorer skall användas och mer aktivt integreras i utbildningsprogrammen. De problemområden som vanligtvis anges som särskilt betydelsefulla är:

* I vilka kurser skall datorstöd integreras? Vilka kursmoment är speciellt lämpade för datoranvändning? Hur förändras det "traditionella stoffet"?
* Ansvarsområden — vem skall ansvara för vad?
* Innehåll i läroböcker, programvaror och databaser
* "Teaching style" — pedagogiska frågeställningar
* Utvärderingar av olika på marknaden befintliga och kommande programvaror liksom courseware från andra universitet och skolor
* Stöd vid utveckling av courseware

Utveckling av courseware

Med courseware avses integrationen av programvaror, data och instruktioner för att uppnå vissa bestämda utbildningsmål. Utvecklingen av courseware har under de senaste åren tagit ordentlig fart. Vid ett flertal amerikanska universitet satsas stora resurser på att producera courseware för olika slag av utbildningar och kurser. Det kan noteras att "företagsekonomiprofilen" är relativt låg i sammanhanget. Inom andra ämnesområden, där man måhända inte tror att datorer skall kunna spela någon större roll görs däremot stora insatser, t.ex. inom religionsvetenskap och teater.

Utvecklingsarbetet bedrivs som regel i grupparbetsform. En s.k. innehållsspecialist svarar för målen, den pedagogiska formen, interfacekrav, programmeringsstil och dokumentation. En programmerare och systemman svarar för själva programmeringsarbetet. Från lärarhåll betonas vikten av att systemmannen har "rätt profil" och kan uppfatta innehållsspecialistens krav och sedan omforma denna till en god systemlösning. Innehållsspecialisten har heller inte alltid tillräckliga kunskaper för att "kunna tänka sig" hur systemlösningen kan se ut, varför kunskaper om design och interface är nödvändiga.

Att utveckla courseware ställer stora krav på programmerarresurser. Vid Stanford konstaterar man att det inte är möjligt att inom universitetets ram klara all framtagning av courseware. Man försöker därför få fram s.k. *courseware authoring tools* med vars hjälp lärarna på egen hand skall klara 90 procent av arbetet med att utveckla courseware. Programmerarresurser skall endast behövas för 10 procent av utvecklingsarbetet.

I samband med utvecklingen av courseware är det också viktigt att det skapas erfarenhetsbanker av "bra" systemlösningar. Eftersom flera olika arbetsgrupper arbetar parallellt är det viktigt med "korsbefruktning" så att innovativa lösningar kan tillvaratas. Genom att regelbundet debattera och i form av övningslektioner "testa" produkter uppnås allt högre grad av förfining. Allt utvecklingsarbete av courseware måste också ledas av en ledningsgrupp med "spjutspetskunskaper" vad gäller tillämpningar av informationsteknologi.

Några kommentarer

Framgångsrik användning av datorer i undervisning och utbildning ställer stora krav på "drivande eldsjälar". Detta framgår klart av de besök och samtal som förts. Likaså är tillgången till välutrustade föreläsnings- och lektionssalar liksom lärarnas tillgång till såväl hård- som programvaror betydelsefull för att datorsatsningarna skall lyckas. "Rätta" data måste också kunna nås, dvs databaser, modellbibliotek och praktikfall måste vara baserade på realistiska och verklighetsförankrade data, som är möjliga att bearbeta och för övrigt hantera i utbildningssituationen.

Man efterlyser också bättre utbyte av courseware mellan olika universitet och skolor samt informationskanaler för utvärdering och analys av såväl programvaror som courseware. Många pedagogiska frågeställningar återstår också fortfarande att lösa.

Utvecklingen av courseware anses vara ett prioriterat område liksom löpande utvärderingar av de programvaror och courseware, som för närvarande finns och som är under utveckling. Man pekar på en "hög profil" just när det gäller skärningen mellan företagsekonomi och data eftersom området anses behöva utvecklas ytterligare. Detta mot bakgrund av den snabba utveckling som sker inom informationsteknologiområdet.

2 BESÖKTA UNIVERSITET, BUSINESS SCHOOLS OCH ANDRA ORGANISATIONER

Graduate School of Business, Stanford University

Vid Stanford finns i stor omfattning datorer av olika slag. Ett flertal kluster av Macintosh, DEC Rainbow 100 och IBM PC AT liksom terminaler anslutna till stor- och minidatorer finns att tillgå på universitetsområdet. Datorkraften används bl.a. för ordbehandling, spread-sheet, statistiska beräkningar och programmering. En organisatorisk enhet IRIS — Information and Research Information Systems — svarar bl.a. för samordningen inom datorområdet.

Ett flertal s.k. interaktiva klassrum finns också. Sålunda är ett klassrum uppbyggt kring ett nätverk av Macintosh Plus med ett image-switching system med vars hjälp en lärare kan projicera bildskärmsinnehållet från vilken Macintosh som helst i salen till en storbildsduk. Ett annat klassrum är uppbyggt kring IBM PC med videodisk möjligheter och anslutna till SUN net och lokala nätverk.

För att främja arbetet med framtagning av courseware finns ett s.k. Faculty Author Development program. Inom ramen för detta har ca 40 programvaruprojekt genomförts inom ett flertal ämnesområden, bl.a. ekonomi, humaniora, matematik, teknik och bibliotek. Ett flertal av projekten har rönt stor uppmärksamhet på grund av de olika innovativa inslagen.

För att försöka minska kraven på programmerarresurser pågår arbete med att få fram mer generella verktyg, med vars hjälp lärarna på egen hand skall kunna klara en stor del av arbetet med att producera courseware. Det konstateras att det inom universitetets ram inte är möjligt att tillgodose samtliga förväntade krav på programmerarresurser. Courseware Authoring Tools (CAT) är därför en serie verktyg — lika enkla att använda som t.ex. MacWrite på Macintosh — som gör det möjligt för en lärare att klara ca 90 procent av arbetet med att producera courseware. CAT implementeras på IBM PC och SUN Workstations.

I det stora kursutbudet kan följande kurser av intresse i sammanhanget noteras:

* Management Control and Technological Change
* Managing Technology for Competition Advantage
* Management of computers and information systems
* Central Issues in Managing Computers and Information Systems

Graduate School of Business Administration University of California, Berkeley

Vid Berkeley finns en rad olika datorsystem, som stordatorer, minidatorer, terminalsystem och persondatorer i drift. Stordatorerna utgörs av bl.a. av en VAX och en Cray X-MP/12 under UNIX, en IBM 3090 under VM/CMS. En VAX 8800 under VMS håller också på att installeras. Stordatorsystemen administreras av Computer Facilities and Communications center (CFC). Samtliga CFC-system är ihopkopplade i ett nätverk, som omfattar hela universitetsområdet. Nätverket inkluderar också ett flertal av de workstations och persondatorer som finns på campus. Som workstations används SUN, IBM PC AT och Macintosh. Vid Graduate School of Business Administration disponeras 40 Macintosh och 20 IBM PC system med tillhörande kringutrustning.

Bland de programvaror som används på de större datorerna kan bl.a. nämnas SAS, SPSS, FOCUS, SPIRES och DISPLAY TELL-A-GRAPH. Det gäller programvaror för programmering, databaser, grafik, statistisk analys och modellarbete. På persondatorsidan används för MacIntosh programvaror som Business Filevision, Kermit, MacDraw, MacPaint, MacPascal, MacProject, MacWrite, MS BASIC, MS Excel, MS Multiplan, MS Word och Page Maker. På IBM-sidan rör det sig om program som Dbase III, Framework, GCLISP BASIC FORTRAN PASCAL Lotus 1-2-3 Statgraphics, Supercalc, Symphony, Turbo Lightning, WordPerfect och WordStar

I the Academic Computing Newsletter tas olika gemensamma "datoriseringsfrågor" upp till diskussion liksom också information om nya programvaror, hårdvaror och courseware.

I kursen Accounting systems for management utnyttjas datorer på ett aktivt sätt:

> "The study of accounting systems, including computer-oriented systems, with an emphasis on the information and control functions of the management decision-making process. Microcomputers will be used to study accounting systems and the more popoular software packages for microcomputers such as Lotus 1-2-3 are used."

The Graduate School of Business The University of Texas at Austin

MBA-programmet vid The Graduate School of Business fokuseras dels mot informationssystem — MBA Concentration in Information Systems Management — dels mot redovisning — Master of Professional Accounting.

MBA Concentration in Information Systems Management

Huvudmålsättningen med inriktningen är att ge en utbildning som överbryggar gapet mellan å ena sidan mer renodlad datakompetens och å andra sidan kunskaper i företagsekonomi. Alltför få personer anses besitta kunskaper om såväl informationssystem som företagsekonomi. Utbildningsbehovet när det gäller "skärningen" mellan informationsteknologi och ekonomi anses vara mycket stort. Efter genomgången utbildning skall de studerande besitta sådana kunskaper att de kan utgöra "förbindelselänk" mellan datapersonal och användarna av informationssystem:

> ".....will be able to bridge the gap between the data-processing department and the senior managers who use information systems. The contration provides a comprehensive education at the master's level that integrates state-of-the-art concepts in information-systems technology with organizational and managerial decision making as they relate to the functional areas in business."

IBM har aktivt medverkat vid framtagningen av utbildningsprogrammet. En donation på totalt $3 million har möjliggjort uppbyggnaden av utbildningen. Av de donerade medlen har $1 million använts för programutveckling, $1 million för investeringar i datorutrustning och $1 million i programvara.

Vad fokuseras då utbildningen mot? Man pekar på följande väsentliga komponenter och egenskaper:

* studenterna ges grundläggande datakunskaper och "hands-on"-erfarenheter (technology background)
* studenterna ges mer traditionell utbildning i företagsekonomi med tyngdpunkt mot "organizational behaviour, communications and quantitative decision-making methods in the functional disciplines of management"
* studenterna ges grundläggande och "djupa" kunskaper om olika aspekter — ekonomiska, legala och sociala — kring utvecklingen och användningen av informationssystem:
  "....the concepts and processes required for analysis, design, and implementation of information systems, data communications network, and distributed processing systems; and the concepts and processes required to manage the flow of information"
* möjligheter finns till olika slag av fördjupningar och specialiseringar inom de aktuella ämnesområdena
* utbildningsprogrammet är starkt integrerat så att förvärvade kunskaper byggs på i kommande kurser
* genom "classroom 2000" har en teknisk miljö skapats för att ge den nödvändiga interaktionen mellan teknik och tillämpning, teori och praktik (" a learning environment").

Classroom 2000

Ett speciellt klassrum har byggts upp för att möta de speciella undervisningsbehoven. Med hjälp av de donerade medlen från IBM har klassrummet utrustats med 48 arbetsplatser bestående av IBM PC AT/370 workstations. Maskinerna är ihopkopplade i ett lokalt nätverk och de är också anslutna till universitetets övriga IBM, VAX och Cyber system.

Längst fram i salen finns ett "elektroniskt lärarbord" med en IBM PC AT/370, digitaliseringsbord, videokamera och mer traditionella autovisuella verktyg. Två väggfasta storbildsdukar finns på varje sida om "lärarbordet". Från vilken arbetsstation som helst i salen kan bildskärmslayouten projiceras på någon av storbildsdukarna. På samma sätt kan information från externa datakällor liksom telekonferencing projiceras på dukarna. Videokameran kan användas för att på storbildsdukarna visa t.ex. någon utrustningsdetalj eller "vanlig rapport" i förstoring. Via digitaliseringsbordet kan läraren "rita ovanpå" en visad bildskärmslayout.

Classroom 2000 är synnerligen väl utrustat. Längs väggarna finns speciellt utformade skåp med IBM-programvaror. Salen är överhuvudtaget mycket "elegant och lyxig"!

The Computer Resource Center
Vid sidan av classroom 2000 disponeras också universitetets övriga datorkapacitet. The Graduate School of Business Computer Resource Center har 2 VAX 11/780 och mer än 220 terminaler. CRC driver också ett antal mikrodatorlab bestående av IBM PC XT. Programvaror som Lotus 1-2-3, Dbase III, Framework och Symphony används. I ett antal mindre lab finns Texas Instruments Professional Computers, Apple Macintosh och i mindre skala IBM PC.

Specially designed ISM courses
Bland mer speciella ISM-kurser kan nämnas:

* Management Science — concepts of modeling, decision analysis and optimization; IBM PC/AT, VAX 11/780, real-world cases and application software (bl.a. Lindo)
* Production and Operations Management — specially computer-integrated manufacturing systems — IBM PC AT/370 and IBM 4341 CAD/CAM
* Computer Systems Hardware and Software — computer architecture, operating systems, programming languages, application software; learn to examine information-systems technology from a manager's perspective
* Data Management and Decision Support Systems — data management concepts, data bases in building decision support systems
* Human Information Processing and Information Requirements Analysis
* Information System Design and Implementation
* Management of Information Systems
* Data Communications, Networks, and Distributed Processing

The MPA Program
The Master of Professional Accounting-programmet inrättades redan 1948. I programmet ingår för det första året samma kurser som i MBA-programmet inriktat mot informationssystem.

Studenterna specialiserar sig sedan mot auditing, financial reporting, taxation, management advisory services, information systems eller management accounting. De olika inriktningarna kännetecknas bl.a. av följande:

* financial accounting and auditing — directed towards the preparation and independent verification of external financial reports
* management accounting — focus upon the information required by managers in planning and controlling the activities of their organization
* management advisory services — principles of management consulting
* information systems — the design and implemenation of accounting systems and controls — special attention is paid to the management of computerized operations.

Undervisningen är i likhet med MBA-programmet ”tung ur datasynpunkt”. Den befintliga datorkapaciteten och tillgängliga programvaror används i stor utsträckning i de olika kurserna.

IC^2 Institute
The University of Texas at Austin

The IC^2 Institute är ett forskningscenter för studier kring ”Innovation, Creativity and Capital”. IC^2 är ”dedicated to understanding, analyzing, integrating, and explaning the nature of innovation, creativity, and capital within our complex enterprise system”. Institutet genomför ett integrerat program bestående av forskning, konferenser och publikationer.

Bland aktuella forskningsområden med anknytning till information technology kan nämnas:

* creative and innovative management, including the management of technology
* dynamic business development and entrepreneurship

För de kommande åren gäller följande forskningsprioritering:

> ”.. will include assessments of competition and cooperation in global markets, the dynamics of technology centers, the role of artificial intelligence in integrated modeling systems, entrepreneurship, economic complexity, and technology transfer for creating wealth.”

Ett stort antal böcker har publicerats i anslutning till genomförda forskningsprojekt och konferenser. Informationsteknologiområdet intar vid institutet en central roll och tydliga synergieffekter med MBA-programmen kan noteras.

Execucom Systems Corporation, Austin

Execucom Systems Corporation är marknadsledande när det gäller programvaror för Decision Support. I mitten av 70-talet lanserades produkten IFPS (Interactive Financial Planning System), vilken för närvarande har installerats vid mer än 1500 datacentraler och används vid ca 350 universitet och högskolor ”world-wide”. Produkten växte fram vid The University of Austin at Texas och kommersialiserades sedan av upphovsmannen i företaget Execucom. Execucom bedriver för närvarande ett aktivt och omfattande utvecklingsarbete inom DSS-området. Kopplingarna med olika forskningsmiljöer är stark.

IFPS/Plus

Kännetecknande för programvaror för DSS är bl.a. möjligheterna till s.k. känslighetsanalyser. Enskilda värden i en modell kan bytas ut. Simuleringar och s.k. målsökning kan också utföras. I IFPS/Plus finns dessutom egenskaper av typ artificiell intelligens inlagda. IFPS/Plus hjälper användaren att svara på frågan varför. Utifrån de resultat som presenteras med hjälp av en modell kan t.ex. frågor av följande typ ställas:

* why did profits go down?
* why are margins so low?
* why is the variance to plan so great?

Programmet utvärderar de nyckelfaktorer, som påverkade resultatet och svar av följande typ erhålls:

* profits declined due to sluggish sales on the East Coast
* margins are low because sales expenses were too high
* variance to plan occurred because of overly aggressive forecasting

IFPS/Plus är utrustad med en s.k. explanation feature med vars hjälp olika ekonomiska skeenden kan beskrivas, analyseras och diagnostiseras. I den totala systemmiljön i vilken IFPS/Plus utgör en del ingår också databas- och grafik-program. Inom Execucom utgör arbete med s.k. executive information systems (EIS) ett prioriterat område.

University Support Program

Genom ett s.k. University Support Program vill man ge möjligheter till breddat och fördjupat erfarenhetsutbyte mellan universitet och business schools. Följande mål har formulerats för programmet:

* make IFPS and related products an integral part of business school programs
* further knowledge and use of IFPS by disseminating cases and materials for teaching
* support planning and management of institutions by encouraging use of IFPS in administration
* extend financial modeling/DSS concepts to managers through collaborative executive development programs with institutions
* encourage graduate and faculty research in DSS
* put students with IFPS skills in contact with IFPS customers

Bland de 350 universitet och business schools som ingår i programmet kan bl.a. nämnas Wharton, MIT, Chicago, Michigan, Creighton och Boston College. Via Execucom förmedlas rapporter och annat material som under årens lopp kommit fram inom programmets ram.

Drexel University, Philadelphia, Pennsylvania 19104

Från och med läsåret 1983—84 introducerades vid Drexel University ett nytt utbildningsprogram. Programmet innebar bl.a. att varje nyinskriven student måste ha tillgång till en persondator att användas i kurser i allt från naturvetenskap till humaniora. För närvarande finns ca 10.000 Macintosh på campus och 1988 förväntas antalet uppgå till drygt 12.000 datorer.

I och med inskrivningen vid universitetet köper varje student — till kraftigt reducerade priser — en Macintosh Plus med program för ordbehandling (MacWrite), grafik (MacPaint), spread-sheet (Excel), programmeringsspråk (Basic och Pascal), filhanteringsprogram (Filemaker) och program för kommunikation. En särskild diskett — The Drexel Disk — innehåller all information, som studenten behöver för att kunna påbörja sina studier. Från ett lokalt nätverk bestående av Macintosh Plus med hårddisk på 40Mb och 6 Macintosh Plus kan studenten kopiera den "mapp", som gäller för den aktuella kursen. Via nätverket kopierar också varje student de speciella undervisningsprogram, som är nödvändiga för resp kurs. Studenten har vidare tillgång till s.k. telefon-hotline och datakonsulter vilka kan medverka om problem uppstår. Studenterna har också en egen användarförening.

