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Teldok

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RAPPORT nr 6

The Automated Office
A Description and Some Human Factors Design Considerations

Martin Helander

Med sammanfattning och några artiklar på svenska

(With summary and articles in Swedish)

Olov Östberg

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INTRODUKTION

Denna TELDOK-rapport har två författare - Martin Helander och Olov Östberg - och redovisar deras observationer av den aktuella utvecklingen i USA.

Olov Östbergs bidrag fokuseras bl a på ett delområde i stark utveckling - talteknologi - som tidigare översiktligt behandlats i TELDOK-INFO nr 1. Östbergs bidrag har tidigare, som framgår, publicerats i artikelform men redovisas här samlade.

Östberg tar också upp frågan om den nya teknikens effekter för arbetsmarknaden: Skapar den nya tekniken verkligen fler, mer **kvalificerade** arbeten, eller blir det bara fråga om mer begåvade "svarta burkar" där arbetsinnehållet - på gott eller ont - inte skiljer sig mycket från dagens arbetsuppgifter?

Martin Helanders bidrag är av annan karaktär: det ger en bred, begreppsmässigt disponerad bakgrundsbeskrivning av rådande utvecklingstendenser i USA. Bidraget publiceras - följdriktigt - på engelska.

Bidragen har tillkommit under en period då Helander och Östberg båda vistats i USA, och gäller ett projekt för vilket författarna delat rapporteringsansvaret. Det är därför naturligt att rapporten - på författarnas gemensamma önskan - publiceras som en helhet av TELDOK.

Bertil Thorngren
Ordförande TELDOK Redaktionskommitté

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SAMMANFATTNING

Projektets ansats var att till Sverige rapportera intressanta händelser inom kontorsautomationsområdet i USA.

Genomgående kan sägas att arbetsmiljöaspekterna är betydligt bättre tillgodosedda vid kontorsautomation i Sverige. Detta gör att rapporteringen från USA till Sverige snarast har haft karaktären av framlyftning av vissa teknikföreteelser än ergonomi- och arbetsmiljöföreteelser. I huvudrapporten **The Automated Office: A Description and Some Human Factors Design Considerations** diskuteras allmänna frågeställningar utifrån en uppdelning av kontorsfunktionerna i huvudgrupperna:

Transaktioner
Dokumentation
Telefonering
Personkontakter/möten

Följande teknikanvändningar diskuteras under separata uderrubriker

Datorstödd konstruktion och produktion (CAD/CAM)
Databassystem
Elektronisk post
Elektronisk informationslagring
Grafiska inmatningsdon
Lokala nätverk
Videokonferenssystem
Bildskärmsterminaler
Röstigenkänning
Röstbrevlådesystem

Eftersom huvudrapporten skrivits på engelska och dessutom är hållen på en nivå som fordrar vissa förhandskunskaper för att kunna tillgodogöras, har projektteamet Östberg/Helander valt att popularisera och snabböverföra vissa av de mer intressanta frågeställningarna i form av tidningsartiklar publicerade i Sverige under projektets gång. Dessa artiklar bifogas och torde inte behöva någon ytterligare sammanfattning.

En fråga har behandlats lite styvmoderligt i projektet. Denna fråga är: "Kommer kontorsautomationen att ge arbetslöshet?" Utan att frågan sammanhållet behandlats i huvudrapporten och populärartiklarna kan det dock vara på sin plats att i sista minuten erinra om ett par färska USA-rön härvidlag.

Allmänt gäller att det i USA år 1983 uppskattningsvis finns ca 10 miljoner bildskärmar. Prognosererna pekar på att antalet kommer att fortsätta öka raskt under många år framöver, men att samtidigt antalet fristående "hemdatorer" (som för övrigt snarast kommit att bli "arbetsplatsdatorer") kommer att öka i ännu snabbare takt. Det förutspås att olika former av lokala nätverk och programvarutillskott

kommer att möjliggöra att former av datorutrustningar snart kommer att kunna kommunicera sinsemellan. Kommer denna datoriseringsvåg att ge spår vad gäller sysselsättningen i USA?

En typ av svar gavs nyligen av generaldirektör William F Bolger vid USAs Postverk. Vid en presskonferens i Los Angeles den 6 april 1983 lanserade han USA-postens senaste automatiserings- och datoriseringsinitiativ. Genom övergång till en helt ny typ av postnummer och genom anskaffning av automatiska postsorteringssystem kommer posten att kunna spara in betydande lönebelopp. Vid den mekanisering som inleddes på 70-talet minskades antalet postanställda med 72 000 personer genom naturlig avgång.

Den automatisering som nu satts in för 80-talet kommer att få ett ännu större antal arbetstillfällen att försvinna, men generalpostmästaren betonade att det fortfarande kommer att röra sig om naturlig avgång i kombination med slopande av övertid och deltid och tillfälliganställningar. Med de nya maskinerna kan 2-3 personer sortera samma brevmängd som 97 personer nu klarar med dagens maskiner.

En annan typ av svar finns att hämta från bankområdet. I Sverige har ju antalet bankanställda under de senaste decenniet ökat med ca 40 procent och bankerna har försäkrat att det inte kommer att hända att bankanställda sägs upp pga introduktionen av datorer och bankautomater. Det har tvärtom hävdats att bankautomatiseringen skulle ge kassapersonalen bättre kundkontakt och rikare tillfällen till kvalitativt bättre arbete. Nu ha emellertid inträffat den händelsen att stora CitiBank i New York infört regeln att enda möjligheten för bankkunder att komma i personlig kontakt med bankpersonalen är att ha ett tillräckligt stort belopp insatt på baken. Alla kunder som har konton understigande 40 000 kronor är förbjudna att anlita kassortna och hänvisas obönhörligt till bankautomaterna. Och av en undersökning bland bankernas beslutsfattare, utförd av Allied Corporation´s Bunker Unit våren 1983, framgår att USAs banker genomgående räknar med att kunna skära ned antalet anställda med drygt 15 procent under den kommande tioårsperioden.

Den kanske mest påtagliga sysselsättningsdiskussionen har i USA hittills gällt möjliheten att skapa sysselsättning via de blomstrande datorföretagen. Det bästa exemplet har härvidlag varit Atari, som är dominerande vad gäller fiffiga videospel för hemdatorer. Detta exempel har emellertid hastigt förbrukats, ty nyligen har ledningen för Atari tillkännagivit att en hel fabriksavdelning med nästan 2 000 anställningstillfällen ska flyttas till Taiwan och Honkong. Fler datorföretag väntas följa efter.

Nu har också en analys av arbetsmarknadsstatistiken och arbetsmiljöstatistiken i USA givit ytterligare belägg för att det kan vara en dubbelmyt att ny teknik skapar jobb, och bra jobb. Forskarna Henry M Levin och Russel W Rumberger vid Stanfords Institut för Forskning om utbildningsfinansiering och utbildningsstyrning har blottlagt dessa obehagliga fakta (The Educational Implications of High Technology, 1983). Visst skapas det jobb, och bra jobb med ny teknik, men samtidigt blir befintliga jobb genomgående av betydligt lägre kvalitet i den mån de de alls finns kvar i sin nuvarande form . Ett betydligt större antal jobb försvinner än vad som nyskapas. Och de jobb som nyskapas är bara till en försummande liten del av karaktär "ny teknik".

Den procentuella tillväxten av "ny teknik"-jobb är hög men det absoluta antalet är mycket litet. Samtidigt som 150 000 programmerarjobb tillskapas växer antalet nya "hjälprede"-jobb med 3 miljoner. Till hjälprede-jobb räknas fastighetsskötare, snabbköpskassörskor, snabbmatserveringspersonal och motsvarande sysselsättningar med mycket låga krav på utbildning. Endast fyra av de starkast ökade sysselsättningskategorierna kräver utbildning på gymnasienivå.

Vid diskussion om sysselsättningsläget ska kommas ihåg att den officiella arbetslöshetsstatistiken visar på ca 3% arbetslöshet i Sverige och ca 10% i USA. Det kan också vara på plats att erinra om att även Sverige medverkar till att exporten av arbetstillfällen sker över gränserna i takt med att antalet datorer ökar världen över. Primdata, som ligger i Oxelösund och som är ett till Svenska Stål knutet datorföretag, annonserar sommaren 1983 i USA med uppmaningen: "Lägg datorjobb i Sverige - pga tidsskillnader har vi ledig kapacitet när USA har som högst beläggning, och våra datorer är bemannade dygnet runt".

FÖRFATTARNA

Olov Östberg har under budgetåret 1982/83 varit gästforskare vid National Institute for Occupational Safety & Health, Applied Psychology and Ergonomics Branch, Motivation & Stress Research Section. Den geografiska placeringen är Cincinnati, Ohio, USA, och arbetsuppgifterna omfattar forskning avseende synbesvär vid bildskärmsarbete samt sociala effekter av tillämpning av industrirobotar. De två föregående åren har han varit ombudsman på TCO och handlagt frågor rörande arbetsmiljö, ny teknik samt forskning och utveckling.

Dessförinnan var Olov Östberg professor i teknisk psykologi vid Högskolan i Luleå, till vilken tjänst han kom från Arbetarskyddsstyrelsens forskningsavdelning för fysikalisk yrkeshygien. Andra arbestslivserfarenheter inbegriper tjänster som ergonom vid Kooperativa Förbundet respektive vid Forskningsstiftelsen Skogsarbeten. Han har också varit gästforskare ett år vid ergonomiavdelningen vid Loughborough University of Technology i England. Publiceringslistan upptar drygt 100 arbeten inom arbetsmiljöområdet, speciellt vad gäller datorisering och robotisering.

Martin Helander var tf professor i industriella ergonomi vid Högskolan i Luleå under de två första uppbyggnadsåren av institutionen för arbetsvetenskap. Han flyttade därifrån till USA för att bedriva forsknings- och utredningsarbete vid Canyon Research Group Inc i California.

Under budgetåret 1982/83 har Martin Helander varit gästforskare vid Department of Industrial Engineering and Operations Research, Virginia Polytechnic Institute and State University, som ligger i Blacksburg, Virginia, USA. Han har varit en flitig anlitad ergonomikonsult och har bl a utarbetat träningsprogram och teknikanalyser, avseende kontors- och industriautomation, för Bell Telephone Laboratories och IBM. Martin Helander är dessutom en drivande kraft bakom ansatserna att i USA utarbeta industristandards baserade på ergonomikrav. Har har en omfattande produktion bakom sig (och framför sig) och har nyligen utnämnts till professor i Human Factors vid Department of Industrial and Management Systems, University of South Florida, Tampa, Florida, USA.

MODERN ADMINISTRATION
Nr 11 16 november 1982

Särtryck ur Modern Administration nr 11/82

Den talande datorn — snart är den här på allvar

Teckning: JERRY KOCK

Av OLOV ÖSTBERG

Under de senaste tjugo åren har säkert tiotusentals persontimmar och tusenmiljontals kronor världen över spenderats på maskinell framställning och avlyssning av röst. Resultaten från denna enorma satsning har låtit vänta på sig men nu ser det faktiskt ut som om förväntningarna kommer att infrias. Det finns skäl att tro att det finns sanningskorn bakom de rykten som säger att Japans satsning på "femte generationens datorer" kommer att resultera i automatiska översättningsmaskiner mellan godtyckliga språk och via skrift eller röst.

En mer blygsam och allmän förväntan är att den mänskliga rösten ska återupprättas som kommunikationsmedel efter att ha varit satt på undantag i tekniksamhället.

391130-0014 måste det heta på hålkortens tid. Senare accepterades också formen *Östberg, Olov N.* och först våra dagars avancerade datasystem klarar att jämställa detta med det naturligare *Olle Östberg*. Våra anspråk har varit så låga att vi genast är beredda att säga att nu har datorn blivit både "mänsklig" och "intelligent".

Vi har hittills "talat" till maskinsystemen via våra händer (tangentbord, ljuspenna) och fått 'svar' med information via våra ögon (bildskärm, utskrift). Röstteknologins genombrott ger nu möjlighet till datainmatning genom mikrofon och datautmatning genom högtalare. Samtidigt har gränserna mellan databehandling och telekommunikation suddats ut, likaså gränserna mellan medierna röst, text, grafik och bild.

Ett klart uttryck för såväl gränsöverskridandet som den hårda ekonomiska kampen om den nya marknaden är, att telebolagen gör inbrytningar på dataområdet och att databolagen gör inbrytningar på teleområdet.

Televerket gör oss till det första land där funktionen röstbrevlåda är tillgänglig för telefonabonnenterna. Med början i Göteborg introducerades röstbrevlådan hösten 1982. Systemet har köpts från IBM.

Olov Östberg, professor och TCO-ombudsman — f n gästforskare vid NIOSH, USAs motsvarighet till Arbetarskyddsstyrelsens forskningsavdelning — har studerat röstteknologi med anslag från TELDOK (startat av Televerket).

Röstbrevlåda innebär att rösten digitaliseras för efterföljande datorbehandling, lagring och åtkomst. När telefonerna successivt förses med knappsats istället för nummerskiva går det mycket snabbt att som telefonabonnent koppla in sig till datorn och prata in ett meddelande av obegränsad längd till den person som vid tillfället inte var tillgänglig för telefonsamtalet. Datorn ringer sedan upp och framför det inpratade meddelandet om mottagaren så önskar och kan identifiera sig med ett lösenord.

Efter studiebesök på IBM i Yorktown Heights, september 1981 och september 1982, kan konstateras att röstbrevlådan där under drygt ett år använts fullt ut och till allas belåtenhet. Röstbrevlådan har blivit ett flitigt använt vardagshjälpmedel och många användare har hunnit övergå till systemnivå III. På denna nivå är det bl a möjligt att reglera hastigheten på den datoruppspelade rösten (utan att tonhöjden ändras!) och med hjälp av knappsatsen går det att redigera det man själv pratar in och t ex omärkligt ändra ett uttryck inne i ett ordflöde, flytta på hela meningar eller i efterhand lägga till en inledning. Andra funktioner är att låta ett och samma meddelande gå ut till många mottagare (kallelse till sammanträde), ringa upp sig själv med en påminnelse ett halvår framöver, under resa

Vänd

Forts

Hemarbete underlättas – men vad säger facket?

per telefon bläddra igenom de telefonlappar som samlats på hög på kontoret, osv.

Röstdigitaliseringen har av företaget Centigram utnyttjats på ett annat fiffigt sätt. På samma sätt som data via modem kan skickas på telenätet, kan med Centigrams utrustning telefonsamtal skickas på ett datanät. Detta utnyttjas av flera stora internationella företag som etablerat permanenta datalinjer mellan t ex dotterbolag i Europa och huvudkontorets dator i USA. Dessa företag ringer transatlantiska telefonsamtal utan merkostnad, eftersom man redan betalar för datalinjen.

Hemarbete och pratbubblor

IBM är ingalunda det enda företag som saluför teknik för datoriserad röstlagring, och röstbrevlåda kopplad till telefonen är bara en av många skilda tillämpningar.

I Kalifornien har First Interstate Bank lanserat ett system för telefonförmedlade och kontantlösa penningtransaktioner. Bankkunden ringer upp det speciella transaktionsnumret och vägleds av en datorlagrad röst genom hela gör-det-själv-processen tills allt är klart och datorrösten ber om en sista knapptryckning som bekräftelse på att kundkonto A överför beloppet B till mottagarkonto C avseende faktura D.

En annan tillämpning exemplifieras av bilden på den hemarbetande småbarnsmamman, som i stora annonser under 1982 använts i Laniers marknadsföring av system Telestaff. Lanier håller på att etablera ett kundnära nät av hemarbetande ordbehandlingsoperatörer. Operatörerna får per telefon från Laniers regionalkontor en utskriftsdiktering, som Lanier i sin tur fått från kunden. Lanier tillhandahåller den tekniska utrustningen men fungerar i övrigt som telefonopererad förmedlingscentral för utskriftsarbetet. Kunderna använder telefonen som diktafon och behöver inte skaffa vare sig avancerad kontorsutrustning eller egen skrivpersonal. Att sådant datoriserat hemarbete rimmar illa med svenska fackliga värderingar behöver väl inte tilläggas.

Passa barn och sköta kontorsjobbet samtidigt – den kombinationen används i reklamen i USA. Småbarnsmamman vid ordbehandlingsmaskinen får utskriftsdikteringen per telefon från arbetsgivarens regionalkontor.

Motorola är en storkoncern inom datorbranschen, vars dotterbolag Four-Phase System säljer en bildskärmsterminal innehållande både mikrofon och högtalare (Series 5000). Terminalen innehåller nämligen en röstbrevlåda som integrerad del tillsammans med delfunktioner som elektronisk post och touch-display. Touch-display innebär att bildskärmens yta gjorts känslig för lätt fingertoppsberöring och programmerats för att kunna tjänstgöra som extra tangentbord vars "tangenter" kan placeras på godtycklig plats på skärmen och kan ges godtyckligt funktionsinnehåll.

IBM har i en hittills ej marknadsförd bildskärmsvariant kombinerat funktionerna röstbrevlåda och touch-display. Resultatet blev funktionen "pratbubbla" (voice annotation) ungefär som i tecknade serier. Om man t ex vill kommentera en tabelluppgift i en skärmbild, så nuddar man skärmen på lämpligt ställe och genast kommer då fram symbolen pratbubbla just där man höll fingret. Genom att därefter hålla en tangent nedtryckt kan man sedan prata in sin kommentar till tabelluppgiften. När tabellen tas fram en månad senare av en annan person i en annan stad, kan den muntliga kommentaren i pratbubblan aktiveras genom att pratbubblan nuddas med fingret och en tangent tryck ned på tangentbordet.

CAI – datorstödd instruktion

First Interstate Banks program för lotsning av bankkundernas knapptryckningar är exempel på tillämpning av datorstödd instruktion: *CAI, Computer Aided Instruction.* En uppsjö tillämpningar finns redan. Sålunda har Centigram till flera leverantörer av ordbehandlingsutrustning sålt CAI-system för röstvägledning av nybörjaroperatörer. Nybörjaren får av en vänlig röst uppgift att hantera tangentbordets olika funktionstangenter och beroende på resultatet kan datorn koppla in olika träningsspår och hela tiden kommentera prestationerna.

I industrin används CAI inte bara för träningsändamål utan också i situationer där det är ytterst viktigt att operationerna utförs i en alldeles bestämd ordning: "Ta komponent A – Skruva fast A med skruv från låda B – Ta komponent C– . . ."

Syntetisk röst

Hittills beskrivna tekniker har handlat om digitaliserad röst kombinerad med datorbehandling och återgivning av ursprungsrösten i mer eller mindre förädlad och omstuvad form, dvs datorn har fungerat som en snabb och kraftfull bandspelare. Ett typexempel på denna tillämpning av röstteknologin är de snabbköpsbutiker i USA, där kassörskan snabbt drar den med streck-kod försedda varan över kassabordets glasruta varvid en laserstråle läser av koden och en högtalare säger t ex "Heinz tomatsoppa. Trettiotre cent". Här kallar datorn snabbt fram de i förväg inspelade aktuella orden från registret över alla tänkbara och behövliga ord i butiken. Visserligen finns det ett enormt antal fabrikat, varunamn, storlekar och priser, men datorer är ju bra just på att klara av stora volymer.

Nästa teknniknivå innebär att datorn uttalar ord och hela meningar som den aldrig matats med förr. Detta kallas syntetisk röstgenerering och innehåller forsknings- och utvecklingsproblem av en helt annan dignitet.

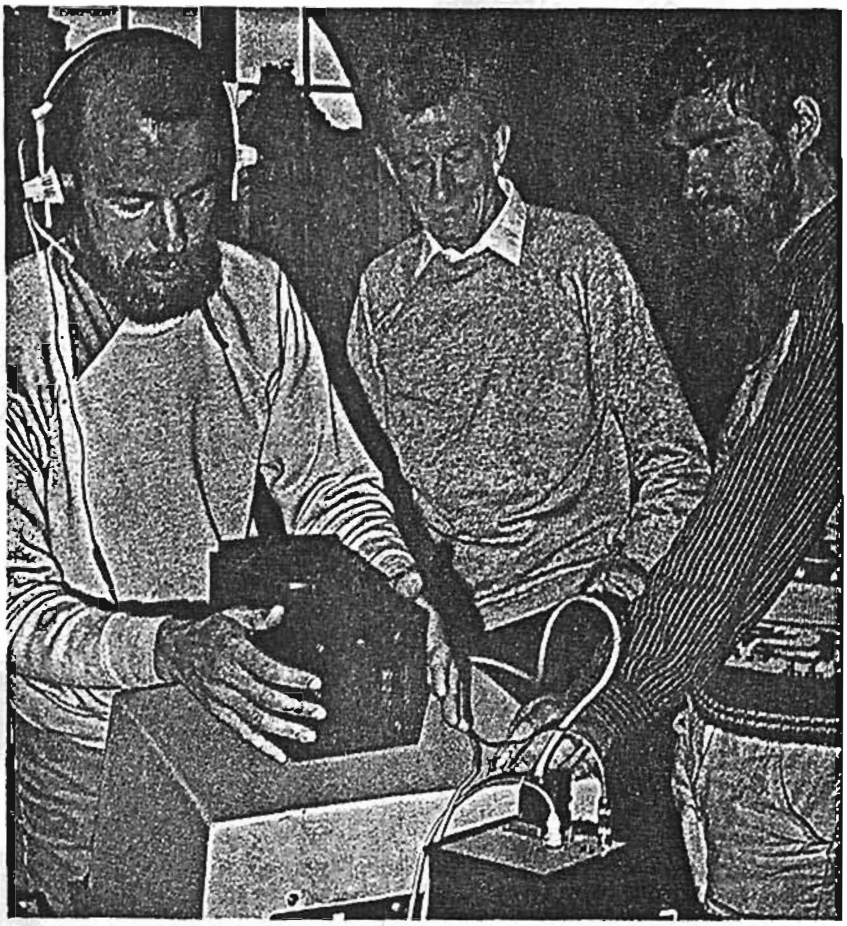
Att åstadkomma för människor förståeligt ljud från skrift kräver inte bara stor och snabb datakraft utan framför allt genuin kunskap om det verbala språkets arkitektur och människans tal- och hörselorgan och den därmed sammanhängande psykomotoriken och perceptionen. Vanligtvis använder system för syntetiskt tal fixa uttalsregler för språkets säg 10 000 vanligaste ord och bokstavskombinationer, samt i övrigt statistiskt och logiskt härledda uttalsregler för att från enskilda phonem ("ljudatomer") bygga upp sammanhängande och människoröstliknande ljud.

Genombrott nära

Sverige kan glädja sig åt att genom professor Gunnar Fant och institutionen för talöverföring på KTH ha tillgång till högsta klassens talmaskiner. Inmatad text från tangentbord (döva personer!) eller genom optisk läsning av tryckt text (blinda personer!) omvandlas automatiskt till fullt förståeligt tal.

Tillämpningarna utanför handikappområdet avgörs helt av vår egen påhittighet. Det syntetiska talet står tveklöst inför ett starkt genombrott inom en snar framtid. Av speciellt intresse är att talmaskinerna i det närmaste är oberoende av vilket språk som ska uttalas. Det kostar obetydligt mer att ha en maskin som

Vänd



Professor Gunnar Fant (i mitten) och docenterna Björn Granström och Rolf Carlson med text-till-tal-systemet (det är de svarta lådorna på och bakom terminalen).

Den svenska talmaskinen

Sverige ligger väl framme inom röstteknologin bl a genom ett text-till-tal-system som utvecklats under ledning av professor Gunnar Fant vid institutionen för talöverföring vid Tekniska högskolan, KTH, i Stockholm.

Systemet står klart att börja marknadsföras av Statsföretags dotterbolag Datavox. Samma system är f ö redan ute på marknaden: det ingår i Facits "talande skrivmaskin", visad på Data Kontor Miljö-mässan i Älvsjö för en tid sedan.

Textläsaren blir relativt billig, bl a genom att man använder komponenter från USA och Japan.

"Text-till-tal-systemet kommer att kosta mindre än 20 000 kr", berättar docent Rolf Carlson, en av professor Fants medhjälpare. "Ett 50-tal maskiner kommer att vara klara i januari 1983. Av dem är ca hälften redan sålda."

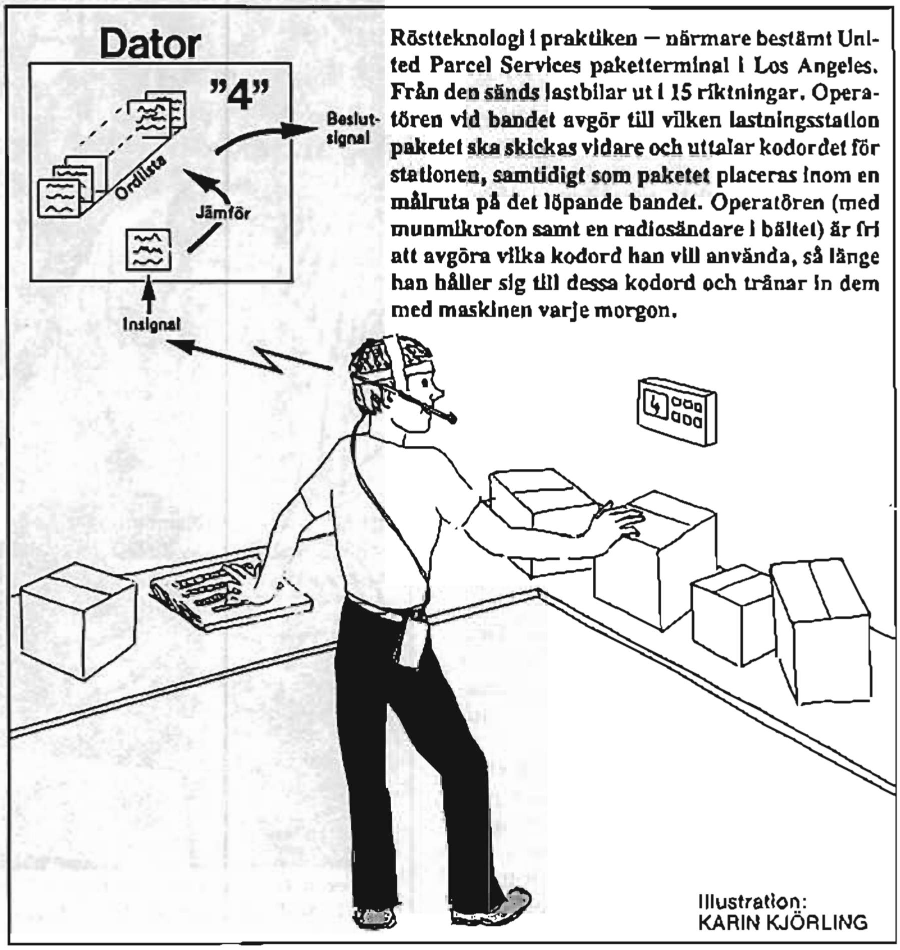
Systemet har många tillämpningar – som handikapphjälpmedel men också i olika funktioner på arbetsplatser. Vid terminalarbete kan det vara ett alternativ till bildskärm, och rösten kan tänkas ersätta text i åtskilliga andra sammanhang.

Rolf Carlson: "Vi känner ett stort tryck från människor som är intresserade av systemet, och vi tror att marknaden kommer att expandera ganska snabbt. Det finns prognoser från t ex USA som tyder på att så kan bli fallet. I så fall är det ju skojigt om Sverige kan vara med i ett tidigt skede."

1:2

Forts

Tekniken ställer krav på oss: Tala rent och tydligt!



Röstteknologi i praktiken – närmare bestämt United Parcel Services paketterminal i Los Angeles. Från den sänds lastbilar ut i 15 riktningar. Operatören vid bandet avgör till vilken lastningsstation paketet ska skickas vidare och uttalar kodordet för stationen, samtidigt som paketet placeras inom en målruta på det löpande bandet. Operatören (med munmikrofon samt en radiosändare i bältet) är fri att avgöra vilka kodord han vill använda, så länge han håller sig till dessa kodord och tränar in dem med maskinen varje morgon.

Illustration: KARIN KJÖRLING

klarar både japanska och svenska, och för begränsade applikationer är det relativt enkelt att mata maskinen med ett språk och få ett röstsvar i ett annat språk.

Det finns som sagt skäl att sätta tilltro till de rykten som säger att japanerna är i färd med att utveckla femte generationens datorer. Med kännedom om vad forskarna på KTH kan prestera ligger det nära till hands att tro på automatiska översättningsmaskiner mellan valfria språk och för både tal och skrift. Detta är inte längre en utopi.

Röstinmatning klarar 300 ord

IBM har i experiment med simulerad röstinmatning visat att en skrivmaskin som automatiskt producerar utskrift från muntlig diktamen är ett utmärkt kontorshjälpmedel även om maskinen bara kan identifiera 1 000 talade ord. Experimenten utfördes med hjälp av manuell utskriftspersonal som utom synhåll för den som dikterade skrev ned talet till en dator. Datorn rensade sedan bort alla ord som inte fanns i ordlistan på 1 000 ord och lät skrivmaskinen framför den dikterande skriva ut återstoden. Resultatet kunde t ex se ut som "xxx företag xxx köpa på torsdag xxx xxx och svara xxx". Resultatet berodde naturligtvis på om ordlistan var helt fri eller anpassad till det dikterade ämnesinnehållet, men det intressanta är att den som dikterade ansåg att den "automatiska" utskriften var fullt användbar som råutskrift. Förbättringen var obetydlig om ordlistan utökades till 5 000 ord.

Att från en läst text rätt kunna uppfatta och skriva ut 1 000 ord är enligt IBM en klart uppnåbar teknik och utvecklingsarbetet fortskrider. Tills vidare kan konstateras att kontorstillämpningarna av röstinmatning, på grund av det starkt begränsade ordförrådet och kravet på uppläsning av enskilda ord med halvsekundlång paus före nästa ord, ännu inte blivit någon framgång. Dock använder Lockheed ett system med frågeterminal för chefer, executives query terminal, som tycks fungera så bra att systemet ska byggas ut. Eftersom chefspersoner är notoriskt ovilliga att använda tangentbord har Lockheed utvecklat en terminal till vilken kommandon kan uttalas muntligt. Chefspersonen kan således utan att använda något tangentbord få fram en skärmbild eller en pappersutskrift på t ex personalkostnaderna för södra regionens civila produktion under 3:e kvartalet 1982. Det räcker att ordmenyn innehåller 300 nyckelord.

Permanentas barnsjukdomarna?

Röstteknologin är förhållandevis ny och innehåller många ofullkomligheter. På 70-talet sågs system för optisk läsning, som fordrade att vi skrev siffror på ett mycket bestämt sätt och att vi satte kryss mitt i kryssrutorna och att vi inte skrev på skrivskyddade ytor och att vi inte gjorde några veck på papperet.

På samma sätt finns det nu önskemål om att standardisera uttal av siffror och vissa nyckelord. Maskinerna vill dessutom höra långa ord för att med större säkerhet kunna avgöra vilket ord det rör sig om. Orden måste dessutom uttalas lika från gång till gång och det måste vara ordenliga pauser mellan varje ord. Vi människor vill säga "dagis" men maskinerna vill få oss att säga "barndaghem". Vi måste också bära mikrofon och hörtelefon. Samtal med arbetskamrater och musik under arbetet kan det tyvärr inte bli fråga om. Den som har svårt att prata rent och den som lätt blir trött i stämbanden får hjälp av talpedagog.

Det finns mängder av utmärkta tillämpningar för t o m dagens lågpresterande system. En varning måste dock resas mot okritisk användning och överföring av systemlösningar från föregångslandet USA. Det får inte gå så långt att språket blir någon sorts robotiska eller syntetiska eller maskinesperanto. Integritetsaspekterna måste också diskuteras, speciellt som vi vet att FBI – USAs federala polis – har kommit mycket långt och snart kan läsa röster lika bra som fingeravtryck. □

Rapporter om hög missfallsfrekvens bland bildskärmsoperatörer har under det senaste året dykt upp i USA och Kanada. Det skriver Olov Östberg, ombudsman på TCO och tidigare forskare på Arbetarskyddsstyrelsen och Högskolan i Luleå. Han gästforskar för närvarande i USA.

Kan bildskärmsarbete orsaka missfall?

□ När bildskärmarna i början av 1970-talet på allvar gjorde sitt intåg i kontoren fick Arbetarskyddsstyrelsen många oroliga frågor.

– Kommer det farlig strålning från bildskärmen?

– Skadas ögonen av att titta länge på skärmens lysande tecken?

– Kan man bli impotent av icke-joniserande strålning (mikrovåg, UV, IR)?

– Finns det risk för fosterskador?

Oron var berättigad, för det var en helt ny teknik som introducerades i arbetslivet. Visserligen hade man en TV hemma i vardagsrummet, men inte satt man åtta timmar om dagen framför TVn och inte satt man heller bara några decimeter från bildrutan. Och faktiskt förekom det joniserande röntgenstrålning av farligt hög styrka hos den första generationen TV-apparater!

Med åren dämpades oron. Myndigheter och forskningsinstitut världen över har upprepade gånger förklarat att strålningen är så svag att den knappt ens går att mäta och att den under alla omständigheter ligger mycket långt under gällande gränsvärden.

Men oron lade sig aldrig helt, och de senaste åren har oron fått ny näring.

Starr och hudutslag

Först var det några uppmärksammade fall på tidningen New York Times, där USAs journalistförbund med uppbackning av läkare utpekade bildskärmsarbetet som en bidragande orsak till att ett par personer fått katarakt (starr, linsgrumling). Någon klarhet har ännu inte nåtts.

Sedan upptäcktes i Norge och England (och nu också på flera håll i Sverige) att bildskärmsoperatörer fått svårförklarade hudutslag i ansiktet. Nu tror man sig veta att utslagen beror på den statiska elektriciteten som alltid finns runt en bildskärm. Det är denna statiska elektricitet som t ex gör att TV-rutan så fort samlar på sig damm. Arbetarskyddsstyrelsen håller sedan ett år tillbaka problemen under uppsikt och gör mätningar av de luftelektriska förhållandena runt bildskärmar.