På universitetet finns ett s.k. allmänt cluster bestående av 100 Macintosh Plus och ca 15 avdelningsvisa cluster av datorer. Alla större föreläsningssalar har inbyggda Macintosh-projektorer. Två klassrum har utrustats med 25—30 Macintosh Plus jämte väggfasta storbildsmonitorer.

Utbildningsprogrammets mål

Beslutet om det nya utbildningsprogrammet togs 1982. Drexel University levde "i skuggan" av Wharton och det gällde att skapa en egen profil. Universitetets ledning ansåg att den framväxande "nya" informationsteknologin var särskilt betydelsefull:

> "The goal of this comprehensive program is to provide Drexel students with the resources and training necessary to meet the challenges of the future — a future in which effective use of computers will be essential in virtually every field.
> While Drexel certainly does not intend to make all its graduates computer scientists, it does seek to create an environment in which students learn about computers and become comfortable working with them as part of their regular coursework. The kind and degree of computer proficiency required will depend upon the student's academic concentration. Some will need to gain competency in one or more programming languages and environments; others wil need to master a variety of application packages. *In all cases, however, the emphasis at Drexel will be on using the computer as a powerful tool for exploring concepts and doing work."*

Organisation

Tre kommitteer har spelat stor roll för utbildningsprogrammets tillkomst och utveckling:

* *the selection committee* — organiserades för att bestämma hur datorerna skulle användas och vilka hårdvarukrav som skulle ställas
* *the user's committee* — skapades för att ur användarsynpunkt precisera krav, önskemål och överväganden av betydelse för programmet
* *he faculty advisory committee* — organiserades för att underlätta kommunikationen mellan enskilda institutioner och mellan institutionerna och det totala utbildningsprogrammets administration. Kommitteen, vilken består av 6 personer, ansvarar bl.a. för rekommendationer om nya programvaror, stöd i samband med utveckling av courseware och samordning över institutionsgränserna.

"Datoriseringsprojektet" vid Drexel leds för närvarande av *The Director of the Microcomputing Program*, vilken är ytterst ansvarig för samtliga aktiviteter. En ledningsgrupp bestående av 8 personer svarar sedan för olika delar av programmet:

* *coordinator technical planning* — svarar för utvärdering av hårdvaruinriktade prestanda och krav
* *coordinator special projects* — svarar för intern och extern informationsspridning om utbildningsprogrammet, för tränings- och utbildningsprojekt, för samordning av pågående projekt inom olika specialområden, för framtagning av policy- och målformuleringar och för juridiska och etiska frågor i anslutning till datoranvändningen.
* *faculty development coordinator* — leder och samordnar utvecklings- och implementeringsarbetet inom "the faculty"
* *manager academic computing* — ansvarig för all "dataservice" inom utbildningsprogrammet. För att klara de växande kraven från användarhåll har två enheter — *the Instructional Support Group* och *the User Support Group* — inrättats. Inom the Instructional Support Group skapas tillämpningsprogramvara för olika utbildningsbehov. Befintlig programvara anpassas och "översätts" i enlighet med målsättningarna vid Drexel. Gruppen består av ca 25 programmerare och konsulter. The User Support Group bistår lärare och studenter då problem och svårigheter med program och datorer uppkommer. Gruppen består av ca 15 programmerare och konsulter.

För närvarande har de aktiviteter som rör framtagning och underhåll av utbildningsprogramvara separerats från den tidigare datacentralen. Den personal som medverkar arbetar dock inom såväl datacentralen som "mikrodatorprogrammet". Avsikten är dock att längre fram integrera det nuvarande arbetet med courseware i datacentralens organisation.

* *manager microcomputer accounts* — ansvarig för ekonomiska och andra finansiella frågor i anslutning till datoranskaffningen för lärare och studenter
* *manager equipment support group* — ansvarig för distributionen av datorer till studenter och lärare, "funktionskontroller" och underhåll av utrustning i föreläsnings- och lektionssalar.

Ledningsgruppen samverkar med två rådgivande kommitteer: *the Faculty Advisory Committee* och *the Student Advisory Committe.*

Utvecklingsprogram för lärarkåren

För att förbereda, utbilda och stimulera lärarkåren fick universitetet en donation på $2.8 miljoner från Pew Memorial Trust. Ett utbildningsprogram för de 350 heltids- och mer än 200 deltidsanställda måste vara så flexibelt att de varierande förkunskaperna och kraven kunde tillgodoses. Vissa fakultetsmedlemmar var redan specialister på databehandling medan andra bara kunde hantera ganska avgränsade tillämpningar medan åter andra inte hade någon egentlig erfarenhet alls. "Träningen" måste omfatta olika nivåer ifrån grundläggande utbildning i att sköta en dator till mer avancerad utbildning rörande teknisk uppbyggnad av datorer och programmeringsspråk.

Seminarier och workshops

Utvecklingsprogrammet för lärarkåren har bestått och består av såväl mer kortsiktiga och avgränsade aktiviteter som mer tidsmässigt omfattande inslag med syfte att förenkla övergången till en bred acceptans och kreativ användning av persondatorer:

Introduktionskurser
* introduktion till persondatorn
* elementär programmering i BASIC
* ordbehandling
* spread-sheet
* databaser
* utbildningsprogramvara

Tilläggsseminarier
* datoralgebra
TK!Solver
MuMath
* att läsa och skriva Pascal
* bortom testning och editering
* vad datorer kan göra
* att söka i bibliografiska databaser
* objektorienterad programmering
* statistisk analys med hjälp av en persondator
* workshop kring "Developing Instruction Software"

Demonstrationer
Inbjudna gästföreläsare
(bl.a. Marvin Minsky, Seymour Papert, Joseph Weisenbaum)

Framtagning av programvaror
En grundläggande förutsättning för Drexel's satsningar är tillgången på bra programvara för utbildningsbruk. För att stimulera lärarinsatser beviljas betald *tjänstledighet* med ca 25% för utveckling av programvara, för utvärdering av befintliga programvaror av potentiellt intresse och för mer övergripande utvecklingsprojekt av betydelse för universitetet.

Ett *Software Review Center* — geografiskt placerat i universitetsbiblioteket — ger bl.a. möjlighet till utvärdering av nya programvaror. Vid centret samlas uppgifter om olika typer av programvaror, manualer, tidskrifter och böcker inriktade på programvaror och courseware utveckling. Vid centret finns tillgång till en Apple IIe, IBM PC, Macintosh och Apple Lisa. Centret har en egen budget för förvärv av såväl programvaror som persondatorer.

Vid s.k. *Developer's sessions* en gång i veckan presenteras och diskuteras en speciell programvarutillämpning. Syftet är att utbyta erfarenheter och få synergieffekter mellan programprojekt bedrivna vid olika institutioner.

En lärare som önskar producera en programvara att användas i utbildningen kan med hjälp av personal från the Instructional Support Group få såväl *design- som programmeringsstöd.* Ett flertal programprojekt har genomförts baserat på ett intimt och fortlöpande samarbete mellan lärare och datakonsult/programmerare. En särskild Instructional Courseware Coordinator förmedlar också erfarenheter mellan olika oberoende projekt. Ca 90 undervisningsprogram har för närvarande tagits fram.

Royalty som erhålls genom försäljning av courseware utvecklad vid Drexel fördelas mellan universitetet, en fond för fortsatt programutveckling och den som utvecklat programvaran (upphovsmannnen). Genom detta arrangemang vill man också ge ett ekonomiskt incitament för lärarna.

Interna nyhetsbrev
För att sprida information om allt som rör "datoriseringsprojektet" publiceras två nyhetsbrev:

* *Boot* — veckoblad producerat av och för lärarkåren
* *Drexel Micro News* — månadstidning för studenter men också lärare.

Varför valde man Apple?

I och med att beslutet om det nya utbildningsprogrammet fattats inrättades en selection committee med uppgift att upprätta en kravanalys och lämpliga utvärderingskriterier. En grundtanke var att studenterna själva måste köpa en egen utrustning. Universitetets behov av investeringar i datorutrustning skulle därigenom komma att reduceras. Omsorgen om den egna utrustningen skulle bli större jämfört med om man disponerar universitetets utrustning. Möjligheterna att experimentera och fritt använda datorkraften skulle också öka. Datorinslagen skulle vara betydande i hela utbildningsprogrammet. För att motivera en investering i en persondator måste utrustningen komma till omfattande användning.

Bland de mer allmänna kraven diskuterades bl.a.: Den dator som skulle väljas ut måste vara så flexibel och sofistikerad att den kunde användas även i de mest avancerade tekniska kurserna. Maskinen måste vara transportabel så att studenten kunde ta den med sig. Datorn måste vara "signifikant" med tanke på framtida yrke och arbetsmarknad. Utrustningen måste ha hög kapacitet och vara utbyggbar. Den måste vara användarvänlig, representera en innovativ och framtidinriktad lösning samt ha bra grafik och möjligheter till ljudåtergivning. Priset måste vara moderat och realistiskt ur studentsynpunkt.

The selection committee kom efter en omfattande utvärdering fram till att Apple's Macintosh-dator bäst svarade mot de uppställda kraven. Man menar att sett i efterhand var valet mycket lyckat. När beslutet om Macintosh togs hade den just kommit ut på marknaden och osäkerheten om prestanda och acceptans var fortfarande stor.

Academic Courseware Exchange

Academic Courseware Exchange har etablerats av Apple University Consortium och Kinko's — en nationell kedja av kopieringscentra —. Courseware som utvecklats vid olika universitet görs tillgängliga och de kan köpas via Kinko's. I en katalog presenteras olika aktuella program. Den senaste katalogen omfattar ca 60 program för Apple Macintosh och ca 10 för Apple II. Programmen täcker bl.a. in tillämpningar i biologi, kemi, datateknik, geografi, historia, matematik, statistik, ekonomi, fysik och sociologi. Programmen kostar mellan $7 och $13.

Ett stort antal program är innovativa till sin uppbyggnad. De utnyttjar till fullo de interface- och grafiska möjligheter, vilka utgör så speciella kännetecken för Macintosh. Inom det företagsekonomiska området är tillämpningarna för närvarande mycket få. Ett bra program för linjär programmering bör dock nämnas. Även om programutbudet inom det ekonomiska området är mycket begränsat kan många uppslag och ideer hämtas från programdesign från andra problemområden.

Columbia Business School, New York

The Information Technology Project vid Columbia Business School är ett treårigt gemensamt program mellan Columbia Business School och IBM. Huvudsyftet är att producera en rad olika courseware och att integrera persondatorer i studieplaner och utbildningsprogram. I arbetet ingår också att förbättra undervisningsformer och ge lärarna bra undervisningsverktyg.

Inom ramen för projektet har ett mikrodatorlaboratorium och ett "elektroniskt klassrum" byggts upp. Med hjälp av en stordator kopplas de olika persondatorerna samman. Klassrummet är utrustat med 24 PC för sammanlagt 48 studenter. I ett ytterligare laboratorium finns 55 IBM-kompatibla datorer.

Tre nya teknologier anses vara kännetecknande för programmet — persondatorer, specialiserade undervisningsprogram och image transferring devices. Image network möjliggör för läraren att visa innehållet från vilken bildskärm som helst i lektionssalen på den storbildsduk som finns längst fram i salen. Med hjälp av RGB net kan också innehållet på lärarens PC sändas över till en valfri monitor eller en grupp av monitorer i föreläsningssalen.

The Columbia Courseware Series (CCS) utgör en produkt av teknologiprojektet. Med courseware menas då specialiserade "models, tools, games och excercises". CCS modulerna kan användas i klassrummen för att illustrera ideer och i uppbyggda modeller demonstrera väsentliga samband och känslighetsanalyser av What-if-typ.

Graduate School of Business Administration New York University

Vid skolan finns persondatorlaboratorier bestående av Zenith och IBM PC. VAX minidator finns också. Utrustningarna är ihopkopplade i ett nätverk.

Management Decision Laboratory är ett lab för att ge studenterna möjlighet att i form av företagsspel leda ett företag på motsvarande sätt som sker i verkligheten. Studenterna delas upp i olika konkurrerande företag och beslut om finansiering, planering, produktionsfrågor, produktutveckling, organisation och marknadsföring skall fattas. Kunskaper som inhämtats i tidigare kurser ligger till grund för de mer praktiskt inriktade analyser och åtgärder som skall genomföras. I spelen används datorstöd i betydande omfattning.

Ett flertal kurser har mer eller mindre omfattande datorinslag:

* **Computer-based auditing**
  "the emphasis is on the review and evaluation of EDP controls and the related tools and techniques needed to accomplish the audit objectives. Student use the computer to augment this concept"

* **Audit and control of computer systems**
  "examines the theory and practice of the control and audit of computer-based systems. Topics include exposure and risk analysis, historical and contemporary audit approaches, computer audit software, computer system misuse, the design of computer controls. Classroom discussion is supplemented by case studies and the use of computer audit software package."

* **Management Accounting Information: Analysis and applications**
  "Course objective is to enrich the student's knowledge and skills in preparing information for decision making. There is opportunity for: critical examination of periodical literature in managerial accounting, familiarization with computerbased managerial information packages, and integration of these in a class project application."

* **Computer-based financial planning and control models**
  "An examination of the techniques involved in the design and implementation of computer-based business planning and analysis models. Several currently implemented models presented

as a means for determining the factors leading to their success or failure. Each student is required to design and implement a model that demonstrates the ability to utilize the computer as a mechanism for both evaluating proposed decisions and for analyzing events that have already taken place."

* **Decision Support Systems**
  "focuses on the design of computer-based DSS. The primarily concerns are , therefore, the capabilities, structure, performance, and methodologies for the design of such systems."

* **Organizational Control Systems**
  "Concerned with principles of decision-making and control in relation to complex organizations and computerized information systems. Stability, equilibrium, variety, amplification, coordination, regulation, steersmanship etc form the intellectual orientation. This orientation provides a rational for designing control systems in an integrated and multidisciplinary perspective."

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Datoranvändning vid handelshögskolor i USA

av *Mats Lundeberg, Ingolf Ståhl och Mats Glader*

Bilaga 3

Särtryck av:

The microcomputerization of business schools

Jason L Frand

THE MICROCOMPUTERIZATION OF BUSINESS SCHOOLS:

Part I: General Strategies, Lessons, and Issues

Part II: A Case Study of the UCLA Graduate School of Management

Jason L. Frand

UCLA
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Foreword

Although there remain some serious skeptics regarding the role of computer integration, we at the Graduate School of Management firmly believe that the information revolution is radically changing business management systems and processes. Managers in the future will not only make decisions differently than in the past, they will also be asked to make decisions that were not a part of their set of responsibilities in the past.

To better sensitize our students and faculty to this revolution so that they may be leaders and not followers in this process, we have made a firm commitment to fundamentally integrate our curriculum in such a manner that we too change the way we think about training managers.

In a very real sense, the challenge before us remains since we have only instituted the first steps of equipment acquisition, familiarity, training and integration. Nonetheless, it is apparent that from a management perspective we will never be the same again. Whether we are planning a whole course, or one exercise, an entire research project (e.g., experimental economics), or a component of it, or simply determining how we can organizationally restructure ourselves to increase the productivity of our ancillary personnel, our *instinctive* inclination has evolved to one of initially focusing on the role this new technology can play in helping to achieve our goals. This evolution obviously further encourages us that we are on the right track if we too are so obviously affected by this new environment.

The response of our students after they graduate is even more impressive. Here too, it is quite clear that the training, exposure and insights that we have given them are extremely valuable to them as managers. Further, when we have shared our plans for the future emphasizing increased integration, they are strongly supportive of our direction and goals.

Given this GSM commitment, if one were to ask what have been the critical elements for our success, I would state them as follows:

- a dedicated, energetic, caring and responsive computer center staff,
- a *majority* of the faculty committed to the integration goal at some or all levels (i.e., personal productivity, teaching, research), and
- an on-going, candid, dialogue with our hardware and software vendors (e.g., Hewlett-Packard, IBM, and Ashton-Tate).

In terms of the latter, it is critical that the donor vendor enter into a substantive dialogue with you concerning your plans and strategies so that they can share with you their experiences and insights. We feel extremely fortunate in that regard. Both with respect to Hewlett-Packard and IBM, we have literally spent hundreds of hours with them here and at their various locations mutually exploring how they view the future and our role in it compared to our own vision. Without this level of cooperation and support, we would have made a lot more errors and become frustrated by our lack of progress. We have just begun this process with Ashton-Tate, but here too we are deeply indebted to them for their technical assistance and willingness to explore new applications.

A first rate professional staff is critical because of the immense importance of proper training as well as the interdependent nature of the computer integration process (i.e., if any major step fails, the whole process is doomed). Even more important than their technical abilities, the staff must have enormous resiliency, professionalism, and patience in dealing with all the inherent frustrations involved in this process. Their personal attitude toward faculty and students must always be one of serving the client and not insulting or mocking the client's temporary ignorance which is so often the case with technical staff. We here at GSM are indeed fortunate to have exemplary professional staff whose reputation is one of unswerving dedication to aiding their clients and rapidly learning from their mistakes.

Finally, due to its enormous resource implications, the administration must enlist the support of virtually the entire faculty or the experiment will fail due to the jealousy and divisiveness so often familiar to academic settings. Here again, GSM has had a faculty that firmly believes in the overall importance of our efforts toward comprehensive computer integration.

The following excellent document by Dr. Jason Frand greatly expands on many of these points as well as providing a superb detailed history of GSM's progress and future plans. It further highlights the fact that this fundamental change in training managers of the future is indeed an exciting process but one which must be carefully managed if it is to generate its promised potential. For those of us in University settings, patience is indeed a virtue, humility a constant watchdog, and enthusiasm a very necessary catalyst.

Michael Granfield
Associate Dean, Graduate School of Management, UCLA
January, 1987

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Part I: General Strategies, Lessons and Issues

Without question, the microcomputerization of our schools is firmly underway. The objective of this paper is to provide information to deans, faculty members, and computer center directors which may be of assistance in the formation of plans and strategies and with the implementation of systems into their own programs.

During the past six years I have been deeply involved in both the computerization effort at the UCLA Graduate School of Management as well as in surveying and visiting business schools across the country.[1] My visits to schools were focused on speaking with those involved in and responsible for the microcomputerization process in order to identify factors they felt important in their effort. This work is an attempt to synthesize these experiences.

This paper is organized in two parts. The first part describes strategies schools seem to follow in their microcomputerization effort and the lessons and issues which have subsequently emerged. The second part is a case study of the microcomputerization experience at the UCLA Graduate School of Management. Although unique in some respects, this experience has significant similarities to events at other institutions.

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[1] Jason L. Frand and Francis Bertram, "Software Trends and Issues in Business School Computing," UCLA Information Systems Working Paper #6-82, June 1982; Jason L. Frand, *First Annual Computing Survey of North American Business Schools,* UCLA Graduate School of Management, Los Angeles, 1984; Jason L. Frand and Ephraim L. McLean, *Second Annual UCLA Survey of Business School Computer Usage,* UCLA Graduate School of Management, Los Angeles, 1985; Jason L. Frand and Ephraim R. McLean, "Summary of the Second Annual UCLA Survey of Business School Computer Usage," *Communication of the ACM,* Vol. 29, No. 1, January 1986, pp. 12-18; Jason L. Frand and Terance J. Wolfe, "A Framework for the Study of the Computerization of Business Schools: A Preliminary Report," UCLA Information Systems Working Paper #6-86, January 1986; Jason L. Frand, "Introduction of a Micro-Software Standard for Curriculum Development and Instruction at the UCLA Graduate School of Management: A Case Study," Proceedings of the Second Annual Educators' and Trainers' Conference at DATACOM, St. Louis; March, 1987 (forthcoming).

1 Strategies for Introducing Microcomputers into the Curriculum

Based on my visits to the various business schools around the country it appears that schools are following one of four general strategies in their initial computerization efforts. These strategies are listed in Table 1. No one model is right or wrong,

Table 1
Microcomputerization Strategies

- Saturation Model
- Selective Model
- Individual Supportive Model
- Departmental Supportive Model

nor better or worse than another. Furthermore, these models are not pure. No schools adhere 100% to a particular model. Rather, the models seems to describe the general approach schools are taking in their attempts to introduce microcomputers into their curricula.

Attempts to determine why a specific school is following a particular model have met with little success. It can only be conjectured at this point that a mix of administrative leadership style, school culture, availability of financial resources, and/or the stimulus of a computer vendor, among other factors, influence the direction a school moves.

- ## Saturation Model

  Every faculty member and student is expected to make extensive use of a microcomputer system. To implement this approach, the school is rigorously supporting the development of computer assignments for every amenable course. Schools selecting this model have sufficient resources available to provide faculty with machines, curriculum development support, and/or release time. Furthermore, curriculum innovation involving computers may be weighted more heavily in tenure and promotion decisions, or restricted to senior faculty. The model also requires that the school have many student micro systems available or a student population affluent enough to purchase equipment without major hardship.

- **Selective Model**

  A specific course or a specific instructor is selected to be responsible for the microcomputerization effort. Schools might choose this approach because faculty as a whole are very research-oriented and the institution does not put a high value on curriculum development; or the school has a very limited amount of money available for buying hardware or for distributing it to students or faculty; or the school is not sure of how to proceed, so assigns the responsibility to one person. One or two individuals are thus responsible for developing a microcomputer course that provides students with the bulk of exposure to this technology.

- **Individual Supportive Model**

  In this approach, the school takes a *laissez-faire* posture. Faculty may use computers in courses if they wish, but there is no organized effort, emphasis or pressure to do so. The school may provide some resources to those taking an initiative but it does not create a formal structure for coordinated curriculum development. Schools using this strategy often lack a clear set of overall goals and objectives. There may be a computer lab which is part of the broader campus effort, but it is not an integral part of the school's resources.

- **Departmental Supportive Model**

  This approach shifts the responsibility of integration to departments and asks the departments to submit plans to compete for resources. By having groups compete for resources rather than individuals, the departments make a commitment and areas of expertise are built across the group. By allowing the department to make the decision to take responsibility for curriculum development, a school can eliminate some of the pressure on junior faculty, emphasizing that curriculum development is now becoming an "area" responsibility, not an individual's responsibility. Schools following this approach are prepared to provide hardware and possibly other forms of support to faculty in the integration effort.

The difference between the individual and departmental supportive models can be clarified by the following example. One may think of core courses as "belonging" to departments while electives "belong" to individual faculty members. A school which wants computer integration into its core classes is following the departmental supportive model.

2 General Lessons

Every school is different and thus the factors which lead to success or failure will be different. However, there are five general lessons which have been identified by those actively involved in the effort for the past few years. These lessons are listed in Table 2 and discussed below.

Table 2
General Lessons for Microcomputerization

- Academic Leadership
- Faculty Comfort with Computers
- "Real" Cost of Computerization
- Rate of Computerization
- "Age Myth"

Academic Leadership

Schools have an organizational culture which predates the introduction of microcomputers, and within the cultures there are very definite subcultures. As the introduction of computers requires adaptation and change, the culture and history of the school will influence the attitudes of the faculty and how the school's computerization effort evolves.

In light of these cultural factors, a strong academic administrative leader is necessary to guide the process and to act as the final decision making authority. As the decision making process is drawn out, it is essential that there be one, strong faculty administrator or dean with academic credentials willing to negotiate controversial decisions and have the authority to decide among competing programs requiring resources. This faculty-administrator must be in a position to handle complaints and resolve differences between faculty or curriculum areas while at the same time providing an equitable, strategic view of the implementation process. It is critical that this person have an internalized sense of where the process is going and feels personally committed to a set of goals and objectives so as to defend and speak for the computerization process. An administrator who sees the process as a bureaucratic pushing of papers becomes an impediment rather than a successful organizing spirit.

Finally, the academic administrator responsible for the integrating process must remember that most faculty have many things on their mind – only one of which might be the computerization process. Adapting to various personalities and backgrounds must be seen as a critical prerequisite for success.

- **Faculty Comfort with Computers**

  Before a faculty member will use a computer, especially in an instructional setting, he or she must feel comfortable with the hardware and software. It is unrealistic to expect instructors to see new applications and means of interpreting concepts with the help of computers before they are able to use the systems. Thus, adequate and relatively private access to systems, along with training and support, are necessary conditions for computers to be integrated into the curriculum. Based on the distribution of these systems and earlier experiences with computer terminal rooms, a critical lesson emerged: a necessary condition for curriculum integration (and hence, growth in student use of computers), is faculty use of systems as a normal part of their academic life (i.e., in their research). With convenient access, computers become research productivity tools for the faculty members, their usage overflows into classroom examples, and curriculum integration follows.

- **"Real" Cost of Computerization**

  Computerization is an expensive process. "Wooed" by vendor offers of substantial hardware and software discounts or gifts, it is easy to overlook the cost of supporting these resources. Large acquisitions of equipment (purchased or donated) necessitate the creation of new jobs (system managers, programmers and operators; communications and software specialists; technical and user consultants), installation of new technologies (networking and telecommunications), preparation of new or expanded facilities (room modifications, furniture and security), as well as the costs of equipment maintenance, software licenses, and data acquisition. All these costs are in addition to costs related to curriculum integration (courseware development assistance, faculty summer support or release time). There may also be a discrepancy between the software offered and that desired by faculty, leading to more unexpected purchase decisions. As a rule of thumb, for ongoing operations support, 25% - 50% of the list hardware dollar value needs to be allocated annually. This estimate does not include equipment replacement costs, which adds on an additional 15% - 20% annually.

Another major cost is that of training. Sending individuals to a course on a particular package or system is extremely expensive both in terms of tuition and time away from the job. Bringing professional trainers to campus can be equally expensive. The development of an internal training program, usually involving student trainers, teaching assistants, is also very expensive and sometimes produces inferior results. The cost of software can easily be dwarfed by the cost of training, which must be considered in calculating the investment in computerization. Training costs become even more critical whenever a change in software occurs, and these costs, both in terms of time and money, can become a major source of resistance to change.

User time is a major hidden cost associated with the computerization effort. The cost of initial training for faculty and students can be measured, but the hours users spend on their own, often frustrated and unable to make progress, is significant. This learning "expense" is a real factor for most people. If individuals cannot take the time to learn to use the hardware and software, the funds for the system may have been used more productively elsewhere.

- **Rate of Computerization**

Going slowly in the decision-making process can be very beneficial. It takes time for change to take place. It is important not to set expectations so high that users are disappointed and/or angry when everything isn't in place and running quickly. Everything takes significantly more time than expected.

Equipment doesn't get delivered on time, facilities are not completed on schedule, software isn't learned as fast as anticipated, and curriculum materials don't get developed as fast as planned. All of these delays are *not* a sign of problems or failure, but reality injected into the hopes and desires of those that want to see the process occur overnight.

On the other hand, once equipment begins to arrive, it is critical to provide fast responses to problems — a hot line for faculty, walk-in consultants, and lab support.

With respect to introducing computers into the curriculum, impatience may lead to costly mistakes. If a curriculum project fails, it is significantly harder to try it again. Thus, "going slow" with curriculum integration may be the fastest route in the long run.

"Age-Myth"

The belief that younger faculty produce courseware is a myth; older faculty producing courseware is a reality. While junior faculty may be more computer proficient when they arrive, the pressure to perform academically mitigates their ability to put time and effort into the design and development of computer-based instructional materials. Senior faculty on the other hand, who are no longer affected by pressures of promotion and tenure, often have time to develop innovative classroom applications. Frequently, they are motivated by a genuine interest in revitalizing their standard courses, and, additionally, may welcome the opportunity to rejuvenate their own lives.

3 Issues Related to Microcomputerization

Lack of funds and a shortage of space plague every educational institution. Even if these perennial problems could be solved, this would not resolve many of the challenges facing the integration of the use of computers into the curriculum. Many issues were identified which must be considered as schools proceed with the introduction of hardware and the revision of their curriculums to integrate computers. Not every issue is of equal importance at each school. However, based on the interviews and survey which have been conducted, it appears administrators and faculty members at all schools involved with the widespread introduction of computers must be aware of these issues.

The issues have been categorized into three groups:

- *strategic*: issues most closely related to policy and funding decisions,
- *operational*: issues related to selection, implementation and management of the school's computing resources, and
- *instructional*: issues directly related to the integration of computers into the curriculum.

A. Strategic Issues

Six issues emerged which deans and other strategic decision makers must face as their schools proceed with the microcomputerization effort. These are listed in Table 3 and discussed below.

Table 3 Strategic Issues
• Lack of Goals
• Evaluation
• Incentives and Rewards
• Management Leadership
• Campus Relationships
• Funding Sources

• Lack of Goals

The computerization of business schools is often occurring independently of a clear statement of goals and objectives. What is it we really want to achieve as a result of the computerization effort? Why are we making the tremendous investment in this technology? What are the expected benefits? Are there alternatives which are more cost effective? What is the role of computer technology with respect to achieving other goals of the school? Where does information technology fit into the overall scheme of things?

There appears to be a general and widespread *belief* that there will be an increase in personal productivity of faculty and students, and that microcomputers will serve as a valuable research tool and contribute to the learning process. There are many anecdotal accounts to support these beliefs.

The failure of schools to establish clear goals has many potentially negative consequences. There is a saying: "If you don't know where you're going, any path will do." Without clear objectives, opportunities to gain resources or support are made more difficult. Faculty are left to set their own priorities, which, in the long run, may not be most beneficial to the school. For the most part, the overall computerization effort has been hardware driven, with initial faculty attention focused on equipment, not the benefits nor the software or resources necessary to achieve the expected benefits. Many faculty have been motivated by anticipated personal productivity gains through word processing.

The establishment of a set of goals which include the role of information technology should be the first priority in a school.

Some schools have computerization goals, yet actual developments may or may not be related. Many decisions are made as circumstances present themselves which make previously untenable options possible. For example, vendors are approaching major business schools and offering hardware, software, and consulting support — frequently on-site and related to technological and courseware developments. In the face of such opportunities, deans and other decision-makers sometimes find it difficult to resist, and may fail to consider whether the opportunity is linked to their strategic goals.

Evaluation

Closely related to the issues of lack of goals is evaluation. Although it is highly important, no one wants to pay attention to it. We may consider the evaluation issues from five perspectives. First, *why* do an evaluation? For what purpose? Is it an attempt to assess progress toward our goals? Is it to provide a vendor or donor a report on the use of their equipment or software? Is it to assess the processes being used? The purpose of the evaluation must be clear to be able to interpret the results and make the outcome meaningful, and actually proceed with the evaluation.

Who do we go to for the information and *what* do we ask? Without goals we have no idea of what to evaluate. And, even if we establish goals, what criteria are used to measure our success? For example, computer integration is frequently indicated as a goal. What does integration mean? Does simply having computer assignments for a class constitute integration? And who do we ask about the value of these assignments, faculty and/or students?

Fourth, *how* do we gather the information? Do we circulate questionnaires, conduct interviews, review syllabi, collect assignments, or observe student classes? How much time should be invested? Ideally it would be a combination of these techniques, but the expertise to select and design instruments for the use of these techniques may not be readily available.

Finally, *when* should the evaluation be conducted? Conducting an evaluation shortly after (say within the first year or two) of the introduction of equipment may be too early to say whether any real long term gains — either in curriculum or personal productivity and quality output — have materialized. Making the evaluation of the microcomputerization effort a formal part of the planning and ongoing process is the ideal approach, but requires significant time and effort on the part of those involved.

Answering these questions may assist in a *quantitative* assessment of the impact of computers. However, an assessment of the *qualitative impact* of the technology may be even more difficult, as there is no way of knowing the long term effects of use of the various systems on the careers or personal life orientations of faculty or students.

Incentives and Rewards

Within the research-oriented environment of most universities, there are few rational faculty incentives for curriculum development. However, the expectation is that given an environment rich in human resources, curriculum integration will occur spontaneously. Curriculum integration requires a restructuring of the incentive and reward system, and possibly even the curriculum itself. Software and courseware development are very time and effort intensive. Faculty promotion and tenure decisions are usually based on published research in refereed journals, and those who invest their time in courseware development, though possible contributing to the pedagogy of management education, may jeopardize their careers and personal advancement within the system.

- ## Management Leadership

As discussed earlier, the attitudes and opinions of the dean's office are instrumental to microcomputer decisions. The level of a dean's involvement is determined, in part, by her/his vision of the role of microcomputers in management education, vis-a-vis competition with other business schools, and the perceived benefits of developing and nurturing strategic vendor relations.

Besides the dean's expressed interest, a day-to-day manager of the process is needed. Someone must be responsible for guiding the development of a computer plan for the school, particularly the goals and objectives, strategies and tactics. Someone must meet and confer with faculty to identify needs, educate and set expectations, and manage the introduction of equipment. Someone must supervise technical and user support staff.

But, who will manage this process? Mini and/or mainframe computing services organizations within business schools have traditionally reported to the administrative dean. However, the introduction of microcomputers to faculty in large numbers, as well as advances in the development of instructional support materials, has shifted operational responsibility to the academic administrator. New, as well as re-allocation of existing, resources are required, and faculty are directly involved at an operational level. Who will assume leadership for this venture? Does the dean shift priorities or reassign computing responsibility to an academic dean, department chairman, faculty member, or professional manager?

- ## Campus Relationships

The relationships between business schools and central campus computing organizations are being redefined. Business school computing activities have become more autonomous as a result of the growth of their own systems. However, these developments are not occuring independently of campus initiatives. Campus-wide organizations still provide large scale computing. In addition, and perhaps more importantly, they are fulfilling key roles in new technological services such as microcomputer information centers, software site licenses and acquisition assistance, training support, consulting, as well as networking and telecommunications.

- **Funding Sources**

  Funds for the microcomputerization effort are a major problem. The computerization effort requires *new* sources of funds which the school may not wish to divert from other established projects. Even if equipment is donated, ongoing costs are significant. Decisions must be made whether funds are spent on faculty, secretarial support, facilities and other competing priorities within the school.

  Some schools are addressing this need by instituting student computer lab fees. There seems to be two approaches: a general usage fee or a per course fee. The general usage fee is generally used in schools which are following the saturation or departmental supportive models while the per course approach is being used by the schools following the selective or individual supportive model. Schools which have introduced fees using either approach have reported that student expectations for service have been raised and that the fees are often insufficient to cover all cost of computing.

B. Operational Issues

Five major operational issues which have emerged during the microcomputerization process are listed in Table 4.

Table 4

Operational Issues

- Short-term Planning
- Role of Mainframes
- Equipment Obsolescence and Maintenance
- Staffing
- Budgetary Process

- **Short-term Planning**

  Business schools have a short-term planning horizon for computing. Limited resources, combined with rapid changes in technology and the computer industry, as well as the day-to-day demands of offering and maintaining user-oriented computing services, make it difficult to plan beyond the immediate future. Schools do not have strategies for dealing with technological obsolescence as new generations of hardware and software are introduced on the market.

  One manifestation of the short-term planning is hardware compromises and trade-offs. As schools attempt to make microcomputers available to faculty, students, and staff, they may select computer vendors based on criteria other than pure technical assessments of the product's ability to satisfy the school's requirements. Other factors weigh heavily. These may include, among others, hardware availability, software and technical support, and the vendor's willingness to make a deal that will simultaneously provide the school with the *volume* of hardware it wants and give the vendor visibility (what some have referred to as the "development of a *strategic* relationship"). Schools that opt for a low volume of a preferred product must develop allocation mechanisms for the distribution of scarce hardware resources to faculty and students.

- **Role of Mainframes**

  As network technology advances we are able to link our micros and mini and mainframe systems. But, what is the role for these larger systems in this networked environment? The question might also be reversed: "What is the role of the microcomputer?" "Why all the fuss?" Isn't networking micros really an attempt to re-establish time-sharing environments with shared resources?

  Even with the increase in microcomputer power and availability, it appears that mini and mainframe computers will continue to play a valuable research, instructional and administrative function. There will always be a need for large databases, numerically intense statistical and mathematical program analysis, and for a system to serve as a communications gateway to other departments, libraries, and institutions. Even though traditional mainframe packages, such as SAS, are migrating to micros, the speed and extent of this transition is not yet clear. There may be some psychological resistance, especially on the part of older "number-crunching" faculty who have worked on these minis and mainframes machines for years, and who have considerable investments in their familiar processes.

The reader should note that this paper is focusing on *academic* rather than *administrative* computing. A continuing, and perhaps growing, role for mini and mainframe systems may be to support the school's administrative information and data processing needs. In fact, as all users (academic and administrative) become more sophisticated, the pressure to support even more applications increases tremendously, thus creating explicit academic versus administrative support trade-offs.