Många missfall

Sist men inte minst: från ett flertal bildskärmsarbetsplatser i USA och Kanada har under det senaste året rapporterats onormalt stort antal graviditetsstörningar av typ missfall, fosterskadade barn och för tidigt födda barn. Ett typexempel är åklagarmyndigheten i Toronto, där 10 av 19 gravida bildskärmsoperatörer fick missfall under åren 1980–81.

Myndigheter och arbetsgivare har förklarat att det måste vara frågan om rent tillfälliga anhopningar av graviditetsstörningar. Det är normalt med en missfallsfrekvens på 15 procent (varierar från land till land), och statistiskt sett är det då också normalt med både betydligt högre och betydligt lägre missfallsfrekvens på enskilda arbetsplatser.

Ändå kvarstår oron. Det finns nu arbetsgivare som för att stilla oron gått med på att förse gravida bildskärmsoperatörer med blyförkläde till skydd mot den strålning man förklarar inte finns.

Utredningar i Kanada och USA

De kanadensiska myndigheterna har tillsatt en snabbutredning om bildskärmsarbete, och i november 1982 publicerades utredningens långtgående rekommendationer. Det konstateras att bildskärmarna förmodligen är säkra enligt i dag gällande gränsvärden, men att detta inte räcker för att stilla oron. Stora forskningsinsatser måste därför sättas in för att studera risker förknippade med lång tids exponering för »ofarliga» låga stråldoser. Till dess att problemen kartlagts bättre rekommenderas följande regler för bildskärmsarbete:

- Gravida kvinnor ska ha rätt att med bibehållen lön och andra gällande villkor övergå till bildskärmsfritt arbete.
- Arbetstiden vid bildskärm får inte överstiga fem timmar per dag.
- Bildskärmsoperatörer ska beredas en arbetspaus per timme.
- Arbetsgivaren ska svara för årlig synkontroll av operatörerna och tillhandahålla specialslipade glasögon om det behövs.

NIOSH, som är USAs motsvarighet till Arbetarskyddsstyrelsens forskningsavdelning, har också funnit missfallsrapporterna och oron vara skäl till förnyade ansträngningar. Under våren 1983 startar NIOSH därför en undersökning där graviditeter hos ca 6 000 bildskärmsoperatörer ska detaljstuderas. Samtidigt startas vid Mount Sinai Hospital en av USAs journalistförbund bekostad undersökning av missfall och ögonskador.

Olov Östberg

Flimmerfri och strålningsfri

□ En »människovänlig» bildskärm håller på att utvecklas på Chalmers i Göteborg. Den ska arbeta med flytande kristaller (som en miniräknare) i stället för katodstrålerör som dagens bildskärmar.

Fördelarna uppges bli flera. Strålningsrisken elimineras; den nya skärmen kräver bara 2 volt för att fungera – de nuvarande 17 000 volt.

Den blir skonsammare mot ögonen: flimret försvinner och den får svart text mot vit botten. ■

Teckning: Håkan Öqvist

Inom tre år hoppas forskarna kunna presentera en bara mm-tjock bildskärm av ungefär A4-storlek.

I Agneta Skarstigs arbetsrum finns sex bildskärmar. Påverkade de graviditeten?

Kvinnor över hela värden undrar:

Beror missfallen på bildskärmar?

Text: Carl von Schéele
Foto: Jukka Hallman, Reflex

Kan bildskärmar orsaka missfall och missbildningar?
Det undrar kvinnor över hela världen sedan de hört om larmrapporter från USA och Kanada.
En av dem är Agneta Skarstig, som nyligen födde ett missbildat barn.

□ Agneta Skarstig är en av de kvinnor som hört av sig till TCO sedan rapporterna från USA och Kanada blivit kända genom tidningar och ett radioprogram.

Hon arbetar vid en bildskärm på en arbetsplats i Göteborg och sitter i ett rum med sex bildskärmar. För en tid sedan födde hon två månader för tidigt ett missbildat barn, som senare dog.

– Läkarna kunde inte hitta någon uppenbar anledning till missbildningen. Till slut sa de, att missbildningen måste bero på en virusinfektion som jag hade i början av graviditeten, säger Agneta Skarstig.

Larmrapporter

Misstanken och oron över att bildskärmsarbetet kunde vara orsaken började gro inom Agneta när hon lyssnade till programmet »Radio Ellen».

Där tog man upp larmrapporterna från USA och Kanada. Från flera arbetsplatser har under det senaste året rapporterats ett onormalt stort antal graviditetsstörningar.

Ett exempel är åklagarmyndigheten i Toronto. Där fick 10 av 19 gravida kvinnor missfall under åren 1980–81.

Blyförkläden

– Det kändes som om hela världen ramlade över mig den här lördagsmorgonen när jag lyssnade till programmet, säger Agneta Skarstig.

– Jag kunde aldrig tänka mig att missbildningen kunde vara orsakad av bildskärmsarbetet. Nu undrar jag hur det egentligen är?

Agneta funderar på att skaffa barn igen, men nu vet hon inte längre om hon vågar.

Samma oro som Agneta känner är vitt utbredd i USA och Kanada. Där

Arbetsmiljöprofessorn:

Oron måste tas på allvar Nu behövs forskning!

— Jag tror inte att bildskärmar är farliga, men det finns all anledning att ta kvinnornas oro på allvar, säger Olov Östberg, som förde över debatten om bildskärmar och missbildningar/missfall till Sverige. (Foto: Agnaldo S Maciel)

– Det finns ingen anledning att tro att risken för missbildningar och missfall ökar vid bildskärmsarbete, men kvinnornas oro måste tas på allvar. Och det behövs mer forskning.

Det säger Olov Östberg, som förde över debatten om bildskärmar och missfall till Sverige.

□ Det är ett dubbelt budskap som Olov Östberg ger till de svenska kvinnor (och män!) som nu känner oro för bildskärmsarbete. Han tror inte att bildskärmar kan orsaka missfall och missbildningar, men samtidigt säger han att det behövs mer forskning.

Den låga strålning som bildskärmar avger anses ofarlig, men vi vet inte hur människan påverkas om hon under en längre tid utsätts för denna strålning.

Ett annat frågetecken är den högspänning som finns i bildskärmarna. Idag ligger den kring 20 000 volt och anses ofarlig. Men höjs spänningen till 30 000 volt blir strålningen definitivt för hög och därmed farlig.

– De första färg-TV-apparaterna som kom hade för hög strålning, så folk har rätt att vara oroliga, säger Olov Östberg.

Han gästforskar nu på NIOSH, den amerikanska motsvarigheten till Arbetarskyddsstyrelsen och är tjänstledig från TCO.

Mycket är okänt

Olov Östberg ställer själv frågan vad det finns för skäl till att tro på larmrapporterna.

– Det måste finnas en biologisk grund. Vi vet att vissa energiformer kan åstadkomma missfall, exempelvis röntgenstrålning. Men den är lika stark från rymden och självlysande klockor som från bildskärmarna, säger han.

– Mätningar från hela världen visar att skärmarna inte avger någon farlig strålning, men det kan finnas förhållanden kring bildskärmarna som inte uppmärksammats. Människor som sitter åtta timmar om dagen framför en skärm kan kanske påverkas av strålningen. Det vet vi inget om.

Mycket är också okänt när det gäller högspänningen i skärmarna. Den anses i dag ofarlig, men det finns undersökningar i andra sammanhang som visar på risker med högspänning. En svensk undersökning visar att barncancern ökar hos familjer som bor nära högspänningsledningar. En annan visar på ökad frekvens av blodcancer hos dem som arbetar med elektricitet i olika former.

Andra risker

– Det är nya fakta som var okända för ett par år sedan. Och det finns möjlighet att dra paralleller. I bildskärmar finns högspänning och att sitta nära den kan vara jämförbart med att bo 100 meter från en kraftledning. Det vet vi inget om, säger Olov Östberg.

En annan orsak kan vara att något material som används i skärmen är giftigt. Det finns ett norskt exempel på att miljögiftet PCB funnits i bildskärmsrum och orsakat hudutslag hos operatörerna.

En helt annan hypotes är att det inte är skärmen i sig som orskat missbildningarna och missfallen, utan arbetssituationen. Stress och andra psykosociala faktorer kan påverka graviditeten. En undersökning från Göteborgs universitet visar t ex att risken för missfall ökar om kvinnan har natt- eller skiftarbete.

Slutsatsen är att det behövs forskning på en mängd områden.

Begränsad arbetstid

TCO kräver t ex att morgondagens bildskärm inte ska innehålla högspänning. Då försvinner många av de här farhågorna.

– Fortsätt alltså att kräva bättre bildskärms- och arbetsmiljöer, uppmanar Olov Östberg och tillägger att det är lika viktigt att skydda både män och kvinnor från strålning.

– Ett sätt är att begränsa arbetstiden vid bildskärmen, men då ska den vara avstängd när den inte används, säger Olov Östberg. ■

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har myndigheter och arbetsgivare satt in åtgärder för att lugna kvinnorna, trots att den officiella inställningen är att anhopningen av graviditetsstörningar måste bero på tillfälligheter.

En del arbetsgivare förser nu gravida kvinnor med blyförkläden till skydd mot strålningen.

Rekommendation

I Kanada tillsatte myndigheterna en snabbutredning. I november 1982 publicerades utredningens långtgående rekommendationer. Där konstaterades att bildskärmarna förmodligen är ofarliga, men att det inte räcker för att stilla oron. Därför behövs forskning för att t ex studera riskerna med de låga stråldoser som bildskärmar avger och som hittills ansetts vara ofarliga.

Till dess att problemen är kartlagda rekommenderade de kanadensiska myndigheterna bl a att gravida kvinnor ska ha rätt att få bildskärmsfritt arbete med bibehållen lön och andra gällande villkor.

– Det är en bra rekommendation om den går att genomföra, säger Agneta Skarstig.

– Men jag vet inte hur det skulle lösas på vår arbetsplats. Här är det väldigt svårt att få ett arbete utan kontakt med bildskärmar. Dessutom, i mitt fall skedde missbildningen mycket tidigt. När en missbildning sker så tidigt är det inte alltid kvinnan vet att hon är gravid och då hjälper inte en sådan rekommendation, säger Agneta Skarstig. ■

Arbeta borta bra

GEORGE ORWELL skrev år 1948 framtidsromanen 1984. Där låter han huvudpersonen Winston Smith lockas i fällan att ansluta sig till en motståndsrörelse fingerad av maktapparaten. Det hela slutar med att Winston blir grundligt torterad och hjärntvättad, så till den grad att han till slut uppriktigt älskar maktapparaten, förkroppsligad i storebror.

1984 närmar sig – på gott och ont...

OLOV ÖSTBERG, 44, gästforskar för närvarande på NIOSH i Ohio, motsvarigheten till Arbetarskyddsstyrelsen i Sverige. Annars arbetar han med arbetsmiljöfrågor på TCO, speciellt i samband med datorisering. Han har varit professor i teknisk pyskologi 1975–80 på Tekniska Högskolan i Luleå, arbetat på Arbetarskyddsstyrelsen och KF med arbetsmiljöfrågor. Från start är han ingenjör med inriktning på teoretisk fysik och är dessutom utbildad psykolog och ergonom.

Winston besöker en av chefsinfiltratörerna i dennes hem. Här får vi världens första beskrivning av datoriserat hemarbete utfört genom direktdiktering till röstskrivaren 'speakwrite' på det supereffektiva nyspråket 'newspeak'. Boken är fylld av sådana framtidsbeskrivningar. Faktiskt finns det nu en uppsjö artiklar och till och med böcker som diskuterar i vilken utsträckning Orwells förutsägelser gått i uppfyllelse.

Boken 1984 innehåller totalt 137 förutsägelser. År 1972 hade 80 av dem gått i uppfyllelse (t ex om persondatabanker) och 1978 hade 100 gått i uppfyllelse (t ex om provrörsbarn). Tidningen The Futurist har oroat sig över den snabba uppfyllelsetakten, ty 1984 ger ju inte någon särskilt positiv bild av framtiden. Tidningen har därför uppmanat läsekretsen att skicka in förslag över hur vi ska kunna förhindra att teknikutvecklingen leds in i sådana banor att alla Orwells 137 förutsägelser hinner bli praktisk verklighet år 1984.

Är det vettigt

Här hemma har Datainspektionen lagt ned omfattande arbete på att förhindra att databanker med personinformation missbrukas av "storebror". Detta är bra, men man kan nog fråga sig om det är vettigt att Datainspektionen kan sätta stopp för myndigheternas möjligheter att genom registersamkörning spåra upp skattesmitare och andra ekonomiska brottslingar, speciellt som Datainspektionen inte lägger sig i att näringslivet, genom datateknikens utveckling, fått möjligheter att i värsta storebrorsstil detaljövervaka och styra enskilda arbetstagare.

I USA är denna tendens förstärkt. President Reagan genomdriver för närvarande en kraftig förstärkning av marknadskrafternas spelrum på de federala myndigheternas bekostnad. Och samtidigt hyllar han dataindustrins nydaningar.

Fin träning

Men många tycker nog att han gick lite för långt, när han för en månad sedan besökte en hall för videospel, där ungdomar matade mynt i spelautomater för några minuters frenetisk krigslek av typ "skjuta ned invaderande rymdskepp". President Reagan uttalade framför TV-kamerorna att dessa videospel gav fin träning inför morgondagens uppgifter i det högteknologiska samhället, men tillade försiktigtvis att ungdomarna inte fick glömma att läsa sina läxor. Många av videospelen är minst sagt betänksamma, eller vad sägs om spelet där det gäller att sätta sig in i en pilots situation och precisionsbomba markmål. Detta spel är en kopia av den simulator flygvapenpiloterna tränas i. Ett annat spel gäller den från USAs inbördeskrig kände General Custor. Uppgiften består i att få den uniformsklädde generalen att springa ikapp, stänga in och våldta en naken indianflicka. Visserligen får man själv försöka föreställa sig slutscenen, men spelet är ändå så osmakligt att det förbjudits i ett par av USAs delstater.

Röstbehandling

Orwells förutsägelse om röststyrning av datorer är sedan länge en verklighet och det finns en livaktig intresseorganisation vid namn "Amerikanska Sällskapet för Inmatning/utmatning av Röst". Datoriserad röstbehandling och röstutmatning fungerar alldeles utmärkt och en tankeväckande tillämpning är att flera amerikanska lokala radiostationer kunnat bortrationalisera väderrapportörerna. En vädercentral skickar per telex basuppgifter till radiostationerna. Där redigeras meddelandena, lokalanpassas och skrivs in till stationens dator. Vid lämpliga tillfällen trycker sedan sändningsledaren på en knapp och låter en datorröst prata fram det maskinskrivna meddelandet.

Bara 300 ord

Röstinmatningen är lite mer problematisk. Datorn har svårt att uppfatta ord uttalade av olika personer och kan för en person bara klara av cirka 150 ord. Alphonse Chapanis, professor i psykologi vid John Hopkinsuniversitetet har visat att så gott som samtliga industriarbeten i dag kan utföras med hjälp av kommandon omfattande högst 300 ord. Morgondagens industriarbetare/maskinoperatör skulle således kunna tränas att prata ett datorspråk bestående av endast 300 ord. Men vilka 300 ord? Uppenbarligen måste näringslivet komma överens om en standard och därför arbetar USAs standardiseringskommission med att framställa en språk- och röststandard för datorkommunikation. Orwells "nyspråk"?

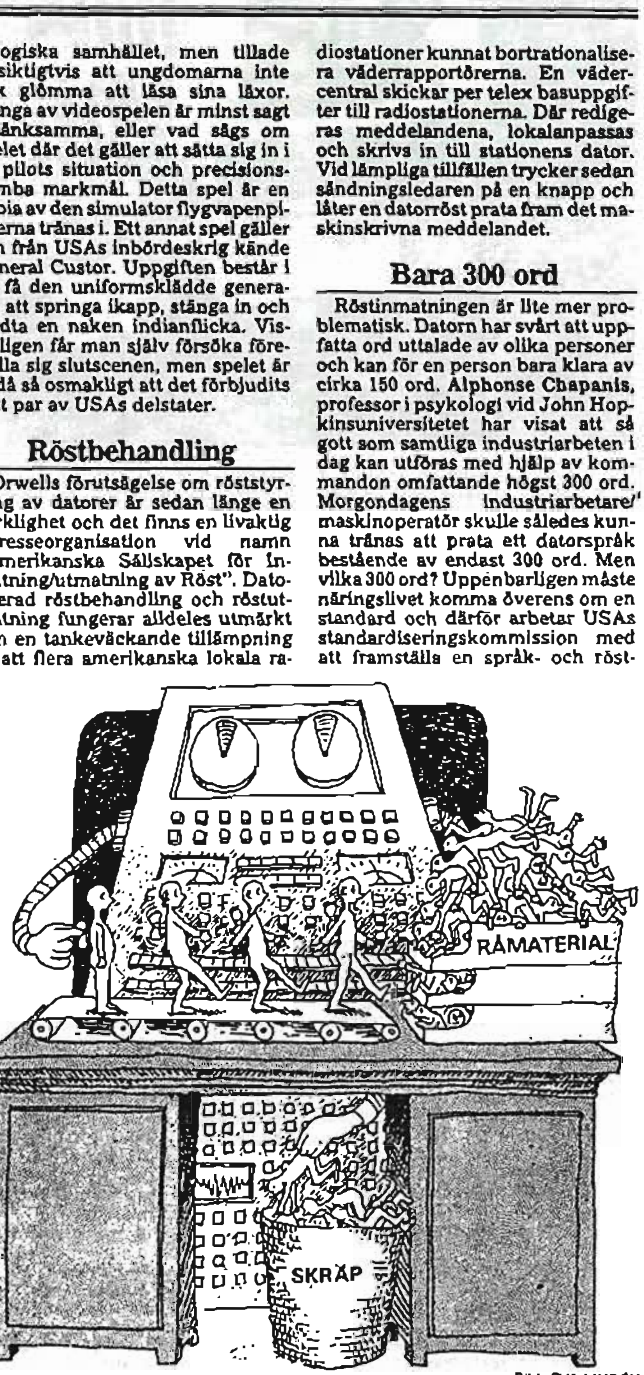

Bild: EVA LINDÉN

Industrirobotar

Röst- och språkstandardisering kan ses som en vidareutveckling av rationaliseringsrörelsens MTM-teknik. Det är numera inte så ofta man ser en rationaliseringsingenjör med stoppur och skrivbräda i färd med att kartlägga minsta handrörelse och verktygsanvändning. Det var väl inte utan orsak han kunde få höra att han uppträdde som "verkmästare för företagets sekundförråd" och tycktes mena att "det gäller att ta vara på varje sekund-dygnet innehåller bara 86 400 sekunder". MTM-tekniken har emellertid inte spelat ut sin roll utan har snarare finslipats, datoriserats och börjat tillämpas inom nya rationaliseringsområden. Ett sådant område gäller industrirobotar och sedan ett par år tillbaka används i USA ett specialgjort MTM-system för robotar (RTM) med vars hjälp produktionsteknikerna kan programmera robotar och därmed operatörerna till maximal effektivitet.

Förfinade metoder

Genom förfinade mätmetoder har det också blivit möjligt att utföra prestationsmätningar för stora tjänstemannagrupper inom bland annat kontorsyrkesområdet. Sveriges Rationaliseringsförbund åtnjuter här stor internationell respekt för sitt ISA-system. Det är mot denna bakgrund man ska se att SAF-kongressen 1980 biföll Verkstadsföreningens motion.

"att SAF i arbete med förbunden skall vidta kraftfulla åtgärder för att öka insatserna för systematiska rationaliseringsåtgärder på kontor samt för ökad tillämpning av premielön på kontor".

Hur det kan gå till i USA illustreras av satsningen vid Harper-Grace sjukhusen i Detroit, som sysselsätter 5 400 personer (läkare oräknade) och har 1 400 bäddplatser. Här har sjukhusledningen under de senaste två åren anställt Mike Garrett och 41 andra rationaliseringsexperter för att effektivisera sjukhusdriften.

"Kvalitetscirklar"

Mike berättar att basen för verksamheten är ett system för övervakning av arbetsprestation och att man nu har prestationsdata som är minst lika exakta som för traditionellt arbete inom verkstadsindustrin. Ett viktigt komplement till prestationsövervakningen är ett speciellt system för uppfångning av problem och spridning av rationaliseringsavdelningens lösningsförslag. Detta system sägs utgöra ett nätverk av "kvalitetscirklar", men med den viktiga inskränkningen att personalpolitik, psykosocial arbetsmiljö och andra medbestämmandefrågor är portförbjudna. Det är således enbart verksamhetseffektivitet och inte mänskliga kvaliteter som diskuteras.

Ingen fackförening

Ett utslag av sjukhusens rationaliseringsarbete är förslaget att ändra mat- och medicineringsrutinerna så att detta arbete skulle kunna klaras av mellan klockan 08.00 och 18.00. Arbetet skulle då kunna utföras

men hemma bäst?

utan skiftgång men med en arbetsdag på 10 timmar. Till rationaliseringsavdelningens förtrytelse har emellertid sjukvårdspersonalen en facklig organisation, vilket inte är vanligt i USA, och denna tills vidare satt stopp för rationaliseringen. Personalen som svarar för sjukhusets interna transporter, lokalvård och läkarsekreterarfunktioner har emellertid ingen fackförening, så inom dessa områden har rationaliseringsströvandena inte mött något organiserat motstånd. Resultatet har blivit att personal har sagts upp och istället har konsultföretag kontrakterats för att utföra arbetet efter rationaliseringsavdelningens detaljinstruktioner.

Löpande band

Det utkontrakterade läkarsekreterararbetet sköts av specialföretaget **Detroit Medical Cooperativ Services**, som med en personalstyrka på 50 personer ger dygnet-runt service till 1 500 läkare fördelade på fem separata sjukhus.

Patientjournaler skrivs bokstavligt talat på löpande band och mot prestationslön. Dikteringarna kommer över det reguljära telefonnätet och läkarna kan ringa från sjukhuset, privatmottagningen eller bostaden. På skrivcentralen finns ca 100 automatiska kasettbandspelare som automatiskt spottar fram miniatyrkassetter efter varje avslutad diktamen. Utskrift garanteras inom tre timmar. Ordbehandlingsoperatörerna har en relativt låg grundlön och får bonus för varje extra skrivrad utöver minimikravet 1 050 rader per arbetsskift.

Ett tekniskt mer avancerat system för läkarsekreterare finns hos **Medical Records Corporation** med filialer över hela USA. På sjukhus som köper utskriftstjänster finns evighetsbandspelare som löpande tar emot dikteringarna. Skrivcentralen har permanent telefonförbindelse med evighetsbandspelarna och betar successivt av dikteringarna varefter journalerna kommer fram på printers, strategiskt utplacerade på sjukhusavdelningarna. Genom samarbete med **Lanier Business Products** har skrivcentralen byggt upp ett system så att skrivcentralen kan skicka ut telefondikteringar till ledig utskriftskapacitet över hela USA och t ex utnyttja tidskillnader mellan öst- och västkusten för att slippa betala skiftersättning till operatörerna. I den nu pågående utbyggnaden har det blivit möjligt för skrivcentraler att i första skedet låta duktiga operatörer arbeta hemma i samband med graviditeter o s v.

Hemmafru-jobb

I fullt utbyggt skick kan skrivcentralen laborera med ett helt nätverk av skrivarbetsvilliga hemmafruar. Laniers **Tony Prano** förklarar att principen bakom detta system med telebemanning (telestaffing, se illustrationen) är att ett företag som behöver utskriftsarbete kan använda det vanliga telefonnätet för slussning av diktamen och utskrifter och slipper hålla sig med anställd personal och sparar in lokalkostnader. De hemarbetande kvinnorna har inga arbetsresor och slipper klä upp sig samt kan parallellt med arbetet sköta hemmet och

Now Lanier lets top word processing people work on your staff.

Even if they can't work in your office.

barnen. För företaget är det också psykologiskt viktigt att veta att man bara betalar för utfört arbete och således "slipper betala lön för den tid anställda berättar roliga historier för varandra". Föutom Medical Records Corporation har Lanier ett 20-tal *försöksverksamheter i drift.*

Snabb utveckling

De första signalerna om datoriserat hemarbete redovisades i TCO-skriften **På Vinst och Förlust – rapport om datorisering i USA.** En uppföljning och systematisk genomgång av pågående försök finns i Arbetslivscentrums skrift **Långt Borta och Nära – om distansarbete på kontorsområdet.** Men utvecklingen går mycket fort och vad som nu skulle behövas är en ordentlig beskrivning av den i USA mycket viktiga nyordningen, att högavlönade och högutbildade tjänstemän/handläggare/tekniker på egen hand och med egna medel skaffa sig persondatorer, hemdatorer och resedatorer för att utöka sin prestationsförmåga. Illustrationen med den sovande hustrun och den idogt arbetande karriärmannen härstammar från **Vincent Giuliano**, som är framtidsstrateg på det våldsomspännande datorkonsultföretaget A D Little. Han har analyserat arbetsvanorna hos karriärarbetarna i USA och kommit fram till att de utför informationsarbete motsvarande 1 000 000 000 000 kronor per år.

"Piratdatorer"

Arbetet utförs hos kunder, i telefonhytter, på restauranger, i hemmet osv. A D Little har tidigare utfört omfattande projekt för att hjälpa storföretag lägga upp strategier för intern datorisering. Nu har man återinkallats för att hjälpa till att reda upp situationen med att enskilda anställda "piratdatoriserat", vilket därmed sprängt tidigare uppgjorda planer.

Ett sätt att komma tillrätta med anarkin och piratdatoriseringen redovisas av Cullinet, som är världens största företag för utveckling av programvara. Cullinet har börjat utveckla programvara som gör det möjligt för företagen få ordning i leden genom att knyta ihop alla persondatorer i ett nätverk. Samtidigt får de enskilda persondatoranvändarna möjlighet att både kommunicera med varandra och med företagets centrala databanker. Detta kommer att revolutionera hela världens datoranvändning och får samtidigt vittgående konsekvenser för den kvalificerade personalens arbetsmönster.

Från Indien

John Cullinane, grundaren av Cullinet, förebådar att det nya arbetsmönstret på ett radikalt sätt också kommer att slå igenom inom det egna företaget. En aspekt av det nya arbetssättet skulle kunna vara att Cullinet köper konsulttjänster av sina nuvarande anställda, som således skulle bli ensamföretagare. En mer hissnande bild är användningen av systemare och programerare från andra delar av världen. I dag betalar Cullinet årslöner på 60 000 dollar för den mest kvalificerade personalen, men har blivit erbjuden att från Indien få tillgång till ett mycket stort antal personer med minst lika höga kvalifikationer men till en kostnad av endast 6 000 dollar per år. Cullinet har tills vidare tackat nej men avser att ompröva beslutet när Indien om något år förmodas ha gett upp sin protektionistiska handelspolitik inom dataområdet. Även svenska datorföretag har visat intresse för att anlita programmerare i lämpliga u-länder, som tvärtemot vår allmänna uppfattning har god tillgång till kvalificerad datapersonal.

Inom området artificiell intelligens (AI) börjar det för övrigt växa fram en ny typ av programmerare och systemare. AI-området kännetecknas av avancerad användning av kraftfulla datorer. Tillämpningarna handlar ofta om att ersätta kvalificerade mänskliga arbetsinsatser med halvkvalificerad arbetskraft uppbackad av expertstöd från datorer. Läkarassistenter kan med hjälp av AI-systemen göra kvalificerade sjukdomsdiagnoser som annars endast en specialistläkare kan göra. Geologassistenter kan med AI-stöd i specifica situationer ersätta geologisk expertis, programmeringsassistenter kan med AI-stöd utföra kvalificerad programmering, o s v.

Stjäl kunskap

Datorföretaget **Digital Equipment** har med stor framgång börjat använda AI-system inom sin egna verksamhet. **Gene Strenger** på Digitals AI-sektion har en mycket aktiv och ständigt växande stab av specialutbildade programmerare och systemare som utför internt konsultarbete för olika produktionsavdelningar. Denna nya personaltyp benämns "kunskapsingenjörer" (knowledge engieers). Det är ett välfunnet befattningsnamn, ty kunskapsingenjörernas uppgifter är att studera andra experters arbetsmetoder och överföra detta till ett datorsystem. Kunskapsingenjörernas verksamhet har varit så framgångsrik att ledningen för Digital Equipment chockats av ett starkt datoriseringsmotstånd från de anställda. Kunskapsingenjörerna stjäl deras yrkeskunskap och bygger datoriserade expertsystem.

"Känsloingenjörer"

Kanske skulle Sverige kunna utveckla kompletteringssystem som gör att de som blivit bestulna på meningsfull yrkeskunskap ändå kan känna sig nyttiga. Hur skulle det gå till? Låt oss konsultera Ingenjörsvetenskapsakademiens skrift nr 221 om **Teknik att satsa på.** Skriften innehåller en rad förslag över hur svenskt kunnande skulle kunna omsättas i exporterbara produkter och system. På sidan 120 föreslås en ordentlig satsning på en ny typ av ingenjörskunnande. Inte på kunskapsingenjörer men väl på "känsloingenjörer" och på teknik (emotional engineering) som ger de anställda en **känsla** av att bidraga till företagets produktionsresultat även under mycket långa perioder av ren sysslolöshet.

Den som vill spekulera i en fortsättning på livet efter 1984 behöver tydligen inte göra studieresor till USA. Tankestoff finns uppenbarligen på närmare håll. Borta bra men hemma bäst?

OLOV ÖSTBERG

THE AUTOMATED OFFICE: A DESCRIPTION AND SOME HUMAN FACTORS DESIGN CONSIDERATIONS

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ABSTRACT

This report is a description of office automation and some research that has been performed to evaluate the new technology from a human factors or ergonomics point of view. Following an overview of the technological development, a task taxonomy for office work is proposed. There are four major types of office interactions: Transactions, Documents, Telephoning, and Meetings. These interactions may be further divided into ten office tasks. The types of interactions are discussed in terms of technological developments and human factors/ergonomics problems. Several ergonomics problems are mentioned: workplace design, human-computer interaction, changes in job structure, training of office workers, and resistance to innovation. In addition, several problems relating to the design of human/machine interface are discussed:

- computer aided design and manufacturing,
- computer conferencing,
- data base systems,
- electronic mail,
- electronic filing,
- graphic input devices,
- local area networks,
- videoconferencing,
- visual display terminals,
- voice recognition,
- voice store and forward.

Several suggestions for human factors/ergonomics research are proposed.

AUTOMATED OFFICE

1. INTRODUCTION

A person observing an office today would see many of the same things that happened 15 years ago. There are people reading, writing, handling mail, talking to one another face to face and on the telephone, typing, operating calculators, dictating, and filing. But there is one major change; a surprising number of people are now working with visual display terminals (VDTs). The operators are managers and clerks and by using VDTs, an astonishing variety of tasks can be accomplished. The emergence of VDTs is symbolic for the shift from traditional ways of doing office work based mainly on paper to reliance on terminals that are linked to a computer and to data bases. Today there are about 10 million VDTs throughout the U.S. and the number is rapidly increasing. By 1990, between 40% and 50% of all American workers will be making daily use of electronic terminal equipment. Some 38 million terminal-based workstations of various kinds will then be installed in offices, factories, and schools. There may also be 34 million home terminals and about 7 million portable terminals (Giuliano, 1982). By the year 2000, there will be much more new technology for handling information. Much of this technology cannot be foreseen but the predictions indicate that more powerful machinery will be available at lower costs.

During the 1960s and early 1970s, most computers were mainframe machines handled by a few specialists and used primarily for accounting functions such as billing, inventory, and payroll. Today, the manager, the knowledge worker, and the clerk interact with computers, dealing with input, output, and memory media. Replacing or complementing the mainframe computer are several compact personal computers which may be integrated into a large information network that serves different workplaces in the office. These networks, often refered to as local area networks (LAN) will play a major role in the future office. A local area network can distribute information throughout the office. It can integrate several functions such as word processing, electronic mail, electronic filing, administrative support, telephone messaging, and so forth. A high degree of technological complexity is thereby introduced in the workplace.

Table 1. Some Milestones in the Development of Office Automation

1968	Integrated circuits used in hardware
1970	Word processing introduced
1972	Electronic typewriters introduced
1974	VDT's commonly used for wordprocessing
1978	Intelligent fiberoptics printers
1980	Merging of wordprocessing and dataprocessing
	Local area networks
1981	Xerox Star executive workstation introduced
1982	Personal computers common
	Systems integration with voice, data, and video
1983	16-bit portable, personal computer with complete wordprocessing

Expected Technological Developments

Office automation is a continuing process and new applications and technology are appearing on the market on a regular basis. Table 1 lists some of the major advances in office automation during the last 15 years. A summary of some of the more recent innovations that are believed to have an impact on future office systems is presented below.

1. Development of integrated local area networks with the capability of processing voice, video, and data in digital form. Most companies will have several networks, including telephone (PABX) centered technology and computer centered networks.

2. Use of lightweight portable workstations such as Grid Systems Compass Computer, Teleram 3000, and Tandy Corporation Model 100.

3. Integration of personal computers and word processing, such as Fortune Systems 32:16. This product combines a Wang word processor with a 16-bit processor and has networking capabilities. These products support color graphics, different local area networks, several operating systems, and application packages such as computer aided design and manufacturing (CAD/CAM).

4. Use of high-resolution display screens to accommodate CAD/CAM, full page viewing and partitioning of the screen, such as presently used in the Xerox Star and Apple Lisa systems.

5. Integration of low cost powerful color graphics, such as Intecolor Corporation's Touch Screen System. A 16 or 32 bit processor may be used to produce graphics and there are several optional output modes including color slides and color laser prints.