- ## Equipment Obsolescence and Maintenance

At the time a school acquires equipment, it is usually "state-of-the-art." However, newer equipment, possibly more appropriate for the business school environment, is very likely to emerge in two to four years. What do we do with our existing equipment? Do we upgrade faculty systems and/or student systems? Can we afford the retraining, software compatability, and operating systems change-over costs?

Assuming that upgrading and replacement is necessary over time, what strategy should be used? Should schools establish special replacement accounts into which a sum is placed each year in anticipation of future equipment opportunities? Should a phased replacement policy be established, each year upgrading some percent of the total equipment? Should schools solicit vendor support to have an established upgrade plan as part of their introduction of equipment?

With respect to maintenance, experience has shown us that if hardware is going to fail, it usually occurs either right after installation or after a year or two. Newly acquired equipment is under warranty, but what should be done after the warranty expires? Service agreements average $40 per month per system. Do we take out costly service agreements or wait until something fails and then pay time and materials? If a school or university has a large number of systems, should they begin their own inhouse repair service?

To make the decision regarding an in-house repair service, a school needs to weigh the total external cost of repair against the cost of running a repair operation. The critical number in the assessment is the ratio of machines to personnel, with estimates ranging from 400 to 1000 micro systems per service personnel.

On the other hand, in many cases it simply may be cheaper and easier to throw away a broken or defective piece of equipment and replace it, rather than to repair it.

- **Staffing**

A major operational problem is finding and retaining competent technical support personnel. In the early stages of microcomputerization when most users are learning, experienced student consultants may be adequate. However, there are three major drawbacks in student staffs. First, with 50% or more student consultants graduating each year, the process of recruiting and training is extremely expensive and time consuming. Second, as faculty become more sophisticated and knowledgeable users, their needs change from wanting a quick response to a simple question to wanting quality explanations of the source of the problem. These more sophisticated and knowledgeable users are inclined to want a more thorough analysis of the problem source so that they can make corrections themselves the next time. Student staff tend not to have the skills to provide this higher level of service. Third, faculty want to develop a rapport with the provider of the service so that they can call that same person over time.

The alternative to students is a professional staff. This too, however, has its problems. For example, when the UCLA Graduate School of Management was given funds to hire new technical support personnel, extensive advertisements for experienced computer professionals to provide expertise in communications, microcomputers, and system operations were placed in the local newspapers and several national computer journals. These brought in approximately a half-dozen qualified applications, individuals who appeared to have both the technical and the social skills necessary to communicate with faculty and students. Unfortunately, those most desirable commanded salaries that were beyond the School's financial means. These individuals already had salaries in the mid-to-high forties and expected the same or higher salary, beyond the guidelines used by the University. Thus, the School turned to a slower approach of internally developing its own expertise by upgrading the skills of its current professional staff. This may have short term drawbacks (i.e., problems arising from the lack of experience), but may develop long term loyalties and a tailored staff.

- **Budgetary Process**

  Creating a budget which reflects the *real* costs of computing is a difficult process. It is difficult to find assistance or guidelines because so few people have ever been through the experience. There is simply a plethora of questions for which answers are evasive. What are the appropriate categories and how much should be allocated to each? What is required for specific tasks, equipment, etc.? Should we plan for permanent staff or count on student assistance, and at what levels? How much will site preparation and furniture cost? How much should be budgeted for contingencies, the unexpected problem or the new opportunities which will inevitably present themselves?

  There is a "common" set of budgetary items such as staff, facilities, software which need to be addressed. With permission of the Dean's office, the UCLA Graduate School of Management computing budget for the 1985 and 1986 fiscal years, and the projected budgets for 1987 and 1988, are presented in Appendix A. In this budget, a zero in a location indicates that $0 were spent, while a blank indicates that the amount is unknown. The budget does *not* reflect the acquisition of approximately 2.5 million dollars in hardware between 1982 and 1985. The reader may find that the budget has greater significance in interpretation after reading the case material presented in Part II of this monograph.

C. Instructional Issues

A major goal of the microcomputerization effort has been the integration of computers into the curriculum. This goal is more elusive than many anticipated. For example, the current curriculum structure and organization may require major revision to accommodate integration. Class time may need to be lengthened or units adjusted or additional lab sessions added. "Retrofitting" computers into a full schedule does not necessarily enhance the teaching or learning environment.

By *curriculum integration* we mean trying to do more than replace a calculator with a computer or introducing computers into courses for which there was no previous use. Integration occurs when the computer is used to introduce concepts and provide insights previously difficult or impractical to achieve. Based on our experiences and discussions with numerous faculty, the following list of issues related to curriculum integration, summarized in Table 5, has emerged. This list is

Table 5

Instructional Issues

- Selection of Courses to be "Integrated"
- Faculty Responsibility
- Teaching Style and Motivation
- Equipment Barriers
- Courseware and Software Constraints
- Lack of Data
- Courseware Development Support
- Student In-class Use of Computers

not comprehensive and the categories are not mutually exclusive.

- ## Selection of Courses to be "Integrated"

  There is no question that some classes lend themselves more readily to computer integration than others. And yet, even in these cases, there are some faculty who justifiably feel the course emphasis should minimize the use of computers. Who is to decide which classes should be computerized? Some schools have a strong tradition of allowing individuals to teach "their" course, and instructors are free to select the content, text, assignments, and examination procedures. Should this orientation be changed if the use of computers is not part of a particular instructor's interests or view of the material? Who should make these decisions and based on what criteria?

  Parallel to the question of "which courses?" is the question of "how much per course?" It is not clear what constitutes an integrated course. To what extent must a computer be utilized to say that the course is integrated? Various scenarios are possible. One is where an instructor uses a computer during lecture to demonstrate a concept, or several concepts at various times through the term. Another is where computers are not used in the classrooms but students are given assignments which require computer analysis, (e.g., one short assignment, one major project, or several assignments of varying length). Or both faculty demonstrations and student assignments may be used. Clearly there is no single approach. Curriculum integration is completely content and/or faculty dependent.

- **Faculty Responsibility**

Faculty are responsible for overall curriculum development, but responsibilities for research will often preclude their spending extensive amounts of time on courseware development. Experiences at schools involved in courseware development suggest that developing computer-based demonstrations and assignments is very time consuming. An individual may spend many hours per student contact hour in preparation. If the materials are of the interactive analysis type, where students sit at a micro and work their way through the courseware, faculty members and courseware developers have reported spending 30 to 60 hours per contact hour when working with an established software package. Furthermore, they have reported spending 100 to 300 hours of development for each hour of self-contained material when the development includes design and programming. Authoring languages may help, but it is not clear how or to what extent. Thus, the question of "Who is responsible for courseware development?" must be addressed.

The computer must be seen as supporting instructional objectives. Courses should not become lessons in the operation of computer applications. Frequently, difficult choices must be made regarding which topics to include or exclude, and faculty are responsible for teaching the concepts of an area in the limited time available in a course. So, with the introduction of computers into a course, what material will be dropped from the course? When will the use of the computer system, the software, and the courseware itself, be taught, and by whom?

- ## Teaching Style and Motivation

When thinking about the widespread introduction of computers into courses, the teaching style of a faculty member must also be considered. It is quite possible that some very effective teachers would be less effective using a computer because their intuitive styles did not adapt well to the use of a computer. Furthermore, instructors who have above average teaching evaluations have little motivation to change. Not only must they address the out-of-class issues already discussed, they must face the prospects of a lower rating if things don't go well.

Faculty need to understand the motivation behind the use of courseware and must believe that it is an important and valuable component of the educational process. Faculty attitude, positive and negative, is very contagious. If a professor just brings floppies into a classroom, throws them on a table, indicates that he just got them, hasn't looked at them, and the students can use them if they want, the material will probably get minimal use.

Furthermore, in the selection of materials, the faculty members must feel some sense of ownership or they probably won't use them. They want to select the material and not have someone else tell them what to use or do. They don't like to be presented with a final product — a packaged course. Thus, with courseware there is a potential "catch-22" — faculty will use materials only if they participate in the development or selection, but they may not do so because of the various barriers.

- ## Equipment Barriers

Faculty will only use equipment such as overheads, videos, or computers in their classes if they perceive it will make their job easier or student learning better at an acceptable cost. If it's a hassle, they won't use it. Along this line is the lack of classroom projection systems which enable students to view the analysis the faculty wants utilized. If a professor chooses to use courseware as part of a lecture, the equipment to run and display the material should be readily accessible in the classroom. If it is necessary for a faculty member to wheel in two or three carts with projectors, monitors, and micros, the courseware will receive little use. The equipment should either become a fixture within the classroom or personnel should be available to set up and test the equipment for faculty before they need to use it.

- **Courseware and Software Constraints**

  A broad array of courseware materials simply don't exist. And, if they did, who should pay for them? Should the school be responsible for providing the materials to the faculty? Schools don't provide textbooks or other materials. Furthermore, evaluating the prospective courseware entails learning the structure of the package as well as how to use the materials. Finally, once a decision is made regarding a package, assignments must be created, and then a way to distribute the materials (copying diskettes, providing copies to library, etc.) must be found. Currently, the obstacles to courseware are such that few instructors are able to implement its use.

  Additionally, courseware use is inhibited by software inflexibility. Faculty see a textbook as a random access utility in which they can move about easily, selecting chapters in any order they choose or omitting chapters at their discretion. At the same time, the student can access the material skipped without difficulty. Software, on the other hand, doesn't have that intrinsic property, and, with floppy diskette systems, moving about a system may be very confusing. Spontaneous classroom elaboration may be constrained by predefined examples and a program's limitations.

- **Lack of Data**

  The ultimate constraint on the success of curriculum integration efforts may be the lack of data. Even if the right software package is available, it may be difficult to find the right data to analyze which will fully illustrate the concepts and challenge the students. As our systems become more sophisticated, we will want to do more "realistic" analyses, which in turn, require more realistic data. One solution may be to have a real corporate database with financial, marketing, production, accounting, etc. data online. However, there are several obstacles to this approach. Acquisition of corporate data may be difficult, and if acquired, modifying it to support instructional objectives, extracting that data appropriate to the separate courses, may be even more difficult. An alternative is to use commercial databases, such as COMPUSTAT (financial statements) and CRSP (stock market data). These, however, require very significant storage capacity (400-500 megabytes) and a mainframe system for support, in addition to site licenses of several thousand dollars per year.

This bottleneck will be relieved somewhat by similar databases such as Compact Disclosure and ONE SOURCE from Lotus, which are being distributed on compact discs, and run on a microcomputer. But once again, the cost of these databases is several thousand dollars a year.

Other possible data sources are the online data services available by telephone hookup, such as COMPUSERVE and LEXUS. Unfortunately, these services are very expensive, usually with a per minute access charge, and require telecommunications equipment to be made available to a large number of students.

The short term alternative to these large databases is smaller datasets tied to the specific case material the student is using.

- **Courseware Development Support**

Faculty express genuine concern about their role in the curriculum integration process. On the one hand, they would like to see better utilization of computer-based applications, in particular micro-based applications, in the educational process. On the other hand, they don't see it as their responsibility to teach computer skills such as how to use micros or various software packages. To the extent that computer applications facilitate the teaching of *concepts* rather than *skills*, faculty seem to be supportive of "courseware" development. Faculty want to know that students have the requisite skills so that their efforts can be concentrated on concepts and applications.

In light of the issues discussed above, what type of support should be provided to faculty so that a school can achieve some degree of computer integration throughout its curriculum? Given the current state of courseware availability and quality, it is not realistic to expect faculty to "go it alone."

One approach is to consider courseware acquisition and development as a team effort. One such team might consist of a faculty member, a curriculum development specialist, and a programmer. The faculty member would be the "content specialist", responsible for identifying the instructional objectives and the specific goals to be achieved. After the courseware was identified and available in the form to be used by the instructor, the faculty member would review the materials to insure accuracy and instructional validity. The curriculum development specialist would identify potential packages which could meet the objectives stated by the professor. If software needed to be developed, the specialist would provide information on program design and user interface issues, and would serve as the project coordinator to supervise and guide the development effort. The curriculum development specialist should have a background primarily in pedagogical concepts and secondarily in the content area of the field for which the courseware was being sought or developed. This person would also be responsible for maintaining professional standards in interface design, programming style and documentation. The programmer would implement the courseware design as specified by the faculty member and curriculum development specialist, and could be a student in the area.

- **Student In-Class Use of Computers**

  If courseware is used with instruction and if equipment is available for use outside of class, then the evaluation procedures may need to be modified so that students can use the computer on their examinations. If they don't, then students may choose to use calculators in their homework. On the other hand, if students bring micro systems to their exams, they could easily have entire sections of text available "online" to use during the exam. Some instructors do not like to give "open book" exams. Could this be monitored? Should restrictions on use of systems be imposed because it creates unfair advantage for those with systems, or those who can afford "better" systems?

  There are other complications. If students bring non-portable systems to class, there may be insufficient electrical outlets and power to support them. And, what if a system "goes down" in the middle of class? Also, printers need to be conveniently located for producing output.

4 Summary

The past several years have seen a significant growth in the number of business schools which are introducing microcomputers into their curriculum. These schools seem to be following one of four paths: saturating the school, selecting specific individuals for penetration, focusing on departments, or taking a laissez-faire position and allowing development to occur wherever there is an interest. Irrespective of the approach, those schools which have moved ahead have learned from their successes and failures. These lessons include the need faculty have to be comfortable with computers before they work their way into the classroom, the significant and real costs of computerization, that going slow in decision-making and curriculum integration and very fast in responding to problems may be optimal, that a strong academic leader is essential for success, and that senior faculty may be more likely to do curriculum development than junior, non-tenured, faculty.

Strategic, operational, and instructional issues have also emerged for which answers, and in many cases, even appropriate alternatives, elude us. The strategic issues include the lack of goals and evaluation alternatives, faculty incentives and rewards, management leadership, changing campus relationships, and finding new funding sources. Operational issues include the lack of long-term planning, the changing role of mainframes with introduction of networks, dealing with equipment obsolescences and maintenance, finding and retaining competent staff, and managing the computer related budget. Finally, there are the instructional issues which relate to the selection of courses to be integrated, faculty responsibility, teaching style and motivation, barriers to using equipment and courseware including materials, textbooks, software, data, and in-class support equipment.

A major challenge for the next few years will be to bring together the people and resources to bring to fruition the promise of the technology which now is, and will become, more available. Part of this challenge will be to remain flexible enough to respond to technological innovations and opportunties as they arise. Identifying our goals — how we want our schools to look in the future — is a critical step in meeting this challenge.

In Part II of this paper, an indepth study of one school's experiences with the microcomputerization process, is presented.

Part II: A Case Study of the UCLA Graduate School of Management

During the past five years the use of computers at the Graduate School of Management (GSM) has grown exponentially. Even though computers have been available and used as an important computational tool for the past thirty years, their impact has only now become pervasive. Faculty and students alike turn to the computer as a support tool; almost 100% of the students and 75% of the faculty use computers regularly. The opportunity for this growth was made possible as a result of various equipment grants. Given this opportunity, GSM faculty and staff have worked toward the successful implementation and thorough penetration of the technology into all aspects of the program. This case study summarizes many of GSM's successes and problems, and GSM's plans for the future.

In Fall, 1984, GSM began introducing microcomputers throughout the School. The previous three years had been spent planning and writing proposals — and the past two years trying to learn, live with, and accommodate the new technology. This six year period 1981-86 is the primary focus of this case study.

We begin with a historical review of the computer planning process at GSM and a discussion of the social-technical environment — a look at the shifts in values and attitudes which have occurred. The study continues with a discussion of the resource allocation scheme which emerged and a description of three major curriculum experiments. Next, a general assessment of the impact of the technology is presented. The case study closes with a glimpse into the future — GSM in 1990 — what may evolve from our investment in information technology.

GSM has approximately 80 permanent faculty, 850 MBA and 125 Ph.D. students, and a two year Executive MBA program with 110 students. Computers have been used at GSM for approximately 30 years. Prior to 1982, computing at GSM was mainframe-oriented, using the central campus systems with access via punched cards and hard copy terminals. Users were charged for system access, and such funds were always at a premium. Beginning in 1982, GSM received the first of a series of major equipment grants, acquiring its own Hewlett-Packard 3000 minicomputer which provided non-recharge interactive access. In the Fall of 1984, GSM provided HP150 microcomputers to one-third of the faculty and established a microcomputer laboratory for the students. In the Summer of 1985, half of the GSM faculty received an HP110 lap-top microcomputer and during 1985-86, most of the remaining GSM faculty were provided with IBM desktop microcomputers and the student lab expanded from 20 to 60 systems. Thus, the *microcomputerization* of the School was well underway. Some of these major computing events at GSM during the past thirty years are summarized in Table 6. The extensive hardware growth during the past five years is summarized in Table 7.

Commensurate with this hardware growth has been GSM's financial commitment to computerization. During the past two years GSM has been trying to clearly identify all of its computing expenses — a most arduous task under the best of circumstances. With permission of the Dean's office, the GSM Computing Budget for 1985 and 1986 fiscal years, and the projected budgets for 1987 and 1988, are presented in Appendix A. The budget includes current operating support for the approximately 2.5 million dollars in hardware and software acquired from its grant efforts between 1982 and 1986.

The budget in Appendix A is organized as follows: the first column is the item category; the next two are a listing of the actual 1985 and 1986 fiscal year expenditures and acquisitions; and the last two columns on the right, the projected budgets for the current year, fiscal 1987, and next year, fiscal 1988.

The budget items have been organized into the following categories. The first part presents a summary of all of GSM's computing resources including both donations and support expenses. For example, for fiscal year 1986, GSM computing resources were $2,523,000. The next three sections are the source values for this summary table, specifying the list value of the hardware and software acquired from each of our grants, the expense categories in support of these grants, and the source of funds to cover the expenses.

The reader may find that the budget has greater significance in interpretation after reading the case material.