6. Low cost micrographics and optical disc storage systems. One of the leaders in the market is Mnemos, which manufactures a micrographic-type image storage with 6,000 images (pages) per plastic disc. There are already products which may be sold for less than $5,000. The personal computer market is one of the prime targets for this innovation.

7. Use of voice recognition and voice store and forward systems. These systems will incorporate voice and typed messages, and may be accessed from any telephone or local area network.

8. Development of videotext and teletext applications in major nation-wide networks. Teleterminals that connect the telephone to a TV screen and visualize information from remote data bases or other types of available services, such as airline schedules have been developed by several manufacturers.

9. Use of teleconferencing to combine audio, video, and computer based graphics and texts.

All of these tools are fairly easy to understand from a technological point of view. However, their future use by management and clerical workers is still largely unknown. Much seems to depend on the so called user friendliness of the systems. In many people's minds, user friendliness will decide which systems will sell and which won't. (A Darwinistic approach to the survival of the friendliest has been quoted as a suitable model for describing the future struggle between different systems, Sullivan, 1983). Unfortunately, there are yet several unknown factors, for example, the technological offerings and marketing strategies by IBM and AT&T.

From a human factors point of view, several methodologies are available for designing systems. In fact, many of the results obtained from human factors research on human-computer interaction may be useful in resolving the questions regarding user-friendliness. Most experts outside the human factors area are yet unaware of this information which will be referred to below.

Changes in the Workforce

Paralleling the advances in computer technology are changes in the composition of the work force. In the beginning of the century, blue collar workers, service workers, and farm workers accounted for 83% of the work force and white collar workers for 17%. Farmers, who by the turn of the century constituted more than 1/3 of the total labor force, now account for 3% of the labor force. In fact, there are more people employed full time in our universities than in agriculture (Naisbitt, 1982). The real increase has been in the information occupations. In 1950, only about 17% worked in information jobs; now almost 60% work with information as programmers, teachers, clerks, secretaries, accountants, stockbrokers, managers, insurance agents, bureaucrats, lawyers, bankers, and technicians.

Figure 1 shows that following clerical workers, the second largest classification is professional and technical workers. This is in accordance with the needs of the information society, in which knowledge is the crucial ingredient. The demand for professional workers has increased substantially since 1960, even more dramatically than for clerical workers.

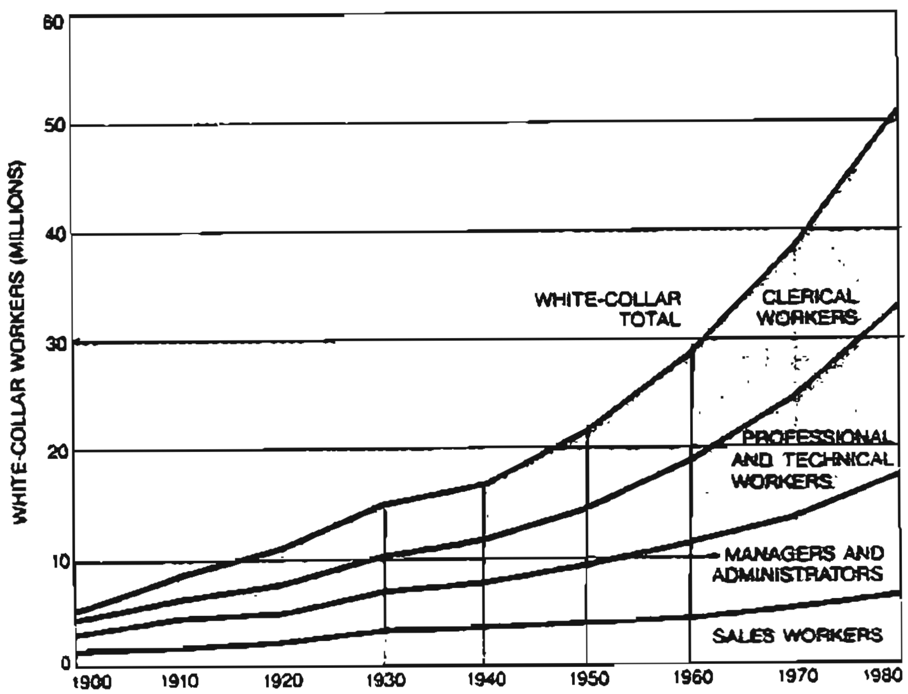

Figure 1. Composition of white collar workers in the U.S. (Source: Giuliano, 1982)

Birch (1981) pointed out that of the 19 million new jobs created in the United States during the 1970s, only 11% were in the goods-producing sector as a whole. Almost 90%, or 17 million new jobs, were not in the goods-producing sector. Birch concluded that: "we are working ourselves out of the manufacturing business and into the thinking business". Naisbitt (1982) observed that the restructuring of the U.S. from an industrial to an information society will easily be as profound as the shift from the agricultural society to the industrial society. But there is one important difference. While the shift from agriculture to an industrial society took one hundred years, the restructuring from an industrial to an information society will take only two decades.

Changes are occurring so rapidly that there is no time to react; instead we must anticipate the future. This report is a description of the present and the future of office automation and the research that has been performed to evaluate the new technology from an ergonomics or human factors point of view.

2. OFFICE PRODUCTIVITY

Office automation would probably not be considered were it not for the gains in productivity that might be achieved. Traditionally, the average capital investment per office employee has been fairly low compared to the industrial working environment. According to Zisman (1979), the average capital investment per office employee will increase from $2000 in 1979 to $10,000 by 1985. The total market for office systems technology could thereby reach $100 billion by the late 1980s. Presently, communication costs are declining at 11% per year, computer logic costs by 25%, and computer memory costs by 40% per year (Gupta, 1982). Expressed as percentages, these numbers may not be particularly impressive, but if the decreases are accumulated over several years, the change is astounding; if the development of the automotive industry were to parallel the advances in the computer industry during the last 25 years, a Rolls Royce would cost 50¢ and deliver 15 million miles to the gallon (Madnick, 1982).

It is generally believed that these advances, once fully applied to restructuring office work, will reduce costs significantly. (The present costs are indeed quite high; for example, the average cost to send a business letter exceeds $7). Booz, Allen, and Hamilton (1980) concluded that managers and other professionals can achieve productivity gains of an "opportunity value" of over $100 billion by 1985 if they make full use of automated office tools. Furthermore, they stated that 15% of a professional's time can be saved through office automation. The total 1979 office costs in the U.S. were $800 billion with only 27% ($215 billion) spent on clerical work, while 73% ($585 billion) was spent on managers and professionals and their activities. A 15% savings for professionals and managers is, therefore, worth more than a 40% savings in clerical functions. Accordingly, the future interest in office automation may concentrate more on management (Avedon, 1983), see Figure 2. Likewise, the pay-off for installing a word processing system to aid secretarial work might be fairly marginal, since the average secretary usually absorbs less than 10% of the office salary payments and spends only about 20% of the time typing (Billadeau, 1982); it may seem ironic that word-processing has been the major application of office automation.

Presently, there are great difficulties in assessing the impact of office automation on productivity; there simply has not been enough research. There are several very basic issues, for example:

Figure 2. Future innovations in the office might concentrate on aiding management and executives. (Source: New Yorker, 14 Feb. 1983)

- What is office productivity?
- How does office productivity differ from factory productivity?
- Can office productivity be measured?
- What are the main benefits that may be expected from office automation?

Measures of productivity have traditionally focused on manufacturing (Kettinger, 1983). In this , productivity is generally defined as the ratio of inputs to outputs over time. For office work, there are questions regarding how to quantity both the input and the output. Typically, input measures have included only portions of labor costs and disregarded additional costs, such as facilities, equipment, training and orientation of staff, planning, and so forth (Kettinger, 1983). Similarly, in order to quantify the outputs of the office, a wide variety of products and services must first be recognized. Some of these products are straight-forward and easy to measure, for example, an invoice, a payroll, and a list of accounts. Management tasks, however, are difficult to define. More than half of a manager's time is spent communicating on the telephone or face-to-face. Although the time necessary for such communication is easy to measure, it is more difficult to quantify the social benefit of such communications.

Perhaps when new tools for office automation become more firmly established, it will be easier to quantify output. These new tools may restructure existing tasks making a comparison difficult. But since most of the information (voice, video, and data) in the automated office will be stored and transferred in terms of digital bits, it might be possible to develop productivity measures based on number of bits (Kitahara, 1982).

Lacking adequate measures of productivity, there are still several tasks that can be improved. Bair (1979) identified five types of measures that may result in cost reductions:

1. Media transformation reduction. Decrease the number of times information is transformed between media (e.g., from speaking to writing to keying). For example, an insurance sales agent might input customer information in the field using a lightweight portable terminal which later can be attached to a telephone to transfer information to the home office. Time consuming (and boring) data input work at the home office may thereby be reduced.
2. Reduction of "echoing functions". Decrease unproductive activities such as misdialed telephone numbers, busy signals, parties out of office, travelling to and from meetings, or waiting for late arrivals.
3. Improved timing. Labor savings can result from reducing turn around time and establishing more control over the scheduling of activities.
4. Computer control. Computers may be used to supervise employees. Thus, the span of control can be increased and the number of supervisors and levels of management decreased.

5. Automation. Replacement of manual processes by machine processes, thus eliminating much of the required labor; for example, replacing bank tellers with automatic teller machines.

Each of these proposed methods for increasing productivity has profound social and human factors implications. Depending upon the design of the new tasks, there might be positive or negative outcomes from both an ergonomics and a job satisfaction point of view. These issues need to be addressed in research in order to come up with user models to guide the systems designer in developing jobs and tasks. Such models, which incorporate both human factors and technological issues are commonly used by the U.S. Department of Defense to evaluate complex weapon systems (Meister, 1971; Williams, 1982). Research is needed to develop systems models for civilian use. With these models, it will be possible to address a variety of issues, such as productivity and job satisfaction, at an early stage before the system has been procured and installed. The systems approach to design is explained in more detail in the next section.

3. SYSTEMS DESIGN OF THE AUTOMATED OFFICE

A systems approach involves a process of planning ahead to anticipate problems. Traditionally, the systems approach to planning has been used by military organizations. Prior to the introduction of systems planning models, equipment was designed and built and only then was consideration given to the tasks, skills, job satisfaction, potential errors, and training of operators. With increasing complexity of civilian as well as military systems, this is no longer feasible (Kidd and Van Cott, 1972; Bailey, 1982; Harris, 1982).

In most cases, the design of a system should be the result of teamwork. The Ergonomist or Human Factors Engineer may function in an advisory capacity or respond to specific requests for information which influence design decisions. For example, the ergonomist might provide advice for determining which tasks should be allocated to various employees and which should be allocated to computers and automated devices, how maintenance should be organized, and how procedures for training and selection of operators should be established.

For the planning and purchase of novel office equipment, five major steps may be suggested: Systems Definition, Task Analysis, Documentation and Discussion, Equipment Selection, and Implementation and Evaluation, see Figure 3. We would like to emphasize that the suggested methodology is merely an example; further research is necessary to refine the systems design methodology.

Systems Definition

Systems objectives should be clearly identified before the design of the system begins. Systems objectives are usually stated in general terms in order not to be affected by changes in technological design or in performance requirements. Examples of systems objectives are: development of a computer integrated manufacturing process for a specific product, implementation of a database management system, or introduction of a local area network.

After the objectives have been identified, it is necessary to develop a set of performance specifications which usually include both performance requirements and constraints. The requirements help to identify the purpose of the system. The constraints, on the other hand, are limits within which the system must be developed, for example: implement a local area network that ties together the offices in Washington, D.C. and Houston; furthermore, it should provide terminals for X individuals and produce Y bits of information per day.

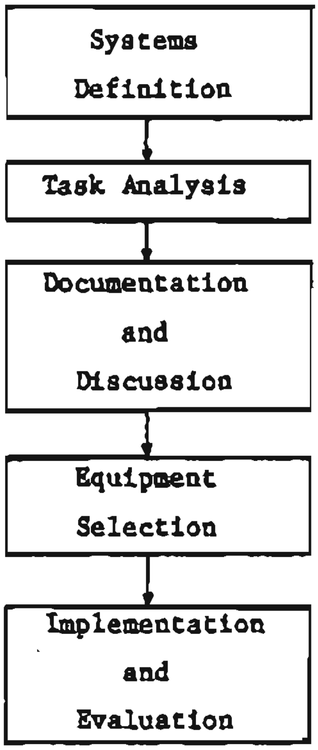

Figure 3. Example of systems approach to the design of an automated office.

It should be noted that many designers first develop a system and then proceed to identify objectives and performance specifications. This approach creates two problems; the first and most obvious is that systems objectives are defined to fit a preconceived design; the second is that a premature design discourages the development of design alternatives; it is usually best to develop several alternative designs before selecting the final alternative.

Generally a designer must consider several alternative systems in order to identify the one with the highest potential for job satisfaction and productivity. Consider, for example, that one design alternative may require only clerical personnel, a second may require only management personnel, and a third may require both clerical and management personnel. A designer must then consider the availability of the different groups of people, the available training resources, the general types of work to be done, and so forth, before making an informed decision on the alternative that will most likely lead to the best system performance. An analysis of users' needs is also important so that the new system can be designed to support all users as fully as possible.

The value or worth of a system is normally judged by several criteria which are not necessary compatible. In the case of automobiles, for example, speed and economy of operation are, in general, incompatible. Fast, high performance cars are usually more costly to operate than those that have less power (Chapanis, 1971). Criteria also vary greatly from system to system and some are specific to particular systems. Some of the criteria that might be used to evaluate a telephone communication system are: the naturalness of the transmitted voice signals and freedom from cross-talk. Military systems are frequently evaluated by a criterion of kill probability, and so on. Although systems criteria are not necessarily obvious and easy to agree on, anyone who designs, builds, or buys a system does so according to certain criteria, either explicit or implicit. The criteria in Table 2 are self explanatory. Other things being equal, the better of two systems is one that (a) has a longer anticipated life, (b) has a more pleasing appearance, (c) is more comfortable, (d) is more convenient, (e) is easier to operate or use, (f) is more familiar, that is, more similar to existing systems, (g) is cheaper to buy, (h) produces job satisfaction, (i) is quicker to repair, (j) requires fewer operations, (k) is cheaper to operate, (l) produces more units, (m) breaks down less often, (n) is safer, and (o) requires less training.

Task Analysis

The tasks in an office are usually not particularly well understood. Unless an effort is made to thoroughly understand the details of each job, any automation efforts are likely to be misdirected. Several methods are available for performing a task analysis, including: questionnaires, checklists, diaries of daily events, motion pictures, participation in the work, observations , observational interviews, and individual interviews. Each of these methods has specific advantages and disadvantages and its suitability depends upon the task and the work situation.

Information on tasks is extremely important in order to plan an office automation system. For example, most people have only a vague appreciation of what an executive does. According to a study by AT&T (Knopf, 1982) the average executive spends 32% of his time in informal meetings, 16% speaking on the phone, 15% in formal meetings, 14% writing, 11% reading mail, 6% business

Table 2. Criteria for Evaluation of System (Adapted from Chapanis, 1971)

Anticipated Life of the System
Appearance
Comfort
Convenience
Ease of Operation or Use
Familiarity
Initial Costs
Job Satisfaction
Maintainability
Manpower Requirements
Operating Costs
Productivity
Reliability
Safety
Training Requirements

travel, and 3% thinking. Such information helps conceptualize how the work might be restructured and what kind of automated office devices should be useful. (The results may also suggest that Knopf's results are not totally accurate. Three percent for thinking seems like an underestimation.)

Information from the task analysis may be used to allocate office functions or tasks between different job classifications and office automation devices. At this stage, it is appropriate to assess the economic impact of automation by calculating cost/benefit ratios for each combination of tasks and automation devices.

Documentation and Discussion

Tasks and procedures which are selected for automation should be documented and comparisons made between the existing system and the proposed automated method of operation. This documentation should also include hardware and software specifications of the system. Such specifications must consider user needs identified in the task analysis.

Equipment Selection

After approval has been obtained, vendors are invited to bid. In order to evaluate proposals, criteria such as the ones shown in Table 2 must be evaluated. Weights can be assigned to the different criteria and a composite evaluation criterion, C, can be calculated:

$$C = A_1X_1 + A_2X_2 + \ldots + A_nX_n.$$

Alternative pieces of equipment and the systems can then be evaluated with respect to a composite criteria.

Users of the system should be encouraged to provide comments and feedback at all design phases. This is helpful both for creating a working system and for developing a positive attitude towards the system after it is implemented.

Implementation and Evaluation

In the final step, the system is installed in the office environment. Simultaneously, users must be trained. This is important for productivity improvements and for user acceptance.

At this stage, the equipment should be field tested using the evaluation criteria established above. In addition, it will probably be necessary to test the basic operation of the system, including compatibility of hardware and software and physical requirements, such as utilization of space. Criteria for evaluating human performance are less straightforward. For example, it is difficult to measure motivation of users, resistance to innovation, and job skills. These factors need to be assessed by an expert - ideally, a human factors specialist.

4. OFFICE TASKS

Most of us have an appreciation of what office work is, for example, producing documents, talking on the telphone, participating in meetings, and so forth. But when it comes to details, such as flow of information, people generally have only a vague idea. For example, how is information flow in a bank different from an insurance company or a credit card company? This section will discuss office tasks and some recent research studies that have addressed the issue of establishing a task taxonomy for office work.

Task analysis is an important tool for analyzing the functions of an office. Only when there is complete understanding of the different tasks can office automation be implemented to serve a useful purpose. Unfortunately, automation systems are sometimes implemented without analyzing existing tasks and needs. For example, obtaining a system that can easily produce pie charts and bar diagrams might encourage individuals to use these functions excessively without much thought to their need.

It is, therefore, important to develop a task taxonomy that can be used to describe office work. This taxonomy should be as general as possible so that it can be applied to different kinds of office activities. It is a great advantage if the task taxonomy can describe both human and machine functions. It will then be easier to make tradeoff decisions with respect to the use of human or automated work. Only recently has there been research in this area; some of the studies are summarized below.

Conrath, Irving, Thachenkary, and Zanetti (1982) compared four different data collection instruments for describing office activities:

1. Questionnaire,
2. Task record,
3. Diary,
4. Interview.

The results indicated that the questionnaire presented few administrative problems although it provided little detailed information about the work. The task record was difficult to use. One of the problems was that many white collar workers found it difficult to describe their jobs in terms of the task taxonomy that was offered by the researchers. The communications diary posed fewer problems, although it was difficult to keep continuous track of oral communications. Typically, the diary included only about 60% of all communications. Finally, interviews were generally most useful for complementing other information.

In a follow-on study, Thachenkary and Conrath (1982) presented a taxonomy of tasks for management and non-management personnel in two companies, see Table 3. Not surprisingly, there were major differences in job assignments. For example, non-management personnel handled most of the bookkeeping and accounting, and all of the typing. Management handled most of the human relations, planning, and selling functions. There were also differences in the percentage of time spent at each task for the two companies investigated.

Parsons (1983) presented an alternative conceptual framework of the main functions in an office. His model, (DIT)[3], is presented in Table 4. The taxonomy bears resemblence to that proposed by Thachenkary and Conrath (1982), yet there are great differences between the two methodologies for classifying tasks.

Research performed in Japan by Komatsubara and Yokomizo (1982) classified the mental tasks in office work into six categories:

1. Perceptual discrimination tasks, for example, use of vision for sorting objects or quality control.
2. Tasks involving the use of short term memory, for example, mental arithmetic.
3. Tasks involving simple judgment and decisions, for example, checking ledger entries against vouchers.
4. Tasks involving logical thinking, for example, solving mathematical problems.
5. Tasks involving imaginative thinking, for example, composing poetry.
6. Tasks involving delicate and complex movements, for example, assembly of small and complicated machine parts.

Using a factor analysis approach, they found that tasks involving imaginative thinking were associated with "job satisfaction", logical thinking with "value", simple judgments with "a feeling of having time to spare", and tasks involving short term memory and perceptual discrimination with "difficulty". From this study, one may conclude that while some mental tasks are highly satisfying, others are boring and dissatisfying, notably those involving short term memory and perceptual discrimination.

A comprehensive study of office tasks was recently performed by AT&T (Knopf, 1982). Eleven companies across different industries at 40 locations were investigated. In total, about 1,200 white collar workers were

Table 3. Taxonomy of Office Tasks and Time Distribution for Management and Non-Management (Source: Thachenkary and Conrath, 1982)

		Percent of Time	
Task Code	Keyword Task descriptors	Management	Non-Management
A	Advising, Counselling, Assisting, Recommending, Problem Solving, Instructing, Acting as Liaison (two-way flow)	12.9	5.3
B	Bookkeeping, Accounting, Calculating, Inventorying, Invoicing (number crunching at clerical level)	2.0	48.1
D	Deciding, Authorizing, Approving (action oriented)	12.8	2.5
E	Evaluating, Auditing, Controlling, Coordinating (non-people oriented comparison against standards)	17.7	11.6
F	Completing Forms, Filing, Recording, Logging (algorithm oriented)	-	7.7
G	General Administration, Paperwork (managerial level)	3.1	-
H	Human Relating, Supervising, Appraising Performance, Staffing, Motivating (people oriented)	21.1	7.3
I	Informing, Reporting (one-way flow)	4.4	4.2
M	Interactive Formal Meetings	3.0	-
O	Orders, Requests, Invoices, Bills	-	3.0
P	Planning, Budgeting, Analyzing (future oriented)	16.2	2.5
Q	Arranging/Scheduling of Meetings, Appointments (secretarial level)	-	7.3
S	Selling, Convincing, Persuading, Advertising (change oriented)	8.2	1.7
T	Typing, Transcribing, Copying, Writing (going from one medium to another)	-	4.5
	Total	101.4	102.7

Table 4. Functional Framework of Office Processes: The $(DIT)^3$ Model (Source: Parsons, 1983)

Decision-making:	Analyzing, diagnosing, interpreting, problem-solving, planning.
Informing:	Accessing, solving, acquiring, inquiring about and generating information; scheduling and reminding.
Transacting:	Negotiating, contracting, buying, selling, paying, ordering, reserving, billing.
Documenting:	Recording, compiling, reporting, creating.
Inventorying:	Storing/filing, retrieving, indexing, updating.
Transforming:	Changing media, changing content or format within medium, copying, editing, manipulating, verifying, developing forms.
Drafting:	Designing, image-making, graphics-using.
Interacting:	Dealing with other people, interfacing with devices.
Transmitting:	Communicating (internal, external) in all media.

interviewed or responded to questionnaires. In addition, their work activities were observed for one day each. Some results of the study are summarized in Table 5.

The tasks were then divided into three major activities: face to face, document, and telephone, see Table 6. There were significant differences between the different tasks. Executives and managers spend most of their time in face to face interaction with other employees, whereas knowledge workers and secretaries spend most of their time with documents. Executives, knowledge workers, and secretaries used the telephone for about 20% of the time. Managers used the telephone to a lesser extent - only 9%. The results of this study may have some important implications for office automation. For example, it may be possible to substitute much of the face to face interaction with teleconferencing, electronic mail, and voice store and forward. Similarly, the amount of time spent on the telephone may be significantly reduced by using automatic dialing and voice store and forward. The information in Tables 5 and 6 may also be used as a basis for analyzing cost-benefit implications. Several questions may be pertinent, for example: "How much may an electronic mail system cost if it reduces the time for formal

Table 5. Task Time Distribution for Executives and Secretaries (Source: Knopf, 1982)

Tasks	Executives	Secretaries
Typing	-	36%
Informal Meetings	32%	-
Speaking on Phone	16%	20%
Formal Meetings	15%	-
Reading Mail	11%	-
Business Travel	6%	-
Writing	14%	9%
Copying	-	8%
Tabulating	-	5%
Record Keeping	-	5%
Filing	-	4%
Research	-	2%
Taking Dictation	-	2%
Thinking	3%	-
Production	2%	-
Other	1%	9%
	100%	100%

Table 6. Major Activities in Some Office Tasks (Source: Knopf, 1982)

Activity	Executive	Manager	Knowledge Worker	Secretary
Face to Face	53%	47%	23%	Negl.
Document	27%	29%	42%	55%
Telephone	16%	9%	17%	20%
Other	4%	15%	18%	25%

meetings by 10%? But several issues need to be addressed in research. For example, if these innovations replace present tasks, will other tasks be created? What are the consequences for the effectiveness of interpersonal communications and job satisfaction?

Taxonomy of Office Tasks

Inspired by the research summarized above, a taxonomy of office tasks may be suggested. The objective is to create a parsimonious, conceptual framework which can be used to classify different types of tasks as well as human-machine interactions, see Figures 4 and 5.

The types of office interaction noted in Figure 4 represent a broad classification. These are activities that a cursory observer of an office would note, and according to the AT&T study (Knopf, 1982), they describe most tasks. The types of office interactions are ordered vertically so that clerical tasks correspond to the items on top of the list and management tasks to the items on the bottom of the list.

Five human characteristics are noted in the figure: perception, short term memory, long term memory, cognition and social skills. Again, the items on the top and the bottom of the list correspond to clerical and management tasks respectively.

There are 10 different office tasks. This taxonomy is mainly an expansion and explanation of the types of interactions noted previously in Table 6. The vertical transition between tasks roughly corresponds to clerical and management tasks. The feedback loop should also be noted: the completion of office tasks creates new office tasks. To illustrate the taxonomy, a typical clerical office interaction is making transactions using a VDT screen. This requires use of perception and short term memory. It is accomplished by "inputting" or "transacting". On the other hand, a typical management or executive task is negotiating. This typically involves the use of social skills, cognition, and long-term memory in face-to-face interaction. Incidentally, the latter task, due to the involvement of cognition and social skills is far more satisfying according to Komatsubara and Yokomizo, (1982).

There are differences between the types of automation that can be used for management and clerical tasks, see Figure 5. Automation for clerical tasks is more hardware oriented, and for management, it is more software oriented. The emphasis in computer technology has historically been on hardware development. This is the reason office automation started with the

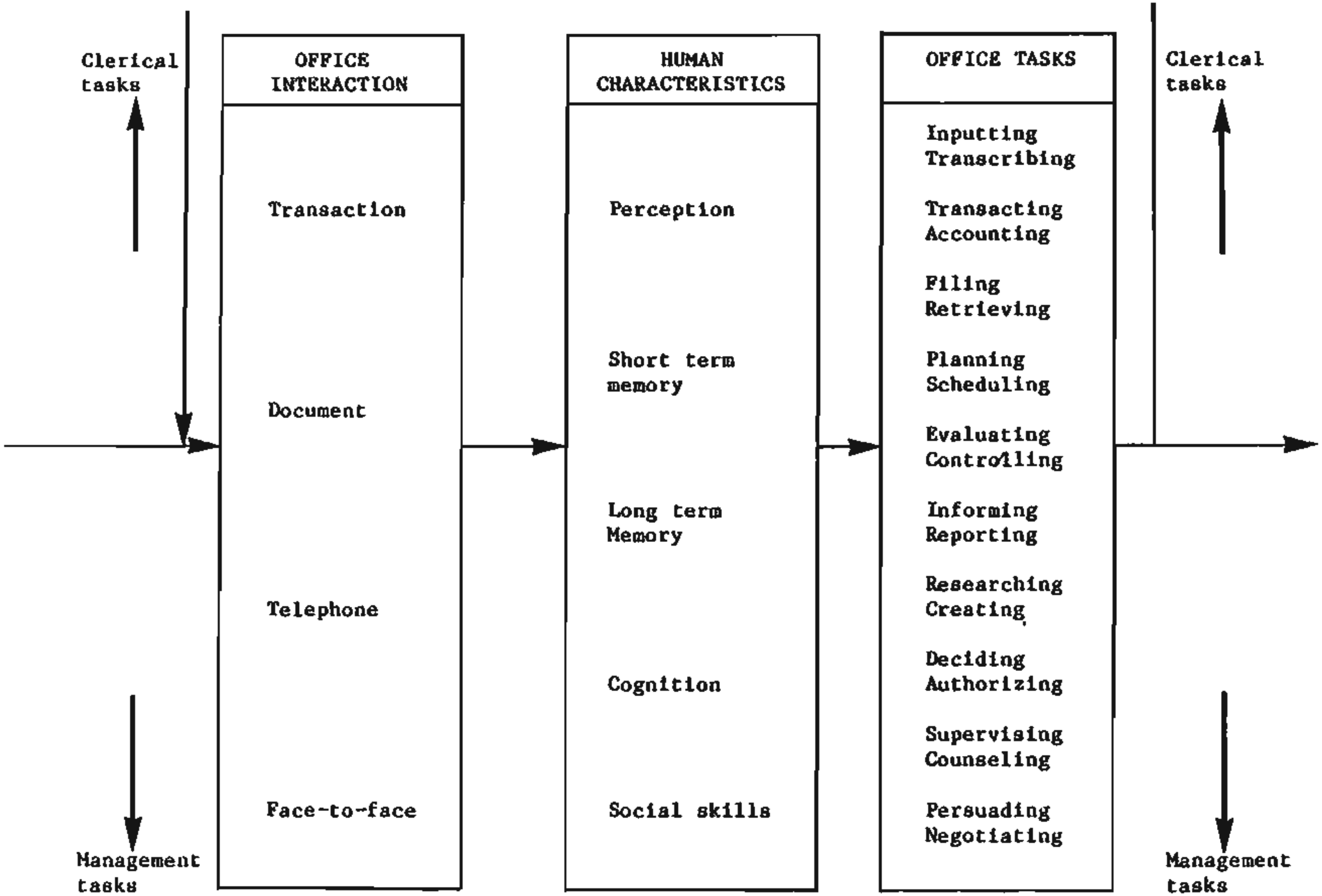

Figure 4. Taxonomies of types of office interaction, human characteristics and office tasks. Note the vertical correspondance between the three boxes going from clerical types of task on the top to management types of tasks at the bottom.

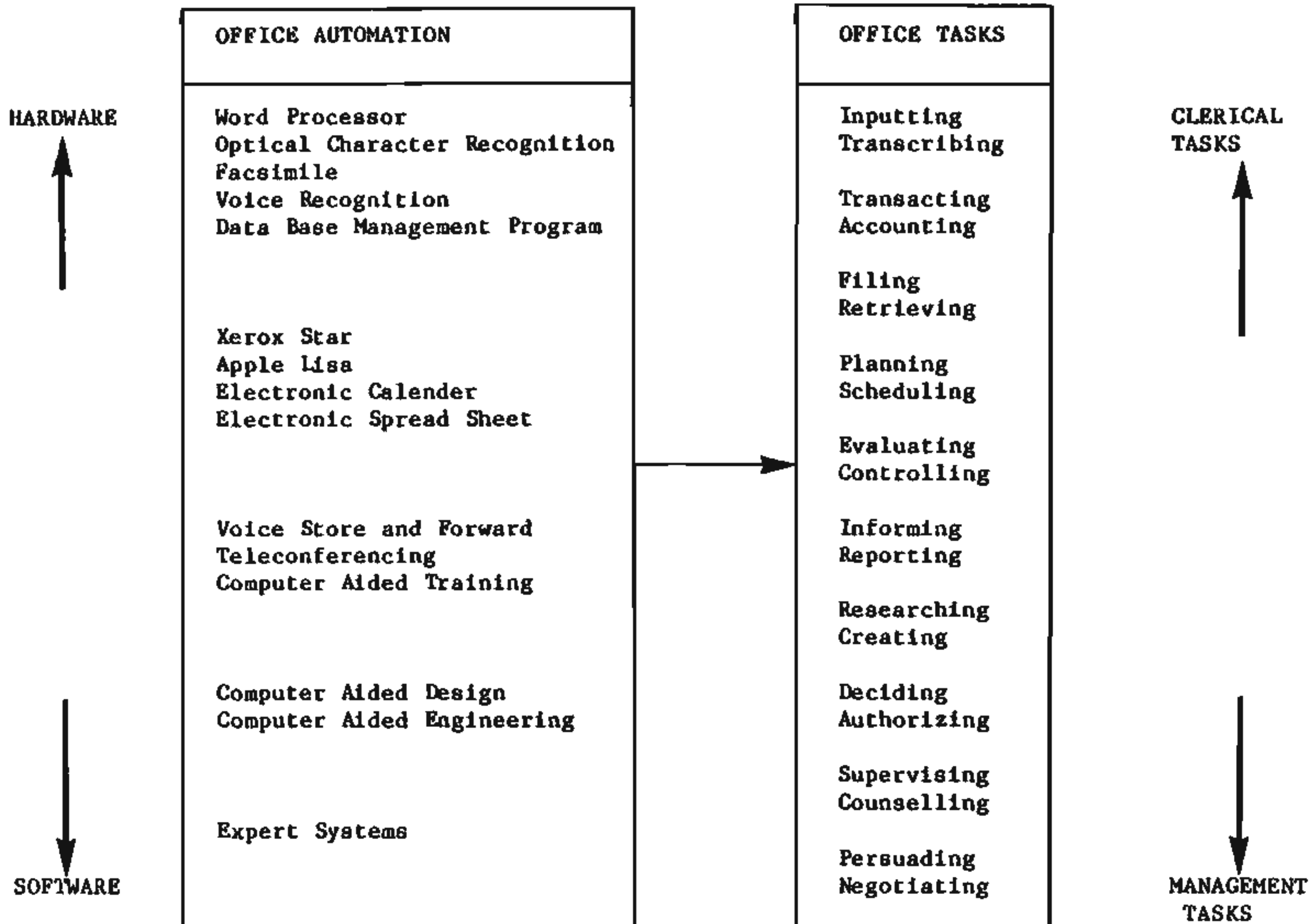

Figure 5. Management tasks are typically automated with software and clerical tasks with hardware.

implementation of word processors. Software is, however, increasingly being used for computer aiding of tasks with primarily cognitive components, such as CAE and CAD for engineering and design. The next development might be CAS (Computer Aided Supervising) and CAN (Computer Aided Negotiating). Are we ready for the electronic boss?