1 The Decision Process

The physical introduction of microcomputers to GSM began in September 1984. For the previous three years, however, a major organizational effort contributed toward the creation of a computerization plan. Since 1981, GSM had submitted several grant proposals in support of its instructional program to various computer vendors. The process of developing these proposals forced GSM to address the role

Table 6

COMPUTING EVENTS AT GSM

1957...	Western Data Processing Center established at GSM; statistical and mathematical programming conducted in batch mode.
Circa 1967	Merger of GSM computing with engineering to form central campus system with GSM as a node; first of several generations of IBM mainframes.
Circa 1971	GSM led in the introduction of interactive end-user-oriented computing using APL and hard copy terminal.
Circa 1980	Text editing type word processing access to IBM 3030 mainframe; 12 coax cables installed over the next couple of years connecting faculty offices to the IBM mainframe; key punch replaced by terminals for mainframe access.
Spring 1982	HP3000 Series 44 with 15 interactive terminals installed at GSM; most MBA student use shifted to HP3000, with word processing as the principal application.
Fall 1984	55 HP150 microcomputers (30 to faculty, 25 to students) installed; HP3000 upgraded; Lotus and dBASE introduced in a few classes; "Micro-supported Case Analysis" experiment with second year students enrolled in Management Strategy and Policy course (Mgmt 420); faculty offices wired to HP3000.
Summer 1985	70 HP110s lap-top portable computers given to faculty; "Lap-top Computer" experiment with 55 HP110s distributed to the entering students in the Executive MBA program for use while in the program.
Fall 1985	40 HP Vectras (32 to faculty) and 60 IBM micros distributed to faculty; Advance Development Center opened with 6 IBM micros; IBM 3090 installed as central campus system.
Winter 1985	Selection of WordPerfect as the word processing standard for administrative support; GSM disk on campus IBM 3090 providing online access to CRSP and COMPUSTAT financial databases.
Spring 1986	Ashton-Tate pilot program: Framework II adopted as software standard for instructional program; AT&T data switch installed linking faculty offices to both the IBM 3090 and HP3000.
Summer 1986	30 IBM PC/ATs installed in student lab; 55 HP110 Plus lap-top systems distributed to the entering Executive MBA class.
Fall 1986	"Physical Science Model" experiment, a required hands-on lab for first year students enrolled in Managerial Computing course, Mgmt 404.

Table 7
GSM Hardware Growth

	SEP 1982	SEP 1984	SEP 1985	SEP 1986
MINIS	1 HP3000/44 with 2Mb	1 HP3000/68 with 5Mb	1 HP3000/68 with 5Mb	1 HP3000/70 with 10Mb
DISCS	2 HP7925 Disc Drive (240MB)	1 HP7925 Disc Drive (120MB) 3 HP7933 Disc Drive (1.2GB)	1 HP7925 Disc Drive (120MB) 3 HP7933 Disc Drive (1.2GB)	3 HP7925 Disc Drive (360MB) 3 HP7933 Disc Drive (1.2GB) 1 HP7933XP Disc Drive (404MB)
TAPES	1 HP7970 Tape Drive (1600 BPI)	1 HP7978 Tape Drive (1600 BPI)	1 HP7978 Tape Drive (6250 BPI)	1 HP7978 Tape Drive (6250 BPI)
TERMINALS	15 HP2622A CRT 1 HP2635B Console 3 HP2641A CRT 1 NEC Spinwriter	15 HP2622A CRT 3 HP2641A CRT 1 HP2647F Console	15 HP2622A CRT 2 HP2627A CRT 3 HP2641A CRT 1 HP2647F Console	15 HP2622A CRT 2 HP2627A CRT 3 HP2641A CRT 1 HP2647F Console
MICROS		150 HP110 Portable PC 55 HP150 PC 2 HP150/B PC 1 IBM PC/XT	150 HP110 Portable PC 55 HP150/C PC 2 HP150/B PC 40 HP VECTRA 60 IBM PC/AT 1 IBM PC/XT	210 HP110 PC Portable 57 HP150 PC 72 HP Vectra 25 IBM PC Portable 14 IBM PC/XT 158 IBM PC/AT
PRINTERS	1 HP2608A LP 1 HP2601A Daisy	1 HP2608A LP 1 HP2601A Daisy 2 HP2563A Printer 5 HP2934A Dot Printer	1 HP2608A LP 1 HP2601A Daisy 2 HP2563A Printer 5 HP2934A Dot Printer 10 HP2686A LaserJet 1 HP2688A Laser Printer	1 HP2608A LP 1 HP2601A Daisy 4 HP2563A Printer 18 HP2686A LaserJet 1 HP2688A Laser Printer 5 HP2934A Dot Printer 23 IBM QuietWriter 54 IBM ProPrinter
PLOTTERS	1 HP7221C 8-pen	1 HP7221C 8-pen 5 HP7475A 6-pen	1 HP7221C 8-pen 5 HP7475A 6-pen 2 HP7550A 8-pen	1 HP7221C 8-pen 5 HP7475A 6-pen 2 HP7550A 8-pen
COMMUNICATIONS	5 Prentice 1200 Baud	8 Prentice 1200 Baud	8 Prentice 1200 Baud	1 AT&T Information Systems Network 1 IBM LAN for 80 PC's 8 Prentice 1200 Baud 2 ARK 24K Modem
OTHER			1 HP46087A Digitizer	1 HP18173A Protocol Analyzer 1 HP46087A Digitizer

and priority of computing within the School. As a state-funded school with limited discretionary resources, GSM saw the donations of hardware and software as a major source of support, but with real dollar costs associated with operations and staff. Thus, the proposal opportunities provided the motivation for developing plans and setting priorities. GSM addressed these issues through a committee structure.

The Planning Committees

During the 1981-82 academic year the Computer Planning Committee drafted a long-range computer plan for GSM which addressed the broad instructional, research and administrative needs of the School. One of the key aspects of this plan was the ready availability of equipment, specifically microcomputers, for faculty and student use. To both acquire this equipment and develop staff resources, the planning committee called for the active pursuit of funds and hardware through purchase discounts or vendor donations.

The 1982-83 Computer Committee discussed the new microcomputer technology and its role in management education. As a result of these discussions, two School-wide goals emerged: computer literacy for all GSM faculty and students and the thorough integration of computers into the MBA curriculum. By *thorough integration* we mean doing more than replacing a calculator with a computer, and introducing computers into courses where there was no previous use. Integration occurs when the computer is used to introduce concepts and provide insights previously difficult or impractical to achieve. These goals reflected the growing role and importance of computers in general, and the increasingly significant impact of microcomputers in particular, on the modern management environment.

During 1983-84, three committees addressed curriculum and implementation issues. An MBA Curriculum Task Force was charged with reviewing and recommending changes to the entire MBA curriculum. A major portion of its report focused on the role of computers. This committee recommended that a computer orientation program be developed for entering students prior to the start of the academic year. It also reviewed the curricula and syllabi of all core MBA courses in an attempt to identify those aspects most amenable to computerization.

Two other committees also investigated the role of computing within the School. In recognition of the interdependent roles of research and instruction in a contemporary program of management education, the Research and Computing Committees were charged with jointly addressing implementation issues such as resource distribution to faculty and students, software acquisition and/or development, hardware compatibility, and space and facility requirements. Through numerous sessions, an allocation scheme emerged and equipment distribution priorities were established. Two proposals to vendors emerged from these various committees. Each was successful: one was part of a campus-wide grant awarded to UCLA by IBM, while the other gained additional equipment from the Hewlett-Packard Company.

In Spring, 1984, a new Computing Policy Committee was appointed. While previous computer committees were dominated by those with a strong interest in or knowledge about computers, the new committee consisted of the chairpersons from ten of the major curriculum areas of the School, as well as two additional Computers and Information Systems faculty. (The associate dean/department chairman[2] and I were *ex officio*.) The Committee was charged with recommending resource allocations and software standards which would impact all areas of the School. (The hardware allocation process is discussed in Section 3 below.)

In Winter, 1985, the Committee approached the issue of software standards by assigning committee members responsibility for different software applications: one each for word processing, spreadsheets, database, graphics, communications, statistics, general modeling packages, and utilities. These individuals were to survey opinions and make recommendations regarding specific packages. Although these areas were identified, the focus during 1984-85 continued to be on acquisition of hardware. Software was to wait a year, at which time the Computer Policy Committee tackled the problem of software standards for both academic support (research) and instruction.

In Summer, 1985, based on the successful introduction of the microcomputers during the previous year, the Committee modified one of the strategic computing goals and added a third. The strategic goal of computer *literacy* was redefined to one of computer *proficiency* to reflect the changing nature of training and support services required by faculty and students. The new strategic goal was "to expand the use of computer modeling and simulation techniques where appropriate in the curriculum." This new goal reflected the growing awareness of the power of spreadsheet and linear programming packages. Although this goal may be seen as

[2]GSM is a one-department school and the roles of the department chairman and associate dean for academic affairs are combined.

a subset of the second goal (thorough integration), it was added to call particular attention to modeling techniques. GSM's strategic instructional computing goals are listed in Table 8.

Table 8
GSM Strategic Instructional Computing Goals

- Computer proficiency for all GSM faculty and students.
- Thorough integration of computer topics and usage into the MBA curriculum.
- Expanded use of computer modeling and simulation techniques.

One of the major benefits of having three different committees, each comprised of 7 to 10 members, was that approximately one-third of the tenured faculty of the School were involved in discussions related to the implementation and use of microcomputers in the curriculum. This broad involvement was part of an educational effort to make faculty aware of the various issues surrounding the use of computers.

Word Processing Standard for Academic Support

Although GSM has a very long history of computer use, software standards were never an issue. Individuals programed in the language they chose, using key punch machines until online systems were available, and then whatever editors were available on the system. Generally users had minimal control over software selection decisions. With the introduction of "personal" computers, however, users gained control over software and could choose what seemed most appropriate to them, using a multiplicity of criteria. With this freedom the software standards issue emerged.

Along with the HP150 microcomputer systems donated to GSM in Fall 1984, one copy each of Lotus 1-2-3 and Wordstar was provided for every two systems. However, Wordstar was not well received. GSM attempted to obtain a site license or special purchase arrangement with Lotus Corporation, but failed. Hence, even though these software packages were the "first in the door," they were not universally used.

Support of faculty word processing emerged as the first area where the software incompatibility became a School-wide concern. With the number of faculty members with microcomputer systems in their offices and/or at home increasing rapidly, and with systems being installed in secretarial areas, the question of which word processing package would be generally supported became critical. Thus, in November 1985, a "word processing" assessment was conducted by the Computer Policy Committee. This process consisted of reviewing the various journal articles, obtaining evaluations of different word processing packages, and speaking with individuals about their needs and what they were currently using. In the course of the word processing assessment, it was suggested that an integrated package which would support word processing as well as other common functions such as spreadsheets and database applications be considered. The argument in favor of a broad integrated package was that it would meet many different needs without the need to acquire and learn new systems for each application. In an integrated package, the user only needed to learn one interface, one file system, and one set of functions.

From the pool of possible packages, three emerged for standards consideration: one word processing package (Word Perfect) and two integrated packages (Framework II and Enable). A software demonstration was arranged and representatives from each company were invited to GSM. Word Perfect was then selected as the official word processing package for academic support. Secretaries were trained on Word Perfect and consulting made available to them. Faculty members who chose to use another package and wanted secretarial support were responsible for making whatever adjustments and modifications were necessary to import and export the files to a Word Perfect format.

Although both Framework II and Enable were found to have significant breadth of application, the primary concern was a high quality word processing package which secretaries would be able to master and use extensively with the mix of equipment available. Although both have now been enhanced, at the time of the decision in December 1985, neither integrated package had word processing capability which matched the power of Word Perfect.

Instructional Software

The objective at GSM is not to teach software or a particular package, but rather to focus on management concepts and issues and use the software to assist students in concept understanding and application. However, it was recognized that if we wanted students to know software, for at least the next couple of years, the School had a responsibility to teach it. Furthermore, the feeling was that the selected software should be educationally sound, and also have a viable commercial following.

The Computer Policy Committee identified seven application areas in which software for curriculum development and instruction seemed appropriate. These are listed in Table 9.

Table 9

Student Software Requirements

- Word Processing
- Modeling tools (including spreadsheets)
- Statistical tools
- Graphics (business and presentation)
- Database
- Idea processing (outlining)
- Communication (file transfer)

The general concensus was that although no one package could do all of these functions, an integrated software package would meet most of the typical MBA student's computing needs. The advantage of such a package would enable GSM to use its limited resources to support one system with one vendor rather than incur the costs of training students, supporting multiple packages, and dealing with multiple vendors.

As part of the debate, the question of requiring students to own a microcomputer was raised and rejected. Some other schools (most notably Harvard in 1984 and Wharton and Chicago in 1986) were strongly recommending or requiring student hardware acquisition. However, the general feeling at GSM was that the *courseware*, (defined as the software, data, and procedures to achieve a specific instructional objective), justifying such a move was simply not available. However, the School was responsible for providing adequate hardware in support of the instructional program. Thus it was appropriate to focus on a software standard to guide faculty in courseware development and students in selecting and learning a package.

Another point discussed was current software acquisition and distribution policies. Some software had been obtained from our grants, but both the number and selection were limited; for example, the School could obtain only IBM logo software via the IBM grant. To meet our software needs, other software had to be purchased. Software was distributed to students in the management library using the same procedures as for book check outs. However, problems of lost, stolen, and damaged diskettes made this less than an optimal alternative. Hard disk network versions of the software as well as the networks themselves for the distribution were not yet available. Thus, in the discussion of software it was felt that the students should become responsible for obtaining and monitoring their own software, and that they could use generic systems to do their analyses. GSM's responsibility was to provide the hardware, training, and support that would enable the students to complete their assignments.

Selection of Framework II

The formal adoption of Framework II by the GSM faculty as the integrated instructional standard occurred in June 1986. There were three simultaneous events which led to this decision. First, one of GSM's senior and well-respected management science faculty members (also area chairman and hence on the Computer Policy Committee) had been using Framework II extensively in his research for almost two years and strongly recommended its adoption as the academic support and instructional standard. He argued that Lotus 1-2-3 (for spreadsheet) and Lindo (for linear programming would always be needed and used), but that Framework II would meet at least 75% of the software needs of most GSM faculty and students.

Second, in December 1985, GSM was contacted by a senior manager from Ashton-Tate, the developers of dBase and Framework software. He indicated that Ashton-Tate was interested in discussing the possibility of a "strategic relationship" with the School. A series of meetings were held during the winter and spring of 1986, which provided opportunities for GSM to present its computing goals and plans, and for Ashton-Tate to explore ways in which to work with GSM for mutual benefits. The dialogue led to an agreement between GSM and Ashton-Tate whereby Ashton-Tate would provide assistance to the School in the form of software, discounts, training, and support, and GSM would provide Ashton-Tate the opportunity to meet and discuss on a formal and informal basis with our faculty and students to obtain information regarding business and management uses of their software. GSM also agreed that anyone obtaining Framework II under the agreement would receive at least a two hour introductory training session.

Third, parallel to the discussions with Ashton-Tate, the Computer Policy Committee began debating the acquisition of an instructional software standard. There was concern that we had adopted Word Perfect for word processing and that to select another package for students would put an unfair and unnecessary burden on the faculty to learn yet another package. Also, Lotus 1-2-3 was the standard spreadsheet in the corporate world and it would be to our students' advantage to learn it. On the other hand, if Word Perfect and Lotus 1-2-3 were adopted, given the University purchase agreements and lack of site licenses, the cost of one copy of each of the packages would exceed $400, and there would still be the need for additional packages. The unanimous agreement was that an integrated package such as Framework II appeared to be adequate for the typical student's basic requirements outside of the more advanced statistical and mathematical modeling requirements. Furthermore, it was not GSM's responsibility to teach a particular package, but rather the concepts underlying generic systems. The students could make the transfer to other packages when appropriate.

As a compromise position, the Computer Policy Committee recommended the adoption of Framework II as the integrated software standard for instruction for a one year trial period. Other software such as Lotus 1-2-3 would still be used if more appropriate, or if cases or material were readily available in that format. But for material developed within the School and for the training provided to our entering MBA students, Framework II would be used for the next year.

In June 1986, a faculty meeting was called to discuss the recommendation. The overall response was positive and supportive. However, a few faculty who had invested considerable time in both learning Lotus 1-2-3 and developing instructional materials with it felt they could not afford the time to re-invest in Framework II. It was decided that the Framework II approach was not to be seen as excluding other packages if they were more appropriate, and some assistance with conversion to Framework II would be available if there was an interest.

Following the Framework II decision, the faculty teaching statistics courses at GSM decided that a single package would also facilitate their program. Hence, in Summer, 1986, SAS/PC was selected and installed on approximately 40 hard disk microcomputer systems.

2 The Social-Technical Environment

Table 6 presented a summary sketch of major computing events at GSM during the past 30 years. This long association with computing created an organizational culture and a set of values, expectations and attributes which were influential in the microcomputer decisions.

During the three years prior to the introduction of the microcomputers in Fall, 1984, major changes in attitudes and values occurred. In this section we will review some of these changes from five perspectives: that of the School's administration, the faculty, the operational personnel, the students, and the central campus administration.

GSM Administrative Perspective

During the 1981-83 time frame, it was clear that the Dean's office was supportive of the early growth of computing, but the extent to which the administration was committed, or understood the scope, breadth and depth of the computerization program, was not clear. The initial equipment grant proposal submitted in 1981 to the Hewlett-Packard Company was the result of contacts by the Associate Dean for Administration.

In Fall, 1983, a new chairman/associate dean was appointed. He felt that the microcomputerization effort was one of the most critical and important events in recent GSM history, and hence, set out to better educate himself on the issues and alternatives and became an active member of the Computer Policy Committee. He was involved both in formulating and carrying out policies and discussing the use of the systems. With the large scale introduction of systems looming on the horizon and faculty demand for such systems becoming more vociferous, the active participation of the Dean's office became a critical link between the implementation effort and the realities of available resources.

The active involvement and support of both the Dean and the Associate Dean has been and continues to be a critical element in GSM's ability to achieve its strategic computing goals. The Dean's office has conducted extensive public relations efforts with both Hewlett-Packard and IBM, as well as influencing the direction of the grant proposals.

Faculty Perspective

Most GSM faculty have, at one time or another, used computers to support their research effort with major focus being on mathematical modeling and statistical analysis. Approximately 50% currently use the campus IBM mainframe, although research support dollars for computing have almost always been insufficient to meet the demand. [3] On the other hand, many faculty members were dubious about the use of computers based on prior disappointing and frustrating experiences dealing with the centralized campus facilities: difficulty of use and limited access methods (primarily batch processing), inadequate administrative and staff support, and changes of mainframe operating systems. These attitudes had to be changed and, in fact, these faculty needed to be "won over" if the School's computing goals were to be achieved.