Much of the remainder of this report is structured to correspond to Figure 4. The major types of office interactions will be addressed: Transactions, Documents, Telephoning, and Meeting and Conferring. Under each of these headings, some technological innovations of particular interest for human factors engineering will be discussed. Examples are voice recognition, computer aided design, teleconferencing, and voice store and forward. First, local area networks and data base systems are described. These provide the systems context for future office automation.

5. COMMUNICATION NETWORKS

Communication networks supply the systems context for the organization of office automation. Several new types of communication technologies are presently available: local area networks, high-speed telephone lines, and satellite communications. They offer the following improved capabilities (United States Congress, 1982):

- The cost of communications, particularly for high-speed long-distance data transmission, will continue to drop.
- Users will have a variety of communication services available to serve different needs.
- Local area networks will interlink computers, telephones, and terminals.
- Larger volumes of data can be carried over the lines.
- An international data communications network will allow establishment of high-speed communication between virtually any points on the globe.

Topologies of Local Area Networks

There are presently three common topologies of local area networks: the star, the ring, and the tree. In the star network, several terminals are connected to a central controlling device, see Figure 6. This configuration is mostly used with mainframes and PABX systems. It is particularly appropriate when a host must transfer data to individual workstations; it is, however, not very economical as a data link between different workstations. The system is easily expanded by attaching new workstations and it is easy to access external communication systems. The central computing power can be used to control data and software and maintain a high degree of security. However, as with other computer based systems, this system is vulnerable to malfunctions.

In the ring configuration, also called a loop or a daisy chain, all workstations are arranged in a circular network. Individual workstations are attached to the circle through a repeater mechanism that monitors all passing messages to check if any is addressed to the particular workstation. One station can be assigned as the master controller. This system, which has gained more acceptance in Europe than in the United States, has the advantage of greater reliability than the star network. There are, however, several

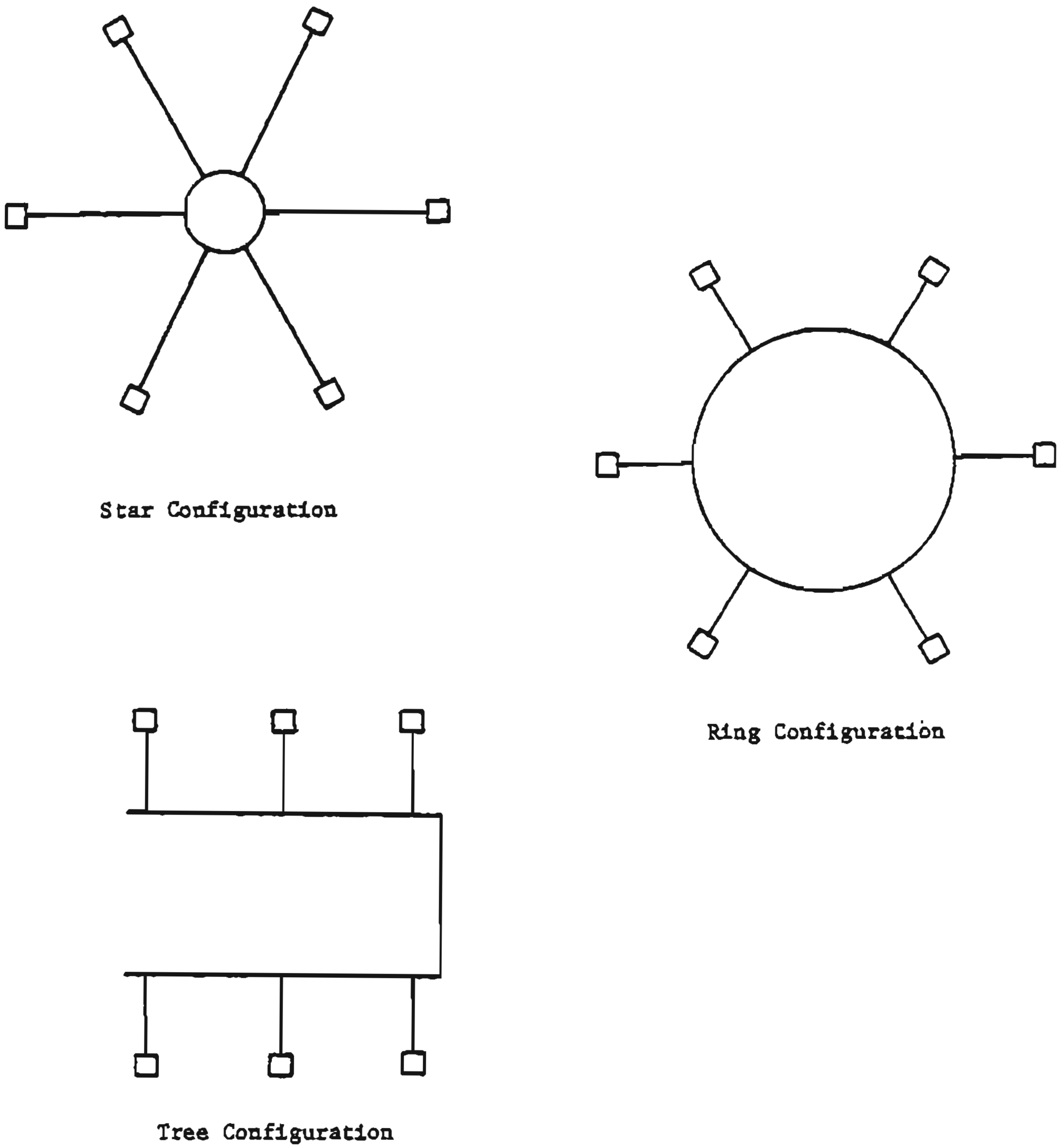

Figure 6. Three different configurations of local area networks.

disadvantages, such as the difficulty in expanding the network and integrating video, voice, and data, and the lack of security.

The tree, or bus network, is becoming the most common topology in the U.S. With this system, stations are attached by cable taps to a fiber optics or a coaxial cable, see Figure 7. The bus topology can easily be expanded and modified and is suited for a combination of video, voice, and data. It does not require a centralized controller and it can handle short messages more economically than the other arrangements. The security of the system largely depends upon the security of the individual workstations.

Transmission of Information

Most networks currently in use transmit messages using either a twisted pair of wires, a coaxial cable, or a fiber optics system cable. A twisted pair of copper wires is the simplest form of connection. It is easy to install and inexpensive. It can typically provide communications at 1 Mbps over a distance of about 1 kilometer. The main disadvantage with this system is that signals lose strength as they travel through the line. The twisted pair wiring is also susceptible to noise from the environment.

Coaxial cable has higher capacity (band width). It can easily carry 10 Mbps, including digitized data, several channels of video, plus several voice conversations simultaneously. The shield on a coaxial cable gives it good resistance to the intrusion of noise, particularly electromagnetic interference. The popular use of coaxial cables by cable television networks makes it easy to install and maintain a cable.

The use of fiber-optics cables has several advantages over twisted pair and coaxial cables, including potentially lower costs, no radio interference, and high security. This technique is presently being introduced by telephone companies. A half-inch thick glass fiber cable can carry 46,000 simultaneous conversations, the same number as a 4 inch copper coaxial cable. The signals from the telephone are converted into a laser light pulse using a digital encoder, a driver, and a laser. The light pulse is then transmitted through the fiberglass cable. Although cables are expensive, they are economical for PABXs, because of their greater channel multiplexing capability.

Methods for Transporting Information on the Network

The functioning of the different networks can be illustrated by describing the various techniques available for transmitting information. For

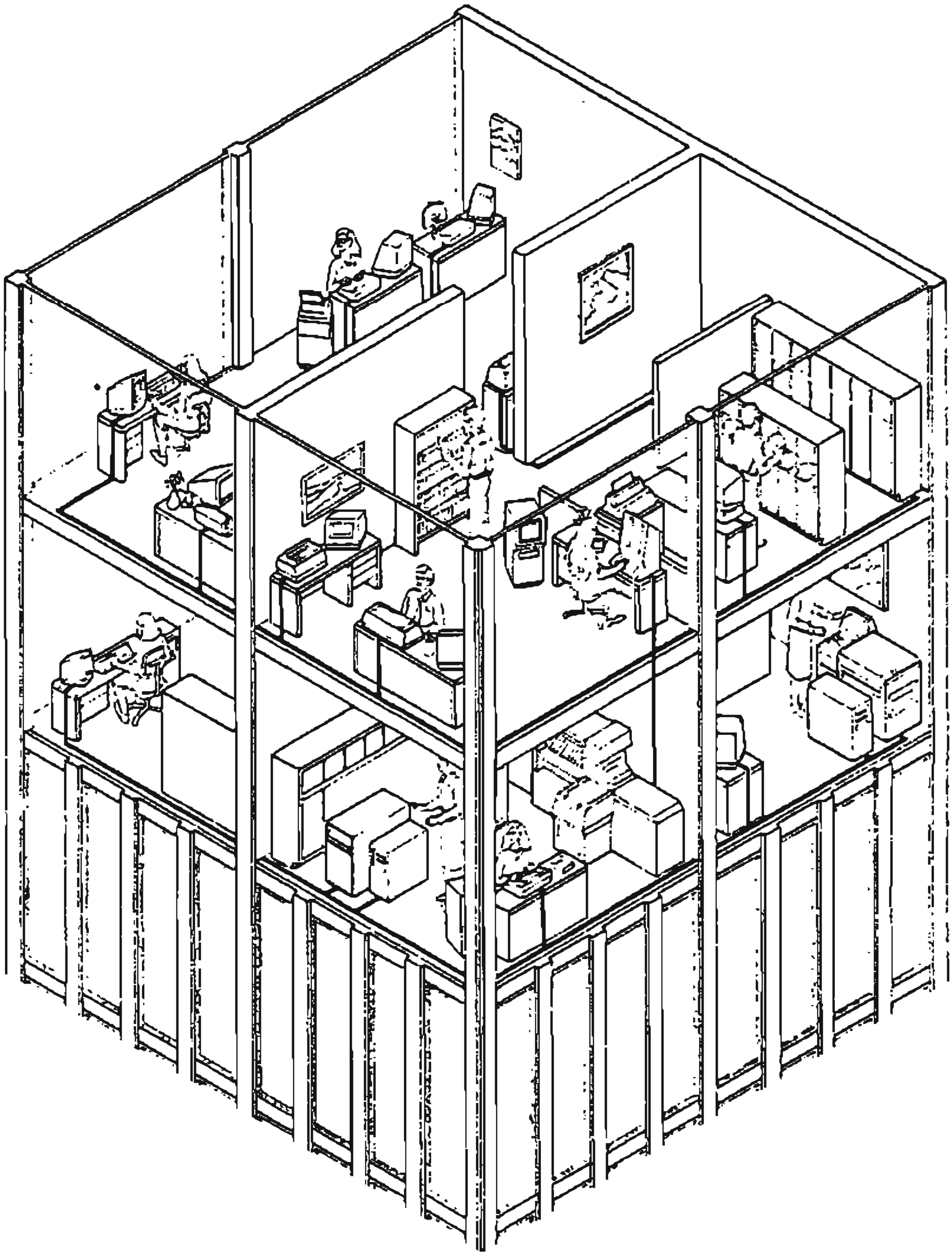

Figure 7. A tree or bus topology can be used to attach several offices.

star and ring topologies, it is common to use master control methods. The two most common master controls are polling and reservation. The polling technique provides access to the network by scanning workstations in the ring. When an individual workstation needs network access, the controller stops and establishes the contact. The principle for reservation works like the word suggests. Time slots for transmission are allocated to the different workstations which may or may not use the transmission time.

In a bus or tree network, there is a common access method known as contention, or "waiting for the bus" (Derfler and Stallings, 1983). Most networks use a contention scheme called "carrier sence multiple access with collision detection" (CSMA/CD). With this system, traffic already in the channel has priority and if one station is transmitting, all other stations must wait. The stations on the network can determine if the channel is busy by listening to the radio frequency signal transmitted by another station (carrier sense). If the channel is clear, a station may transmit a message. If there is a collision with a message from another station, both stations must withdraw their messages and wait for a random time period before resubmitting. This is the collision detection part of the system. CSMA/CD is an efficient technique; however, networks just using just CSMA without collision detection usually find that this system works almost as well.

Another scheme for passing information is referred to as "catching the ring". In this case, a signal is passed around the ring network. There are two types of signals, "slotted ring" and "token passing". In the slotted ring, a frame is passed from station to station. If the frame is empty, an individual station may fill the frame with information and pass it on to the next station. If the frame is full, the individual station has to wait until an empty frame is available. In this system, all stations read all frames, and the receiving station removes the information from the frame. Because of the time required for frame reading and information processing, slotted ring systems are fairly slow.

Token passing is a more efficient method; it is especially suited for bus networks. A short message (a token) is circulated around the network indicating that the channel is free. When a station wants to transmit, it may grab the token, and change the token message to read "here comes a message" (Derfler and Stallings, 1983).

These types of networks that use timesharing techniques are referred to as base band networks. Higher capacity networks - broadband networks - do not have to timeshare, they can transmit and receive simultaneously. Traffic is separated by using different frequencies rather than time. Broadband networks require the use of a fiber optics or a coaxial cable system and may carry a radio frequency spectrum of 450 Megahertz (MHz). Typically, this frequency range is divided up into several bands, much like a cable television system. Table 7 shows the frequency divisions used on the WangNet Local Network.

Table 7. Frequency Allocations for the WangNet Local Network

Frequency Range MHz	Use
10-22	Dedicated channels
22-48	Not used
48-82	Switched channels
82-174	Not used
174-216	Video channels
216-217	Not used
217-251	Data channel (Wang Band)
251-350	Not used

6. DATA BASE SYSTEMS AND THEIR MANAGEMENT

A data base is the common term for an information bank. The most common types of data bases are summarized in Table 8. In addition to the data bases listed, there are other aggregations of data used in an office, for example, personal work files, electronic calendars, and so on.

According to Table 8, there are 6 different kinds of data bases which are either external or internal. External services may be accessed over the telephone network, whereas internal data bases are those existing within an office or a company. Information services are typically external and include stock exchange information, news services, and airline schedules and are made accessible by services such as Dow Jones News/Retrieval Service, the New York Times Information Service, and The Source. Most of these services also offer electronic mail, and data storage. The best known information bank is the Dialog Literature Search Service with approximately 150 data bases with 40 million scientic references.

One of the first professional data base systems was ARPANET, operated by the U.S. Department of Defense. Originally, this network was established for computer to computer communication for resource sharing but the dominant use has been electronic mail. SUMEX-AIM (Stanford University Medical Experimental Computer-Artificial Intelligence in Medicine) is used by a group of medical scientists around the country who are concerned with sophisticated computer applications to medicine (Newell and Sproull, 1982). Professional data bases may also be stored internally within a company; an example is computer aided design (CAD). A CAD system may be used by engineers to produce drawings and for engineering analyses of stability and strength. Archive storage contains information of less relevance to the immediate work and may be stored on media such as magnetic tape, video disks, or micrographics.

Perhaps what most people understand about data bases is transactional, such as used by banks and insurance companies. A data base used by a bank may sort information on transactions in several ways. Typically it contains four files of information with transactions sorted according to different accounts, teller stations, branches, and activities (Abbott, 1983).

Table 8. Types of Data Bases Accessible in an Office

Type	Location	Example
Information service	External	Dow Jones
		The Source
		Videotex
Information banks	External	Dialog Literature Search
Professional databases	External	ARPANET
		COGNET
Professional databases	Internal	CAD/CAM
Archive storage	Internal	Magnetic Tapes
		Video Disk
		Micrographics
Transactional database	Internal	Banking
		Inventory

Management of Data Bases

There are two main issues that relate to the management of data base systems: the design of software and the strategic use of information in an organization.

Typically, what most people associate with a data base management system is the software that is used to manipulate the data. There are several data base management systems (DBMS) available for structuring the format of a data base and for accessing critical information. A DBMS offers several services, including:

1. Arrangement of the data on the screen so that it is easy to use. This description usually differs significantly from the way data are stored in the computer.
2. Data language that allows the user to retrieve, update, insert, and delete data from the data base.

There are several general application DBMS programs for personal computers: Selector V, dBASE II, FMS-80, Condor III, and QSORT. All of these programs are available for approximately $500 for use with 8-bit or 16-bit microprocessors (Abbott, 1983).

Decision support systems (DSS) for management control and strategic planning are gaining in popularity (Gupta, 1982). Some of these systems rely on artificial intelligence and adaptive programming techniques. Examples are: Interactive Financial Planning System developed by Execum, IRIS at RCA Corporation, MYCIN at Stanford University, DAISY at Walton School, and BRANDAID at MIT. Many of these DSS programs were originally designed for use on mainframes, but there are now versions available for operation on mini-computers. For example, the program offered by Execum runs on virtually any system. It can be used for financial planning, model building, model analysis, sensitivity analysis, goal seeking, risk analysis, customized reporting, graph plotting, simulation, and forecasting. It is clear that as office computer usage increases, there will be software for every conceivable application ranging from information retrieval to budgeting, and from marketing to engineering.