Unfortunately, the initial equipment grant of a minicomputer and 15 terminals did not help to alleviate these feelings. The grant supported the instructional program and specified that the equipment was to be used by the students. Thus, all the terminals were located in a public location with common access for both students and faculty. In this environment, only a few faculty members developed programs and assignments for their classes. These faculty were primarily already regular computer users and for whom statistical and linear program packages were readily available. For the most part, the faculty viewed the new minicomputer in the same way as the central campus mainframe, rather than as a new opportunity to change their own work or their instructional approaches.

It was difficult for faculty who were not already computer literate to have an opportunity to use the system in an atmosphere closely related to their normal work environment. Coming to the computer center for an occasional workshop or

[3] UCLA uses a recharge system with a portion of the funds provided annually by the Vice Chancellor for Research Programs and the remainder provided by research contracted funds.

demonstration showed the potential power of the system, but without being able to spend time alone, reflecting and exploring the system, nor able to use it easily and regularly to directly support their general needs, most faculty simply didn't use the computers.

In light of these faculty attitudes and the restrictions of the initial minicomputer grant, all efforts were focused on involving students with the use of the system. Faculty who were interested in transferring their work from the mainframe to the minicomputer were encouraged and supported.

Parallel to these developments was a drive for greater microcomputer involvement from a few key faculty in the curriculum areas of Management Science, Marketing, and Computers and Information Systems. These faculty members were extremely anxious to see GSM introduce microcomputers throughout the School, and provided leadership and guidance to their colleagues by sharing insights and ideas which helped to shape GSM's plans. They argued that for faculty to develop instructional materials they needed to use the equipment as part of their regular set of tools, that they had to become comfortable before significant progress could be made. Furthermore, there had to be sufficient equipment close to faculty offices so that they could use the system to meet research as well as instructional objectives. As outlined earlier, the various computing committees involved a large, broad segment of faculty and encouraged members to return and discuss the various options with their colleagues. This played an important role in helping to enlighten, change attitudes, and establish a base of values geared toward the computerization effort.

There was a new element in all of this — the personal computer. The emerging plans indicated that faculty members would be responsible for and have access to equipment which they could control themselves, without competing with colleagues or students, or depending on a central computing facility. Given this new atmosphere, faculty appeared more willing to listen and more open to trying a variety of new options. There were also social forces — media advertisements being aired and general "computerese" becoming prevalent — creating a bandwagon effect and broadening the base of support.

Operational Perspective

A third perspective on the computerization process involved operational personnel — the Computing Services support group. In July, 1980, I was appointed director of GSM Computing Services.[4] At that time, Computing Services consisted of a key-entry operator and two FTE of student personnel used as programming consultants. Two programming languages, APL and PL/1, were taught and the the statistical package SPSS was widely used. Computing Services support staff were technically-oriented students proficient in these languages. All computing during this period was on the central campus IBM 3033 mainframe with access via punched cards and hard copy printing terminals.

When I became Director, the role of Computing Services was changed from that of a reactive, technical programming group to a proactive, multifaceted organization interacting with all aspects of the computerization effort. This included development of the School's computing plan as well as development of space and facility plans, general coordination of the incoming systems, and planning the training and support options to be offered to both faculty and students. Computing Services became an instructional support unit of the School, responsible for offering consulting assistance to students enrolled in courses in which computers were used as well as providing learning experiences to students with no previous computing background who wanted to enter the field. It should be noted that although during this period Computing Services reported to the Associate Dean for Administrative Affairs, it was charged with only supporting GSM's academic program. During 1983-84 a re-organization took place and Computing Services now reports to the Associate Dean for Academic Affairs.

With the introduction of the HP3000 in Spring, 1982, the Computing Services staff grew. A computer system/user services manager was hired, the key-entry position was upgraded to an administrative assistant, and student personnel were increased to three FTE. Besides the HP3000, Computing Services had the ongoing responsibility for providing programming consulting for the IBM 3033 users. This period was the beginning of the shift of almost all student computing to the HP3000 and reserving the IBM 3033 for faculty and doctoral students.

During the subsequent year, it became evident that a significantly larger com-

[4] I had joined the GSM faculty in March, 1979, as a lecturer in statistics and mathematics. I have continued to teach two or three course per year while serving as director, and in Spring, 1985, was promoted to an Adjunct Assistant Professor in Computers and Information Systems.

puter staff would be necessary to successfully implement the computerization effort. Thus, a plan for increasing the computer staff was submitted to the Dean's office and was wholeheartedly supported. The Dean's office then presented the plan to the Chancellor's office for approval and funding. This effort was successful and in Fall, 1984, Computing Services staff was expanded to four FTE for career positions and seven FTE for student support personnel.

A measure of the student's perspective of the role of computing in the School can be derived by comparing the number of student applicants for positions in Computing Services in 1980 with those in 1983. In 1980, approximately 20 students applied for positions while in 1983, over 75 students applied. Currently, approximately 80 students per year have the opportunity to gain direct computer-oriented experience from a "provider" rather than "user" perspective.

During the Summer, 1982, an entering MBA student came seeking employment. When told no funds were available, she said she would like to work simply for the experience. From this modest beginning a full-fledged volunteer program emerged. Currently, Computing Services receives approximately 40 applications per quarter for 20 volunteer openings. Paid student support is now drawn directly from the volunteer pool. The volunteer experience trains and orients new students, while providing an evaluation period to assess the volunteers ability to contribute to the program. Paid computer consultants work 10 to 20 hours per week while volunteers work 5 hours per week (2 hours training and 3 hours as assistant consultants on duty the same time as a regular consultant). All computer support staff wear bright orange vests so that users can spot them in the crowded labs.

Student Perspective

Prior to the introduction of the School's minicomputer in Spring, 1982, student computing on the campus mainframe was restricted to class assignments (usually programming or statistical analysis) and to use in masters and doctoral research projects. There were approximately 200 active MBA student accounts on the IBM mainframe. In Spring, 1982, with the availability of the HP3000, an entirely new computing era began. Not only was an "open access" machine available for student use, but also new functions such as word processing and interactive statistical analysis became available. Within two years of the introduction of the School's minicomputer, the number of active MBA student accounts increased to almost

500.

The students were extremely supportive of the computerization effort as evidenced by their queuing up to use whatever equipment and facilities were available. They signed-up for terminal access one, and sometimes two, days in advance. The graduating class of 1982 purchased a letter-quality printer as its class gift so that students would have the advantage of high quality output. Students constantly raised questions about the availability of more equipment. They attended workshops on the use of the equipment and software regardless of whether the workshops were directly tied to specific class assignments.

Student demand for increased computer support came mainly in the form of questions and complaints: "Why do we have to wait so long to get on the system?" "When are we getting more equipment?" "Why aren't their more workshops?" "Why can't we do more graphics?" "Shouldn't we have Lotus 1-2-3?" "When will we have microcomputers to work with?"

Campus Perspective

Between 1981 and 1984, the UCLA administration's attitude with respect to computing underwent some major changes. In 1981, computing was seen only as a mainframe activity. By 1984, campus administration was advocating "coordinated" decentralization and allocating resources in support of this effort. In large part, this change was due to the proliferation of minicomputers and the potential introduction of microcomputers, combined with a major report prepared by the Academic Senate calling for a reorganization of campus computing. In Spring, 1982, the Chancellor appointed an Academic Computing Committee charged with recommending a computing plan for the next five years. The committee met twice a month for fifteen months and completed its report in Summer, 1983. There were two major outcomes of this committee report. First, it established the ground work for a successful campus proposal to IBM for a major equipment grant. The grant, obtained in May 1984, provided over 1000 IBM PCs to the campus, with approximately 100 for GSM. These systems were installed at GSM beginning in Fall, 1985.

The second major outcome was the appointment of an Academic Computing Council consisting of several deans and other university administrators. The council was appointed by and charged with advising the Vice Chancellor for Research

Programs (responsible for academic computing at UCLA) on issues related to the IBM grant. Each school or college at UCLA was to submit a computing plan specifying instructional and research objectives, equipment requirements, support dollars needed and the source of these dollars. Following negotiations between the campus administration and the relevant dean for operational funds to support computerization efforts, the Academic Computing Council reviewed the school's or college's equipment requirements and recommended the allocation of equipment from the IBM grant.

3 Hardware Allocation Process

Through its own grant proposal efforts, GSM obtained 55 Hewlett-Packard 150 microcomputers which were installed in Fall, 1984. Prior to the actual delivery of this equipment, discussions focused on whether GSM should accept non-IBM compatible micros. Specifically, the concern was related to software acquisition. However, the two packages initially seen as most important were Lotus 1-2-3 for spreadsheet analysis and a word processing package. Lotus and Wordstar, the popular choices at the time, were available for the HP150. Most computer language compilers were also available. With the software impediments rationalized, the HP150s became an important element in the microcomputerization effort.

Since GSM has approximately 100 faculty and 1000 students, the more difficult question was: How should the equipment be divided between faculty and students? This decision had to be made in an environment characterized by the provision of only 55 available machines, a rapidly growing student demand, and a more interested and motivated faculty.

Allocation Objectives

Since this was GSM's second major equipment grant from Hewlett-Packard (the first being the HP3000 minicomputer system), we wanted to benefit from our first experience. In the first grant, Hewlett-Packard specified the grant was to support instruction and wanted all equipment available to students. However, the restriction on distributing equipment to faculty was counterproductive. The lack of access to the system limited faculty development of assignments requiring educational use of the system. Thus, students increasingly used the system for word processing support, with 80% - 90% of its use at any given time being word processing. We wanted to avoid a repeat of this situation with the introduction of the micros.

The introduction of microcomputers also presented entirely new opportunities for instructional development. Realizing the key to this success was through direct faculty involvement, we argued that the best way to increase meaningful academic student use of computers (i.e., beyond just word processing) was to increase faculty knowledge about and skills with computers, and to change attitudes towards the usefulness of computers as an instructional tool. Furthermore, this could be achieved more effectively through faculty use of the equipment in what was important to them, namely research, and in an atmosphere in which the computer was a natural part of their work environment, preferably in their offices. With this approach, we predicted we would have more student assignments requiring computing. This has proved to be generally accurate. In light of the experience with the minicomputer terminals, we requested that approximately half of the new microcomputers be allocated to faculty and half to students.

Allocation Scheme

Knowing that a portion of the equipment was destined for faculty did not end the dilemma. Meeting after meeting discussed the equipment allocation issue. Should the equipment go to common areas or be given to individuals for use in their offices? Should allocation be based on individual faculty proposals to develop curriculum? How should the IBM equipment obtained from the campus-wide grant and coming the following year (i.e., Fall, 1985) be handled? Should faculty who received HP equipment be able to switch to IBM equipment at a later date? In the majority of cases, it was the most innovative faculty who were anxious to get equipment first, and who would thereafter want the latest, best and most advanced equipment. The decision was to give faculty the option for replacements as additional equipment became available.

Once the equipment was allocated to faculty, how should they be supported? What types of support would be necessary? What kinds of workshops? What kinds of training? These and other allocation questions were battered about in hallways as well as in committee meetings.

From these encounters an idea emerged that rather than supplying individuals with equipment, entire curriculum areas should compete for it. Also funds should be provided to hire a doctoral student from each area who would be trained in the use of the equipment and could support the area's implementation effort. This student would be able to work on curriculum, faculty training and tutorials, and provide opportunities for area support. Furthermore, it was thought that providing equipment to academic areas rather than individuals would create a sense of synergy; the equipment would penetrate an entire curriculum area rather than a single class. The idea thus presented the opportunity not only for greater faculty education, but also motivated curriculum penetration.

Allocation of Resources

The allocation question then became very specific: Which of GSM's eleven curriculum areas would receive computers? Some of the areas had faculty who were active on the various committees and they indicated their interest in the HP equipment. Some areas were indifferent, while still others were strongly committed to IBM and wanted to wait until those microcomputers arrived. Thus, the consensus of the faculty was that five areas would receive the initial HP150 systems: Management Science, Marketing, Production and Operations Management, Accounting Information Systems, and Organizational and Strategic Studies.

In September, 1984, each of these areas received approximately five microcomputers and a quarter-time student assistant known as an Area Computing Consultant (ACC). The ACCs were assigned to help support the overall introduction of equipment and to train and support the area faculty. Although each of these areas had more than five faculty members, the area chairperson and faculty drew up a list of those individuals who seemed most likely to use the equipment and benefit from its ready availability. Within the areas, specific efforts were undertaken to develop faculty literacy and competence as well as alerting the faculty to potential classroom possibilities. Faculty members were encouraged to ask the ACCs for assistance as needed. In becoming comfortable with the equipment and using it for research, we expected faculty members would began to see spinoffs for use with their students.

During Spring, 1985, GSM submitted its master plan for computing to the campus-wide Academic Computing Council discussed above requesting equipment for faculty during 1985-86 and for student laboratories in 1986-87. This equipment would be from the campus-wide grant. The plan included course integration proposals, budget projections, and an allocation mechanism which specified that an equipment budget would be allocated to each curriculum area proportional to the number of ladder faculty and each area. Each area would then allocate resources to its faculty and decide whether each member got equal funding or if the area would pool resources to account for differences in individual needs and the benefits of resource sharing within the area (e.g., print and file servers).

The plan also indicated that the School would be standardizing on IBM PC/AT or AT compatible microcomputer systems. This decision followed from many discussions after the PC/AT introduction in Fall, 1984. The reason for the PC/AT standard was that, even though we would get fewer systems, they would provide the technological base needed to enable GSM to meet its needs through the end of the decade. This decision gained further support in August, 1985, when Hewlett Packard introduced its AT compatible system, the HP Vectra. Thus, through the combination of grants, GSM obtained sufficient equipment to meet its initial needs.

During the 1985-86 academic year, GSM received approximately 80 IBM PC/ATs and 40 HP Vectras. Twenty Vectra's were installed in a student lab and the remaining systems were distributed to faculty members. Some areas chose to have HP equipment and some elected to go with IBM. This widespread distribution of equipment prompted the selection of Word Perfect as the word processing standard as discussed previously.

In Spring, 1985, GSM was awarded one of the thirteen IBM Management of Information Systems business school grants. This grant provided each school with up to $1 million in hardware and $1 million cash. The cash contribution by IBM reflects the corporation's deep understanding of and appreciation for the schools' need for resources which will enable the grant equipment to be more effectively used and objectives more readily achieved. GSM is using its hardware grant to acquire additional desk-top microcomputer systems for its general student lab, a few very sophisticated powerful systems for an advanced development lab for students specializing in Computers and Information Systems, as well as a 2.5 gigabyte (2.5 billion bytes) disk pack to be installed on the central campus mainframe and to be used to store the large databases used by GSM. The cash is being used for faculty and staff support. (See budget items in Appendix A for more detail.)

During Spring and Summer, 1986, space was identified and preparation of an additional student laboratory was begun. There was a considerable amount of discussion over tables, chairs, lights, air conditioning, and power requirements, as we wanted to take advantage of what we had learned from our experience with the initial labs to make the new lab a better facility. In Fall, 1986, student systems arrived (before the physical lab was ready) and the new lab came online in November, 1986. A fourth (and final) student laboratory is due to come online in February, 1987.

In summary, as a result of its grant efforts, GSM will have approximately 250 workstations distributed in faculty offices and five student laboratories. Two student labs have Hewlett-Packard equipment: one consists of 30 HP150 microcomputers which also double as terminals to the HP3000, while the other has 30 HP Vectras. The Advance Development Center, consisting of six advanced IBM microcomputer based systems (AT/370, 3270 PC AT/GX, and 4 PC/ATs), and the newest microcomputer lab opened in Fall, 1986. This new lab consists of 30 IBM PC/ATs with a video display system which, when finished this Spring, will enable the instructor to display the output of any workstation to any other workstation, to the entire class, or any combination. Also, cabling for a token ring network has been installed and the ring should become operable as soon as the network hardware arrives. A second lab of 30 IBM PC/AT and video display equipment is scheduled to open by Summer, 1987. All the labs have laser and dot matrix printers and numerous plotters for the preparation of quality presentation graphics.

Evaluation of the Initial Allocation

There were several successful components to our initial scheme for allocating microcomputers to faculty. In retrospect, it did create the opportunity for faculty areas of synergism to develop, and the sharing and assistance amongst these faculty proved very useful in increasing their individual productivity and some new class assignments. But most important, we gained significant experience with the equipment and exposure to some problem areas which we were able to better manage during the widespread introduction of equipment the following year.

However, one major problem was that some faculty received equipment and then didn't use it.[6] During the initial few months (when hardware was still scarce), I met with each faculty member who had received a micro and discussed their individual

[6] It must be noted that, as indicated above, GSM has been fortunate to have received a significant amount of equipment through grants and hence many of the equipment problems were shortlived.

needs and objectives. Based on these interviews it became clear that three faculty members had decided not to invest the time and energy to learn to utilize the computer at that point in time. Even though consultants were available to help, the faculty chose not to take advantage of their services. Since there were requests from other faculty, these systems were reallocated to the Business Economics area, and the faculty who received this equipment became extremely adept developers of Lotus programs for their classes. The lesson we learned was that it is important to be flexible in identifying individual innovators and supplying them with the equipment they need.

With respect to the allocation of hardware to the student labs, it seems that the more equipment made available, the greater the demand. One wonders if the saturation point will be reached only when every student has his/her own system? This is a very positive indication of the overall growth of computers within the School, but a major source of frustration for many students. In response to the student needs, lab hours have been extended — going to full 24 hour availability during the last weeks of the quarter.

Our Area Computing Consultant (ACC) concept initially seemed very fruitful in helping to get equipment set up, but we did not fully utilize these student assistants. Furthermore, management of the ACCs was difficult since they reported to "area faculty" rather than a specific individual who could be held accountable. Being assigned to a whole area rather than an individual, they seemed to slip through the cracks, rather than actively seeking out and developing material. Some faculty used them for research support and not classroom support, or let them just work on their dissertation, not on class material.

Even with these difficulties, the concept of a computer-trained person assigned to an area for faculty support was important enough that plans to expand the program for the 1985-86 academic year were approved. Part of this resource was used to set up a faculty "hotline," a special phone number where faculty could call for immediate help, with the remainder allocated to areas which submitted plans to use an ACC. The "hotline" met with mixed success, with the faculty preferring to call our full-time professional HP3000-oriented staff, rather than the student consultants, even though the students at that time, were more knowledgeable about microcomputer hardware and software. By the middle of the year, the hotline was discontinued and the allocation was shifted to developing microcomputer training and workshop materials.

The 1985-86 ACC program was more successful than the previous year, however we found, for both the hotline and ACCs, that we again lacked sufficient management supervision of the students. There were however, three very significant projects completed by the ACCs, two microcomputer based and one mainframe based. For the microcomputers, a set of exercise modules using Lotus 1-2-3 were developed for an economics course and a set of ten laboratory exercises using Framework 1.1 were developed for a computing course.[6] The mainframe project was in the finance area and was made possible by installation of the large 2.5 billion byte disk on the campus computer. Two major databases used by finance faculty, Compustat and CRSP, which have the financial statements of organizations and daily stock returns, respectively, were previously stored on tape and required extensive programming to access. The project involved the installation of these databases on the new disk pack and the creation of a menu-based access program. Our plans are to create a subset of the data to be installed on the School's minicomputer and create programs for student access and downloading of data to microcomputers for analysis.

4 Curriculum Integration

GSM, in accepting the equipment grants, initially from Hewlett-Packard and later from IBM, had agreed to use the equipment to impact the curriculum. This has been an extremely long and arduous process, much more so than many of us anticipated. Although there are numerous examples of individual faculty who developed assignments for their classes, they tended to be in the quantitative areas. There was no guarantee that our stated goal of computer literacy for *all* our students was being achieved.

In this section we relate three experiments designed to more fully impact the curriculum. The first involved the entire second year MBA class — the "Micro-supported Case Analysis" experiment. The second involved the Executive MBA class — the "Lap-Top Computer" experiment. The third is based on a new idea which emerged from these experiences — the "physical science model" for management instruction, which involved the core managerial computing course. The

[6]The ACC involved in these two projects was an MBA student who graduated in June, 1986, and was subsequently hired to fill a new position, Courseware Development Manager. His responsibilities include soliciting faculty courseware proposals and supervising the ACCs to implement these proposals.

section closes with a discussion of student orientation and training workshops, our main effort focused on increasing general computer literacy.

The "Micro-supported Case Analysis" Experiment

During the committee discussions of equipment allocations to faculty, one idea which emerged was to allocate the equipment in such a way that it would affect the maximum number of students. With this in mind, the Organization and Strategic Studies curriculum area became a prime candidate. This group had not previously used computers in its courses. However there was a specific course, Management 420, *Management Strategy and Policy*, required of all second year students and the capstone for the first year MBA core curriculum. Entirely case-oriented with most of the cases lending themselves to "what-if" analysis, this course provided relatively easy and straightforward applications for spreadsheet analysis.

In Spring, 1984, the faculty who would be teaching the seven sections of the course next fall were asked to meet and discuss the possibility of computer support for the course. It was proposed that each of them would receive a microcomputer and the support to create Lotus templates for data analysis. Although there was some skepticism, they agreed to the experiment. One professor served as coordinator and an ACC was assigned to work with the faculty on the course. The coordinating professor polled the other faculty to identify which cases should be prepared. Based on this information, templates with the data and formulas for twenty-three cases were prepared.

The creation of the templates and the inputting of the data turned out to be more difficult than originally anticipated. The microcomputers had 256K of memory, which proved insufficient for many of the cases. There were problems setting up the templates as they predetermined the nature of the analysis and could limit the approaches used by the students. The question of how to distribute the data to the students also needed to be resolved. They would each need their own diskette, but depending on the instructor, they would be using different cases, and hence different data.

The data size and template design problems were resolved by the coordinating professor simply making a decision of how to proceed. The data distribution was handled by storing all the templates on the minicomputer, with students downloading the data to the microcomputers.

At the start of classes in the Fall, the ACC visited each section of Management 420 and explained that the Lotus spreadsheets were prepared to assist them with their case analyses and how to access the files. Numerous Lotus workshops were scheduled to teach the students how to use the package and download the files.

Unfortunately, this course development effort achieved only marginal success. Approximately 20% of the students made use of the programs on a regular basis. There were two main reasons: problems with the equipment and lack of faculty support. Our microcomputers were scheduled to arrive in June but did not arrive until September. This delay prevented the faculty from having sufficient time to learn and become comfortable with Lotus. Additionally, there were communications problems in establishing the link between the microcomputers and the minicomputer for downloading the files which weren't completely resolved until mid-quarter. By this point, many students were already doing their case analyses without using the system, so the time the system was operating consistently, was little motivation to use it. Finally, the computer staff were learning Lotus along with the students in the classes and hence not as able to help them as would have been ideal.

A second, and in many ways a more significant problem, was faculty support. Some of the faculty did not believe this was a valuable tool, and as such, its usefulness was not impressed on the students. In a subsequent evaluation meeting, faculty agreed that the course experience was not all that it could have been, in part because they had not reevaluated the course material in light of the new equipment and opportunities. They simply had not taken the time to do so. One professor argued that the arrangement we used for disseminating the data and having the students work individually on the material assumed that the students could figure out how to do the analysis on their own. Another instructor, soon up for tenure, felt that it took so long to prepare the first time he taught the course, that with a tenure decision so close, he didn't want to again make such a major time commitment. This constant conflict between research, with its incentives for tenure and promotion, and the desire on the part of the School and the sponsoring computer companies to achieve curriculum integration, emerges over and over again.

In retrospect, given the late arrival of the equipment and the training and faculty support concerns, it probably would have been better to delay this integration attempt one year. However, the desire to achieve a major curriculum success made us overly optimistic regarding the difficulties. As a result, we did not achieve our objectives, and even more significantly, one group of faculty was discouraged from trying to use computers in their classes in the near future. On the other hand, we moved along the learning curve as a School.

"Lap-top Portable Computer" Experiment

In June, 1985, HP made a grant of HP110 laptop microcomputers to GSM for use in the Executive MBA program, designed for the full-time senior level manager who wants to return for a rigorous two year MBA, with classes meeting alternate Friday/Saturdays including three one-week live-in sessions.

In August, before classes began, each member of the ExMBA program was issued an HP110 portable computer to be used during their tenure in the program.[7] Entering students, depending on their background, attended either two or six two-hour workshops to familiarize themselves with data processing concepts in general, and the HP110 in particular. Students were shown how to access the HP3000 for the mail system and to use the available software packages. The instructors created assignments which required the use of computers, and for many, this was the HP110. Students brought the systems to class and took notes "online," and some used them during exams. Overall, student acceptance and use was very positive.

There were and are several problems, most relating specifically to the HP110 (e.g., the liquid crystal display being difficult to read, 16 lines too few, and the limited memory often frustrating). There was a need for printers and floppy diskettes. The 300 baud modem was too slow, especially for those making long distance calls into the HP3000 system. It is clear that all these problems will be resolved with more sophisticated technology — HP's upgraded lap portable, the HP110 Plus, overcomes most of these problems. A pedagogical problem was that the instructors could not readily display the individual student's work for full class discussion.

The student evaluation of the lap portable experiment, however, was extremely positive. They felt the systems were an important tool, and most of the students used the portable in their work environment. They saw themselves learning skills with immediate transferability. Based on this success, the lap-top portable computer experiment was expanded and the class entering in Fall 1986 was also

[7] The HP110 is a 256K lap-top computer with an electronic disc, internal modem, and weighing 9 pounds. Lotus 1-2-3, a wordprocessing package, and communications software are ROM-based.

assigned HP110 systems.

"Physical Science Model" for Management Instruction

In light of the previous two experiments, it was agreed that for curriculum integration to succeed, there should be greater faculty involvement and more intensive support for both faculty and students. A teaching assistant, for example, might bring the students into a computer lab and actively conduct analyses. Thus, the students, under the tutelage of a computer lab teaching assistant, could glean the maximum benefit from the process.

This idea emerged as our "physical science model" for computer support of instruction in management education. In the physical sciences, professors lecture in large halls on a topic's background and theory. In assigned lab sessions, students spend two or three hours per week under the direction of a teaching or lab assistant, conducting experiments specifically aimed at illustrating the concepts discussed in the previous lecture. A similar model could be developed for use within the business school environment. Lectures which present general concepts and principles could be followed by specific lab assignments. Under the direction of a teaching assistant, students would use the computer as a laboratory instrument, manipulating data and conducting experiments which might illustrate and highlight the theory presented in class.

The first class at GSM to experiment with the "physical science" model was *Managerial Computing*, Management 404. This core MBA course is taken by approximately two-thirds of our students and has been the "computer literacy" class for years. During the 1970s the course discussed business data processing and focused on APL and PL/I for interactive and batch programming, respectively. In 1982, APL and PL/I were replaced by database and Pascal assignments on the School's new minicomputer. When microcomputers arrived, the course included dBASE II and Lotus assignments. With these changes, more lecture time was spent on business computing and managerial issues and less on the tools. Hence, it seemed very appropriate to try the new instructional model with this course.

During Spring, 1986, the usual four hour lecture class was scheduled as two hours lecture and two hours lab.[8] The lectures were condensed versions of the

[8] This arrangement was used because we wanted to experiment with the model and not have to go through formal procedures for changing course hours and credits.

previous material and the labs used a student version of Framework 1.1 accompanied by an instructional textbook.[9] The overall reaction was quite favorable, and hence the experiment was expanded and tried with all the Management 404 sections during 1986-87 year, with a couple of modifications. First, the lecture time was scheduled as three hours (instead of four) and the lab as two hours (counting two hours of lab as one hour of lecture). Second, the full, complete Framework was used instead of the limited instructional version, and additional material on telecommunications and program development were included. Teaching assistants conduct the lab sessions under the supervision of the instructor. As of this writing (January, 1987), the course is achieving its goals of teaching both concepts managers need to know about computing as well as introducing the end-user managerial skills, tools and concepts.

A second course, *Managerial Finance*, Management 408, is experimenting with the physical science model during Winter, 1987, and another course, *Productions and Operations Management*, Management 410, will be evaluating this approach during the Spring quarter, 1987. For both of these courses, an ACC has been working with the course instructors to identify and develop appropriate lab material. The School as a whole is looking toward these experiments to decide whether lab sessions should be associated with more courses. Alternatively, a single lab with each week's session focusing on a different functional area, required for all students, is being considered. Irrespective of the approach finally selected, the initial view is that there is merit to the physical science model for integrating computers into the management curriculum.

Student Training: Orientation and Workshops

Entering MBA students are required to attend a week long orientation and registration program conducted by the admissions office before the start of fall classes. In order to increase general computer literacy, in 1984, for the first time, the incoming class was taken on a tour of the computing facilities and students signed onto the School's HP3000 system to get access to their accounts. This orientation proved very effective. In the fall of 1985, the entering class had a four hour computer orientation: hands-on sessions on GSM's HP3000, the campus IBM mainframe, and the HP150 and IBM PC microcomputer systems.

[9] Beil, Donald H., *Using Application Software: An Introduction Featuring Framework,* N.Y.: McGraw-Hill, 1986.

To fund the development and teaching of the orientation workshops, the program was offered as a service. Participation was voluntary and those choosing to attend paid a $25 fee. Approximately 300 students (about 75% of the entering class) elected to attend in the fall of 1985. A similar fee arrangement was used for the 1986 workshops and approximately 370 students (92%) elected to attend. The orientation workshop instructors were GSM students who work as Computer Services consultants during the academic year.

Based on an evaluation of the 1985 orientation program and the introduction of Framework II as the instructional standard, a 5-hour computing orientation was developed for the fall of 1986: 1/2 hour overview, 1 hour using the HP3000 system, 1 hour introduction to MS-DOS, and 2 1/2 hours introduction to Framework II. The Framework II sessions focused on introducing the concept of a frame, the menus and application environment (1 hour), with the remainder of the time spent on word processing.

The Fall 1986 computer orientation program represented four major changes from the 1985 program. First, the focus was on software rather than hardware. Second, the IBM mainframe sessions were dropped since by the time students used the mainframe (for some specialized second year courses), they needed another workshop. Third, rather than a lock-step approach, students were able to select the sessions which they felt would be most beneficial. Fourth, the learning style approach was changed from almost 100% tutorial, with each student working from written materials at their own pace with consultants available to assist with problems, to about 50% lecture and 50% tutorial materials.

For the second year MBA students, a three hour introductory Framework II workshop was offered which introduced the frame concept, word processing, and spreadsheets. Significantly different approaches were made for the first and second year student orientations to Framework II, as it was assumed that the second year students had been exposed to word processing and spreadsheet packages during their first year and that there would be concept transfer to Framework II.

Besides the orientation sessions, GSM Computing Services consultants provide about 200 hours of hands-on workshops for GSM students during the academic year. During 1985-86, about half the workshops were microcomputer-oriented and focused on Wordstar, Lotus 1-2-3, and graphics software. The other workshops were HP3000 or IBM mainframe-oriented and concentrated on the use of the editors and statistical and linear programming packages required in various classes. Many of the workshops provided both elementary and advanced sessions. For 1986-87, the plan has been to present a series of "advanced" Framework II workshops as well as continue most of the previous workshops but with fewer sessions offered.

5 Impact of the Microcomputerization Effort

From the perspective of January, 1987, how have we fared during the past five years? Have GSM's three strategic instructional computing goals (listed in Table 8) been achieved? The following three sections revisit these goals. First, however, some caveats. The goals speak in terms of "computer proficiency" and "computer integration." As was discussed in the section on evaluation, no clear definitions or means of assessing proficiency and integration are available. Hence, our evaluation is based on survey, interview, observation, and anecdotal records of what is happening, as well as on material faculty members were asked to prepare as part of an extensive evaluation of the campus-wide computerization effort.

Goal 1: Computer Proficiency

During the past two years, approximately 80 microcomputer workstations have been installed in GSM faculty offices and approximately half the faculty have attended workshops on the use of these systems. A data switch provides faculty access to the campus and school's mainframe systems and electronic mail systems. About one-third of the faculty reported that they make extensive use of the data switch.

We can approach the issue of faculty proficiency in terms of their reported use of computers. Faculty members from all areas of the School report research benefits of having the computer systems available in their offices. This benefit has been expressed in two areas. First, GSM faculty produce a large volume of articles and books and have reported major productivity gains from word processing which eases the task of composition and revision. Second, because of the links to the mainframes, faculty are able to do most of their quantitative research from the peace and quiet of their offices rather than in the noisy and distracting computer rooms. This leads again to greater productivity and better work. Many individual faculty have reported that these two elements have been a tremendous boost to their own productivity, thus leaving valuable time for other responsibilities.

In terms of software, almost all faculty use either Word Perfect or Framework II for word processing. TEX is popular for typesetting papers. Approximately 30% of the faculty have had PC SAS installed on their systems and use it regularly. Furthermore, many GSM faculty write their own code in support of their research, mainly using Turbo-Pascal or FORTRAN. There is some use of SPSS on the mainframe, but SAS is the more popular, with many individuals reporting transfering files from the IBM 3090 to their micro and using SAS in both locations.

Student proficiency can be inferred from their attendance at workshops and reported use of the various systems. As discussed earlier, 75% and 85% of the 1985 and 1986 entering classes, respectively, attended the voluntary computer orientation programs. A total of 114 workshops were offered during the 1985-86 academic year, with 55% microcomputer-based, 31% on the HP3000, and 14% were on the campus mainframe. Workshop offerings have also been classified by major software categories: spreadsheets (32%), quantitative analysis (25%), word processing (24%), database (14%), and graphics (5%).

A student survey in December, 1985, indicated that GSM students used the computer resources an average of 5.3 hours per week. A similar survey in December, 1986, indicated that usage has increased 25% to 6.6 hours per week. GSM also provided approximately 75 consulting hours per week to the user community. The adoption of Framework II, the installation of additional student facilities, and approximately 90% of the entering MBA class attending the Fall 1986 computer orientation, all indicate that the trend will be toward even greater student use of systems.

The evidence suggests that the first goal, computer proficiency, is nearing reality.

Goal 2: Curriculum Integration

It is extremely difficult to determine the exact *quantitative* impact of computers on the curriculum. Many faculty at GSM give assignments which require data analysis but they do not specify whether the student is to use a calculator, computer, or just pencil and paper. Observations of students working in the computer labs suggest that their use far exceeds the specific course requirements. Recognizing this limitation, GSM has gathered data which suggests the depth of penetration.

At the end of the Spring quarter, 1986, GSM faculty were surveyed to determine the courses for which students were required to utilize GSM's computer resources or the central campus computer. Sixty-eight full-time faculty members who received equipment were contacted and 49 responded, a response rate of 72%. Thirty-eight different courses, representing a total of 73 sections, reported required computer assignments. These sections had a total enrollment of 1,967 students. For 27, or 37%, of these sections, the 1985-86 academic year was the first time the computer was used. Most of the responses from faculty indicated that they were very satisfied with the initial use of computers and planned to continue and/or expand their instructional usage. Additionally, the physical science model of using computer labs is being extended as discussed earlier.

The second source of data suggesting that curriculum integration is well underway is from a pair of student surveys. A survey of first year MBA students was conducted in December, 1985, and again in December, 1986, asking students to list the courses in which they used computers. Under the current GSM curriculum program, first year students usually enroll in four of seven courses. Table 10 shows the results of the surveys for these courses. Unfortunately, due to sampling constraints, the data may not represent a true random sample of the GSM student population. However, it is considered adequate for identifying trends.

Table 10
Student Use of Computing in First Year Core MBA Courses

	Fall 85	Fall 86	
Surveyed/Enrolled (percentage)	219/372 (59%)	247/402 (61%)	
Computer usage by course	%	%	% change
402 Data Analysis	23	56	+143
403 Accounting	25	13	- 52
404 Computing	100	100	0
406 Economics	100	100	0
407 Modeling	71	90	+ 27
411 Marketing	50	77	+ 54
440 Problem Solving	50	50	0

From the data presented in Table 10, a general trend is that the use of computers is on the increase. Specifically, for two courses, *Managerial Computing* and *Managerial Economics,* computer use has been required for at least the past two years. However, there has been significant increases in the use of computers in the *Managerial Data Analysis, Managerial Modeling,* and *Managerial Marketing* courses. No change was shown in the *Managerial Problem Solving* course. The decrease in student computer usage in the *Managerial Accounting* course is explainable in terms of the faculty who taught the course this year and last year. Seven sections of the course were offered both years and the one professor who encouraged computer usage taught two sections in 1985 and only one section in 1986.

As promising as the data in Table 10 appears to be, GSM expects to make even greater gains this next year as many of the technical and equipment barriers, and issues related to curriculum integration, are overcome.

Goal 3: Expanded Use of Modeling and Simulations

Faculty reports of their specific projects indicate that our goal of expanding the use of computer modeling and simulations is being achieved. There were many successful spreadsheet applications throughout the curriculum, with major expansions in the Management Science and Production Operations Management areas which focus on managerial decision making, forecast scheduling, and production planning. There were also several unique applications from other academic areas. One is the Collective Bargaining Simulation from Human Resource Management, which introduced the students to the process of costing out a collective labor agreement using contract data and formulas contained in a Lotus spreadsheet. Another is the Industry Analysis Modules project which has been developed in the Organization and Strategic Studies area to assist students in their ability to analyze "ill-structured" industry situations.

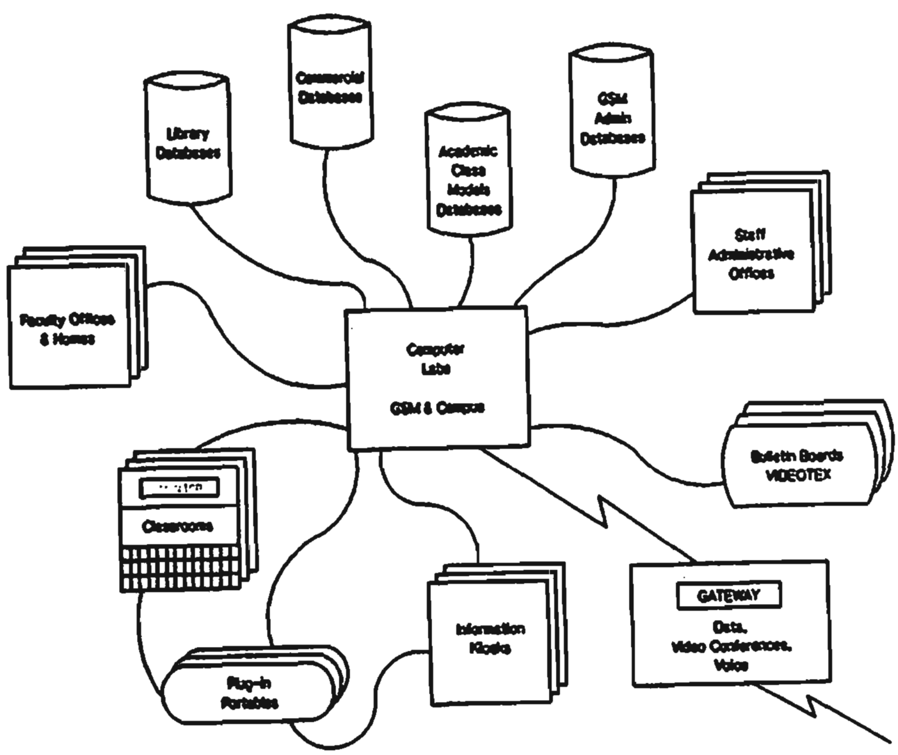
Our third goal of expanded use of modeling and simulation is, like curriculum integration, well underway. And, here again, further gains are expected in the next several years as the computer proficiency of both the faculty and the students at GSM continues to expand.

6 GSM in 1990: A Sketch of the Future[10]

Subsequent to this review of recent GSM history, problems, alternatives, and experiments, I want to conclude this case study by looking ahead. I'd like to outline my image of GSM's computing environment three to five years from now. Since my crystal ball has some cloudy spots (in some places, it is very dense), I offer these remarks to help stimulate discussion. Rather than writing this scenario in the future tense, I'm writing it as if I'm looking backward from 1990. Figure 1 diagrams the major components of GSM's future technological environment.

Figure 1

GSM Projected Information Technology Base



[10] I want to thank Warren McFarland from Harvard Business School and James Moore from the Center for Expert Systems, Boston, Massachusetts, for sharing their ideas and stimulating this view of the future.

In the past few years we have moved firmly into the information age. Technologically we have established an "information network" (a local area network) linking all faculty, staff, and student workstations located within GSM. The network has the usual features of electronic mail and quality printers and plotters. However, what makes the network more than simply a physical link for workstations, truly an "information network," are the databases which are available. These databases, which cover all the areas of interest for management studies and provide data cross-referenced by industry, corporation, region or sector, and other views which enhance research and instruction, are located on the campus and School's mainframe systems. Access is also provided to real world databases, such as Dow Jones, COMPUSTAT, and CRSP, as well as to the various campus libraries. In addition, a set of School-oriented databases are available to assist students and faculty with enrollment, registration, job placement, and field study.

Our information network has had a very positive effect on the infrastructure of the School as well as on research and instruction. Electronic communication among faculty, between faculty and students, and among students is very common, and allows special interest groups to form and maintain contact easily. Electronic bulletin boards using a videotex-type system provide menu selection features and allow common mass information dissemination. The access to databases enables faculty to pose questions for student investigation, to run an analysis before class, and to display the results in class.

Starting with the class entering in Fall, 1988, GSM required all first year students to own or have easy access to a microcomputer. GSM established a purchase arrangement for students to acquire a lap-top portable at a reasonable price. Most students choose this option (even if they have a system at home) and the portables are used in classes for note taking as well as for exams, in the computer classrooms, libraries, and at home. In support of the student systems, "information kiosks" are located around the School. At these kiosks, students are able to plug their portables into the network. Other features of the kiosks are printing capability, online assistance to various software and data packages, and consulting. The traditional open-access "computer labs" from the early '80s are still around, but now with only a relatively few, very powerful systems.

Many classrooms are equipped with micro-linked video projectors so that instructors can demonstrate concepts or display "overheads" that were prepared on their office systems. Also there are several "computer classrooms" which have outlets for students to plug in their portables. What makes these computer classrooms unique is that under the instructors direction, any particular student's output can be displayed to the entire class. In this environment, a student can display his or her analysis of a case and the other students can respond.

Beginning in 1986, the MBA curriculum was significantly revised to take advantage of the information technology which had become available. The revision was organized around two efforts: curriculum area databases and major revamping of the core courses. We recognized that a major hurdle to research and instructional use of computers was the lack of access to data. Word processing and spreadsheets provided productivity gains, but the real power of the computer in assisting with qualitative and quantitative analyses was hampered by the lack of data. Software was readily available, so we chose to put our efforts into identifying and acquiring the data needed to do the various analyses. Back in 1986, it was argued that if such databases and software were made available for faculty use, these applications would find their way into various upper-level MBA courses by the end of the decade. (Happily we can say that the prediction was accurate!) Therefore, an organized effort to identify and find or create the appropriate databases was undertaken and, based on our success, will continue. This database development was given a significant boost when, in 1987, a consortium of business schools was formed to assist with the gathering and sharing of these databases.

The second curriculum revision area was that of the MBA core courses. Back in 1984, a MBA Task Force examined the core courses and made recommendations for revising them to include use of computer technology where appropriate. Building on this work, significant modifications were made to many of the first year core classes beginning in 1986. A common pattern for the revision was to change the course structure from a four unit lecture to a three unit lecture and a one unit 2-hour required and graded computer lab. These lab sections are now conducted in the "computer classrooms" and taught by area computing consultants.

Because of the tremendous time commitment needed for courseware development for the lab sessions, the faculty agreed that each core class would have common lab sessions, and for some sections, a common course syllabus. To develop these lab sessions, "core teams" were established. Each team consisted of the faculty who teach the core class, a curriculum development specialist (a system designer with an educational orientation) and an area computing consultant (a doctoral student from the area to do the programming).

The faculty are responsible for identifying objectives and making suggestions. The area consultants do the actual writing and data entry. Faculty certify that the material is, in fact, appropriate to the course material and contributes to the achievement of stated course goals. The curriculum development specialist is responsible for coordinating the efforts of the team and supervising the area computing consultant to be sure that common user interfaces and software engineering standards are achieved across all areas of the School.

A major hurdle to curriculum revision was faculty incentives. We were able to overcome some of the problems by using the curriculum development specialists and area computing consultants. Also, some senior faculty requested either a course release or summer support to assist with the development effort. Also, for some areas, adjunct lecturers were hired specifically to do curriculum development and instruction.

7 Conclusion

A major element in GSM's success is that the faculty as a whole have gained first hand experience with the technology and are beginning to believe in its potential. GSM as an organization has made significant progress along the learning curve and can collectively think and speak of the benefits of the technology from a common experience base.

The primary factors leading to the successful progress toward the achieving of our organizational goals have been individual faculty being motivated by the opportunity presented by the various grants to introduce new technological tools into their environments, combined with a strong support program to assure the effective and efficient use of these tools. The strategy for managing our implementation has been for curriculum areas to submit plans and the School to allocate resources (hardware, software, and personnel support). The success of this strategy has been due to the availability of equipment and funds through the various grants and the assistance of the campus administration in providing additional funds.

During the next few years GSM will continue to stride toward achieving its long term goals by developing additional instructional materials and support programs which lead to student and faculty proficiency and integration of information technology throughout the program. Information technology is becoming a "normal" part of the environment and it appears that a growing number of faculty members automatically think about the potential impact of technology use in their courses. Over time we see it being a natural component of most classes, especially those which use or can benefit from simulation or modeling as part of the analysis procedures of the discipline.

GSM COMPUTING BUDGET

NOTES: In the following budget, a zero in a location indicates that $0 were spent, while a blank indicates that the amount is unknown.

	FY 85 Actual	FY 86 Actual	FY 87 Projected	FY 88 Projected
TOTAL GSM COMPUTING SUMMARY				
Hardware Donations	$979,000	$1,118,799	$1,251,500	$1,692,500
Software Dontations	$33,500	$171,650	$469,800	$385,500
Expenses	$94,310	$410,549	$598,300	$600,800
Salaries *	$285,750	$530,804	$779,994	$1,171,490
OAC IBM 3090 Utilization	$294,373	$291,198	$283,000	$283,000
TOTAL GSM COMPUTING SUMMARY:	$1,686,933	$2,523,000	$3,382,594	$4,133,290
SUMMARY OF HARDWARE AND SOFTWARE DONATIONS				
Hardware:				
IBM Project ADVANCE	$21,000	$453,816	$650,000	$772,500
IBM Business School (MISSLE)	$0	$112,200	$250,000	$250,000
Hewlett-Packard	$958,000	$552,783	$351,500	$670,000
Hardware Donations Subtotal:	$979,000	$1,118,799	$1,251,500	$1,692,500
Software:				
IBM Project ADVANCE	$0	$11,365	$30,000	$30,000
IBM Business School (MISSLE)	$0	$12,100	$37,500	$37,500
Hewlett-Packard	$33,500	$82,160	$93,900	$70,000
Ashton-Tate **	$0	$66,025	$308,400	$248,000
Software Donations Subtotal:	$33,500	$171,650	$469,800	$385,500
TOTAL HARDWARE & SOFTWARE DONATIONS:	$1,012,500	$1,290,449	$1,721,300	$2,078,000

* Includes benefits and 5% inflation factor for FY 87 and FY 88.

** GSM faculty received complimentary copies of Framework II and students paid $75. Donation value based on list value of $695.

	FY 85 Actual	FY 86 Actual	FY 87 Projected	FY 88 Projected
SUMMARY OF EXPENSES AND SALARIES				
Expenses				
Communications Equipment	$8,800	$86,832	$78,700	$78,700
Software & Data		$25,649	$43,500	$93,500
Supplies, Facilities, Furniture, etc.	$15,000	$117,043	$262,500	$142,500
Computer Maintenance and Service	$70,510	$76,848	$105,600	$178,100
Faculty and Staff Support		$104,177	$108,000	$108,000
Expense Subtotal:	$94,310	$410,549	$598,300	$600,800
Salaries				
Career Staff	$138,000	$271,689	$549,994	$872,490
Student Staff	$147,750	$259,115	$230,000	$299,000
Salaries Subtotal:	$285,750	$530,804	$779,994	$1,171,490
TOTAL EXPENSES AND SALARIES:	$380,060	$941,353	$1,378,294	$1,772,290
SUMMARY OF FUNDING SOURCES				
Designated Computing Funds				
Vice Chancellor Research Funds				
GSM Computing General Funds (GN-36)	$0	$189,849	$199,341	$209,309
Instructional Computing (GN-05)	$0	$150,000	$150,000	$150,000
Special allocation *	$0	$70,000	$0	$60,000
IBM Business School Grant Funds (MISSLE)	$0	$187,604	$189,000	$189,000
Total designated funds:	$0	$597,453	$538,341	$608,309
Additional Funding				
GSM Operating Budget (GM-16)		$207,159		
Instructional Material Fee (GN-15)		$45,358		
Summer Session (SS-03)		$24,464	$63,000	$63,000
Executive MBA (GN-21)		$10,740		
Finance Area (GN-06)		$9,500	$9,500	$9,500
Finance Area (GN-91)		$4,899	$5,000	$5,000
Discretionary Funds		$6,780		
Total additional funding:	$380,060	$308,900	$77,500	$77,500
Funds to be identified:	$0	$35,000	$762,453	$1,086,481
TOTAL FUNDING SOURCES:	$380,060	$941,353	$1,378,294	$1,772,290

* FY 86 for data switch; FY 88 request for classroom video equipment.

DETAIL LISTING OF HARDWARE AND SOFTWARE DONATIONS

	FY 85 Actual	FY 86 Actual	FY 87 Projected	FY 88 Projected
IBM Project ADVANCE				
Faculty Workstation	$21,000	$344,470	$0	$225,000
Additional Peripherals	$0	$33,661	$150,000	$0
IBM 7171 Port Controller	$0	$14,080	$0	$0
Student Workstations	$0	$61,605	$400,000	$347,500
Network Equipment	$0		$100,000	$200,000
Hardware Subtotal:	$21,000	$453,816	$650,000	$772,500
Faculty Software	$0	$11,365	$10,000	$10,000
Student Software	$0	$0	$20,000	$20,000
Software Subtotal:	$0	$11,365	$30,000	$30,000
IBM Project ADVANCE Total:	$21,000	$465,181	$680,000	$802,500
IBM Business School (MISSLE)				
Grant Hardware	$0	$112,200	$250,000	$250,000
Grant Software	$0	$12,100	$37,500	$37,500
IBM Business School Total:	$0	$124,300	$287,500	$287,500
Hewlett-Packard				
HP 3000 and Upgrades	$694,000	$167,528	$68,300	$300,000
Microcomputer Workstations	$220,000	$139,235	$0	$50,000
Lap Portables		$216,000	$222,200	$220,000
Microcomputer Peripherals	$44,000	$30,020	$25,000	$50,000
Network Equipment	$0	$0	$36,000	$50,000
Hardware Subtotal:	$958,000	$552,783	$351,500	$670,000
Minicomputer Software	$6,000	$13,000	$21,000	$25,000
Microcomputer Software	$27,500	$50,850	$59,700	$25,000
Consulting and Support	$0	$18,310	$13,200	$20,000
Software Subtotal:	$33,500	$82,160	$93,900	$70,000
Hewlett-Packard Total:	$991,500	$634,943	$445,400	$740,000

DETAIL LISTING OF ALL COMPUTER EXPENSES

	FY 85 Actual	FY 86 Actual	FY 87 Projected	FY 88 Projected
Communications Equipment:				
Port Selector	$0	$50,057	$43,500	$43,500
Fiber Cable	$0	$17,717	$0	$0
Wiring Installation	$8,800	$10,758	$15,000	$15,000
Data Telephones		$7,300	$7,000	$7,000
Modems		$1,000	$1,000	$1,000
Service Contracts	$0	$0	$7,200	$7,200
Software	$0	$0	$5,000	$5,000
Subtotal:	$8,800	$86,832	$78,700	$78,700
Software & Data (Purchase or Site License)				
Word Processing		$2,000	$1,000	$1,000
Spreadsheet		$0	$0	$0
Database Management System		$0	$0	$0
Graphics		$0	$0	$0
Integrated		$0	$0	$0
Micro Instructional/Miscellaneous		$2,250	$25,000	$25,000
HP3000 Software		$7,000	$3,000	$3,000
CRSP Database		$9,500	$9,500	$9,500
Compustat Database		$4,899	$5,000	$5,000
Other Databases			$0	$50,000
Subtotal:	$0	$25,649	$43,500	$93,500
Supplies, Facilities, Furniture, and Security for HP3000 and all Microcomputers				
Supplies	$15,000	$44,597	$56,500	$56,500
Peripheral Equipment		$3,400	$5,000	$5,000
Printing and Publications		$13,001	$10,000	$10,000
Security Devices		$3,834	$18,000	$9,000
Computer Furniture		$9,343	$31,000	$0
Preparation of Student Lab		$38,660	$100,000	$0
Classroom Projection Equipment		$2,500	$40,000	$60,000
Miscellaneous Equipment		$1,708	$2,000	$2,000
Subtotal:	$15,000	$117,043	$262,500	$142,500

	FY 85 Actual	FY 86 Actual	FY 87 Projected	FY 88 Projected
Computer Maintenance and Service				
HP3000 Minicomputer Maintenance	$70,000	$24,708	$27,200	$27,200
HP3000 Software Maintenance		$19,965	$21,900	$20,000
HP Microcomputers Service		$16,032	$17,600	$17,600
IBM Microcomputers Maintenance		$0	$15,600	$80,000
Insurance		$6,763	$10,000	$20,000
OAC Installation Charge	$510	$6,780	$10,000	$10,000
OAC Disc Storage/Backup Charges		$948	$1,600	$1,600
Terminal Rental and Port		$1,652	$1,700	$1,700
Subtotal:	$70,510	$76,848	$105,600	$178,100
Faculty and Staff Support				
Professional Staff Development		$3,961	$5,000	$5,000
Faculty Course Release and Summer Support		$97,816	$100,000	$100,000
Office Supplies, Mail, Xerox., etc.		$2,400	$3,000	$3,000
Subtotal:		$104,177	$108,000	$108,000
TOTAL EXPENSES:	$94,310	$410,549	$598,300	$600,800
IBM 3090 UTILIZATION				
IUC Allocation	$291,000	$247,802	$275,000	$275,000
Extramural Faculty Usage		$38,098		
Summer Session Usage	$3,373	$5,298	$8,000	$8,000
TOTAL OAC UTILIZATION:	$294,373	$291,198	$283,000	$283,000

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