With the availability of multiple data bases and an overflow of information, guidelines for the strategic use of information are necessary. Flanagan (1983) suggested the following basic guidelines:

1. Analyze the needs for information within the organization.
2. Identify reliable and up-to-date data sources.
3. Deal with as few external data bases as possible.
4. Control access to data bases; the potential for abuse is high and experimentation is expensive.
5. Consider using specialists.

Computer Aided Design and Computer Aided Manufacturing

The use of computers for product design manufacturing, and engineering analysis is expanding very rapidly. There are predictions that by 1990, practially all U.S. engineers will occasionally interact with CAD/CAM workstations, and approximately 35% will conduct most of their work at CAD/CAM workstations. There are, therefore, good reasons to analyze and improve the design of CAD/CAM workplaces.

The opportunities for automation in the factory are often misunderstood (Helander, 1983). The emphasis has been placed almost exclusively on the production process, and automation has become symbolized by the use of industrial robots. Actually, the work involved in assembling a product is not where automation is likely to have its greatest effect; direct labor accounts for 10-25% of the cost of manufacturing. The major challenge is organizing, scheduling, and managing the total manufacturing enterprise, including product design, distribution, and service. For this reason, the most important contributions to increased productivity will be obtained by linking information networks and providing a common pool of data on design, management, and manufacturing. A computer integrated manufacturing system can handle just about all aspects of the work including forecasting, cost planning and control, purchasing, manufacturing, inventory control, quality control, and plant maintenance, see Figure 8. This CAD/CAM system can also be used to tie together manufacturing plants in different cities and different countries through the use of communications satellites. Thereby , information from drawings and manufactured parts may be transmitted momentarily to other plants. This extended information network makes it possible to design and share work in a much more flexible fashion between different plants. The management of information is, therefore, likely to have much greater impact on the work in an automated plant than automation of the assembly. It is likely that these changes will alter far more white collar jobs than blue collar ones. As an example, it would be possible to hire computer scientists in countries outside the U.S. (at lower salaries) and provide remote supervision and instructions through the CAD/CAM information network. The possible impacts of such changes, however, are likely to be debated by labor unions and management.

Decision Making in CIM

One of the major problems is that of operator competence and information overload. Computer integrated manufacturing (CIM) relies on the use of a centralized mainframe that may store and transfer information between the different functions and processes in manufacturing. It seems unlikely that a single operator would be able to handle the decision making for the entire system. Even in the future, there will be different experts handling different areas such as product design, marketing, and plant maintenance. However, the CIM relies on the integration of different functions and there will always be trade-off decisions and suboptimizations which involve several subsystems. The decision making process might be quite awkward when several individuals must jointly decide over processes that they only have partial understanding of.

Another important issue is that of decentralization of computer power and decision making. CIM relies largely on the use of a centralized computer. So what will happen to employees working in "the periphery" of the computer network? Will they have their own terminals, and if so, will they be able to

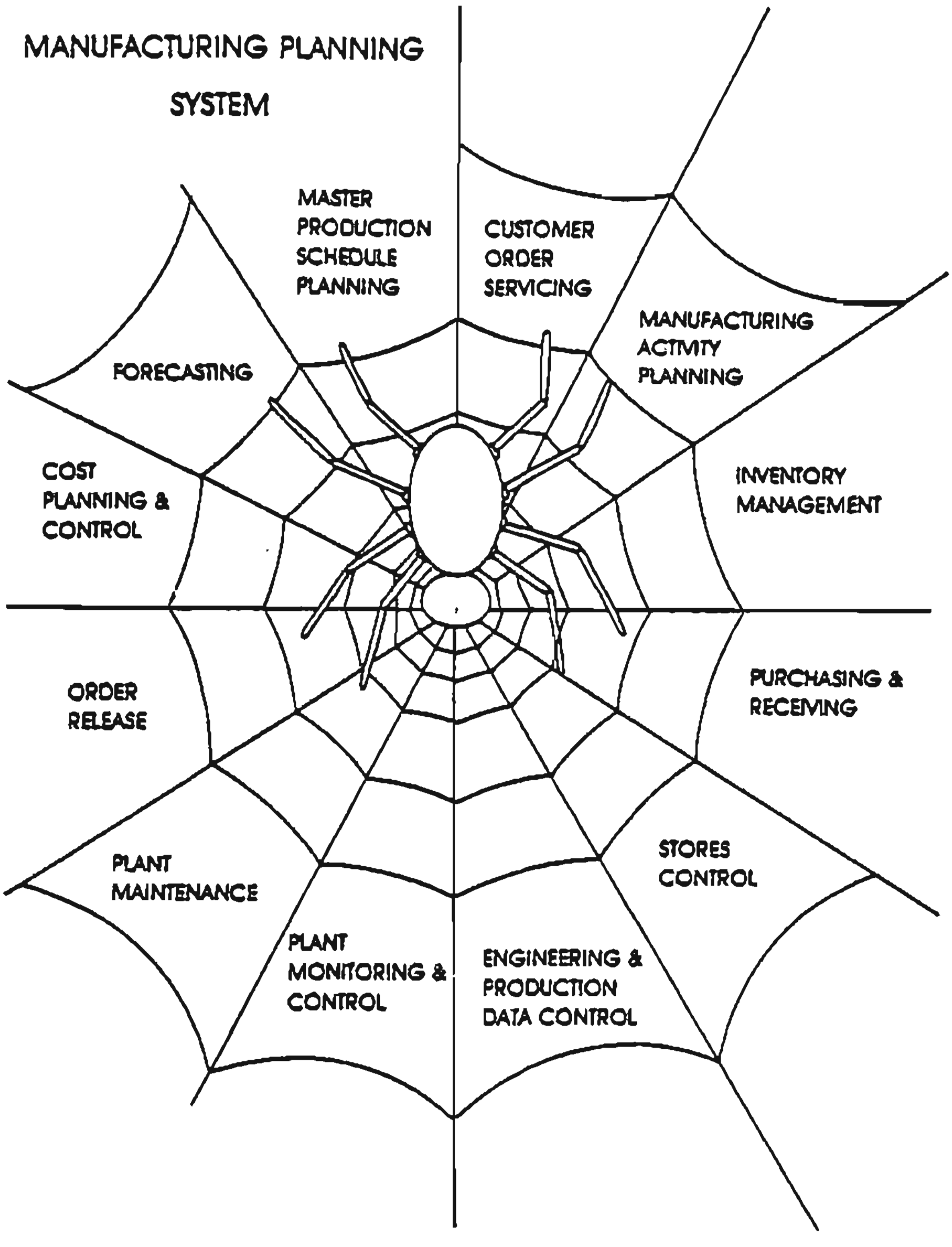

Figure 8. Manufacturing planning system. (Source: Helander, 1983)

influence decision making for purposes other than routine tasks? The issue of decentralizing computer and decision power is an important one. Presently, there is a danger that the systems programmers, who are responsible for developing CIM, will become so immersed in technical difficulties of integrating the system, that they will forget about issues such as democracy on the shop floor, quality circles, and so forth.

Design of CAD/CAM Workstations

As CAD/CAM workstations become increasingly used by engineers and designers, there will be an increased demand for ergonomic design features. Many of these design features are presently incorporated in VDT workstations and include: height adjustable tables, wristrests, footrests, and the use of "ergonomic chairs" with height adjustability, lumbar support, and a high backrest. It is also important to control the illumination in the office in order to reduce reflections on the screen. As with other CRT terminals, there are problems with veiling reflections (washout of character contrast) on the screen and specular reflections (mirror-like reflections of surrounding objects). Both of these problems may be reduced by deliberate design of the office illumination system. For example, an illumination level of about 300-400 lux allows visibility of both the screen and the source documents. However, when the screen is not used, the operator might prefer to increase the illumination level. Similarly, when the operator is interacting exclusively with the screen, with no need to refer to printed source documents, he/she might want to lower the illumination level to below 100 lux. It is, therefore, suggested that graphics workplaces with a CAD/CAM systems should have easily adjustable illumination.

As with other CRT terminals, there is a problem with display flicker. Unless the screen is refreshed at a rate greater than 60-70 Hz, there might be problems with flicker. Flicker is perceived easier and is more annoying the larger the light area of the display is. As a result, some CAD operators, in order to keep the display as dark as possible, avoid crosshatching of drawings and similar details. Flat panel displays such as plasma, LCD, and electroluminescent displays require less space at the workstation and entirely avoid the problem of flicker. It, therefore, seems likely that these alternative display technologies might be used in the future.

Work with CAD/CAM equipment requires considerable concentration. The design of the work area must, therefore, permit concentration by allowing individuals privacy at their work. It is recommended that the background noise not exceed 50dB. Computers, plotters, printers, and other noise producing machines should be located in special room(s) accessible from the design room. A high level of security, including fire detection and extinguishing equipment, must be built into the facilities.

Finally, most present designs of CAD/CAM equipment seem to disregard the fact that there are unusually high demands for storage space for drawings and other computer generated graphics and documents. Information from such documents is often used as input to the CAD/CAM design process, and operators need to refer to them constantly. As a result, there is a need for tables where operators can spread out and store drawings. An example is given in Figure 9.

Figure 9. In a couple of years there will be considerable design improvements of the CAD/CAM workplace. (Source: Helander, 1983)

Graphic Input Devices

A graphic input device should enable the operator to quickly and easily specify the contents of the display. Appropriate selection of a graphic input device has the following benefits:

a) reduction of time to alter the display
b) reduction of errors in selecting or specifying symbols
c) reduction of operator fatigue.

There are several different methods for graphics control:

- keyboard

- light pen/light gun
- mouse
- trackball
- joystick
- digitizing pad/tablet
- cursor control keys
- touch sensitive display
- keyboard coordinate entry
- scanner/digitizer
- touch sensitive pad.

Research has been performed to evaluate the relative advantages of different input devices (Parrish, Gates, Munger, and Sidorsky, 1981). For example, a light pen is usually preferred for sketching and drawing lines on the display when the need for accuracy is not great, or for placing, moving, and deleting symbols. On the other hand, the main advantage with a mouse is the speed by which it is possible to move symbols between different locations on the display. A joystick is particularly advantageous for selecting or specifying graphics commands where the input rate is high.

As seen above, it is possible to optimize the choice of input device depending upon the task. It seems likely that as CAD/CAM workstations become more frequently used, there will be greater freedom in the choice of input device. One word of caution, however, is not to mix several input devices on the same system. Alternating the use of, say, a light pen and a mouse may produce confusion and decreased productivity (Chapanis, Anderson and Licklider, 1983).

Management of Information

In the information age, information is available in large supply but only a small amount is applicable to any specific topic. The difficulty is to access the right information and avoid irrelevant information. Information Resource Management (IRM) is a strategy for centralized coordination of information resources within a company. IRM is such a new concept that very little has been published about it. All companies will, in the future, be concerned about how they administer information. For some organizations, especially those in which information is the end product (e.g., libraries, research companies, universities), IRM might be more important than for other organizations.

In a centralized, autocratic, company the coordination of information implies control over the company. In a more decentralized company with a democratic structure, control over information access might remain decentralized.

Regardless, the implementation of a fully automated office will affect the power structure significantly (Gaffney, 1983). For example, the design characteristics of a local area network may decide if the computer memory will be distributed, centralized, or something in between (admittedly, the introduction of inexpensive processing power in desktop computers has made the distinction between distributed and centralized systems difficult to define). The use of computerized data bases and decision aids will also change the power structure considerably. For example, imagine an executive secretary who prioritizes mail, sets the calendar, allows people into the executive's office, and produces various kinds of information. When the executive has the electronic tools to do this directly for himself, the secretary may loose many of the existing duties including a sense of control and power gained from organizing the job. Adjusting to such changes will probably be difficult unless the job is restructured with complementary tasks and contacts that can replace the old ones (Gaffney, 1983).

Clearly, in the information society, access to information will greatly influence the individual's power and prestige. Whoever controls the creation and flow of information will also control the distribution of power. The management of access to information is, therefore, a question of utmost importance. Much research is needed in this area.

7. TRANSACTING

The word transaction is taken to mean any routine manipulation of a data base, for example, changes made in customer accounts. Transactions are usually performed on a visual display terminal (VDT). There has been a fair amount of research on VDT's. The research has been reviewed in a previous report (Helander, Billingsley, and Schurick, 1983). Recommendations for the design of VDT workplaces are also available (e.g., Helander, 1982). Here we will only give a brief account of work with VDT's.

Perhaps more interesting from a future technology perspective is the use of computer voice recognition as an alternative input media to keyboards. Voice recognition has been available only for a couple of years but it has several advantages over keyboard input.

Design of VDT Workplaces

The use of visual display terminals (VDTs) in the office environment has aroused fear that the health and comfort of the operator might suffer. There are numerous reports of eye strain and headaches. As a result, many scientific studies have investigated the importance of various design factors such as the seating and work posture of operators, methods to avoid glare and reflections from the screen, and the need for adjustability of the screen and furniture. Attention to such problems has already led to considerable improvement in the design of VDTs, and some potential sources of discomfort have been eliminated by manufacturers.

It has been suggested that the operation of a VDT is, in many ways, similar to watching TV and accordingly, should be associated with the same low level of health risks. This analogy is not particularly useful. The viewing distance, the nature of the information displayed (text rather than pictures), duration of exposure, postural constraints, and a host of motivational and environmental factors are clearly different. For some design questions, research has already provided an answer; for others, research is still necessary.

Ergonomics problems are systems problems. This implies that for most design solutions, there are usually trade-offs that make it difficult to choose the best design. For example, if the ambient illumination level is raised to enhance the visibility of the source document, the legibility of the characters on the screen may suffer. Or, if the height of the desk top is made adjustable to accommodate operators of different sizes, then, operators have to accept the inconvenience of making the adjustments. Or, if workstations are moved closer to each other in order to simplify verbal communication, then, there may also be more disturbance from noise. Ergonomics problems are, therefore, usually analyzed in a systems context. Before a design can be finalized, designers frequently need special studies to learn about the human factors implications of their particular problem. And, after the design is finished, evaluation is needed. Such studies should evaluate the people who use the design to determine whether design features and users are suited to one another. If they are not suited appropriately, design modifications are necessary.

Types of VDT Tasks

There are three basic categories of VDT tasks: data entry, dialogue, and data inquiry. For data entry, the main items of importance are the keyboard and the source document. The operator reads information from the source document and enters it using the keyboard. The screen is less important since it is used mostly for checking. The screen should therefore have a less prominent position than the source document. In fact, it can for most purposes, be positioned to the side of the table. For dialog tasks, there is a constant flow of information from the keyboard to the screen and back again. The amount of data input is considerably less than the data entry task. For this task, the screen should have a more prominent position. The third task, data inquiry, mostly involves the monitoring of data or text displayed on the screen. For this task, source documents are rarely used since there is seldom a need for additional data input, so the screen should have a prominent position.

The different tasks are usually initiated in different ways. For example, for both dialog and data inquiry tasks, a telephone call or a visitor might initiate the activity. This is rarely the case for data entry, where the task is initiated by a document with information that must be keyed into the computer. In addition, the usage of a visual display terminal varies for different jobs. For some tasks, the VDT is used rarely, but for others, it is used throughout the day. All of the factors mentioned above, type of task, task initiation, and frequency of VDT use will affect the design of VDT workplaces.

Design of Furniture

Poorly designed furniture may constrain work posture and result in backaches, fatigue, and discomfort. These problems can at least be partially avoided if proper consideration is given to the choice of furniture during the planning and design of an office.

For example, the selection of chairs is affected by several factors: differences in body size, work habits, and idiosyncratic differences in sensitivity to poor chair design. Some individuals can sit in almost any type of chair, while others, particularly those with back trouble, are uncomfortable unless the chair is exactly right. Chairs are inexpensive relative to the costs of manpower and equipment. Since the design of the chair has a great impact on comfort, there is good reason to select a comfortable one.

There has been a reasonable amount of research on the design of chairs and tables. Although some of this research has provided answers to many critical questions, there remain important issues that have not been fully resolved. For example, the German standard for keyboard height specifies that the home (middle) row of the keyboard should be at a height that allows the operator to maintain an elbow angle of 90°. Since this applies to both large and small operators alike, the chair and/or table must be adjustable to conform to the standard. Figure 10 shows a workstation with a short (5th percentile) female and tall (95th percentile) male operator. It is obvious that the furniture must be adjustable in order to accommodate both operators. Two alternatives are shown in Figure 10: a height adjustable chair and foot rest and a height adjustable chair and table.

Recent research has shown that the recommendation for a 90° elbow angle should be relaxed, and that the elbow angle could vary between 75° and 90° without affecting operator comfort. Adjustability is still important, especially when both male and female operators use the same workplace. Dynamic sitting, implying a change in posture about every 5 minutes, is important for comfort and promotes good circulation. The adjustability of seat and table heights promotes dynamic sitting, but the adjustments must be easy to make, otherwise they will not be used.

Design of the Screen

The visibility of characters on the screen has, in the past, raised concern both among users and in the research community. In a raster scan CRT

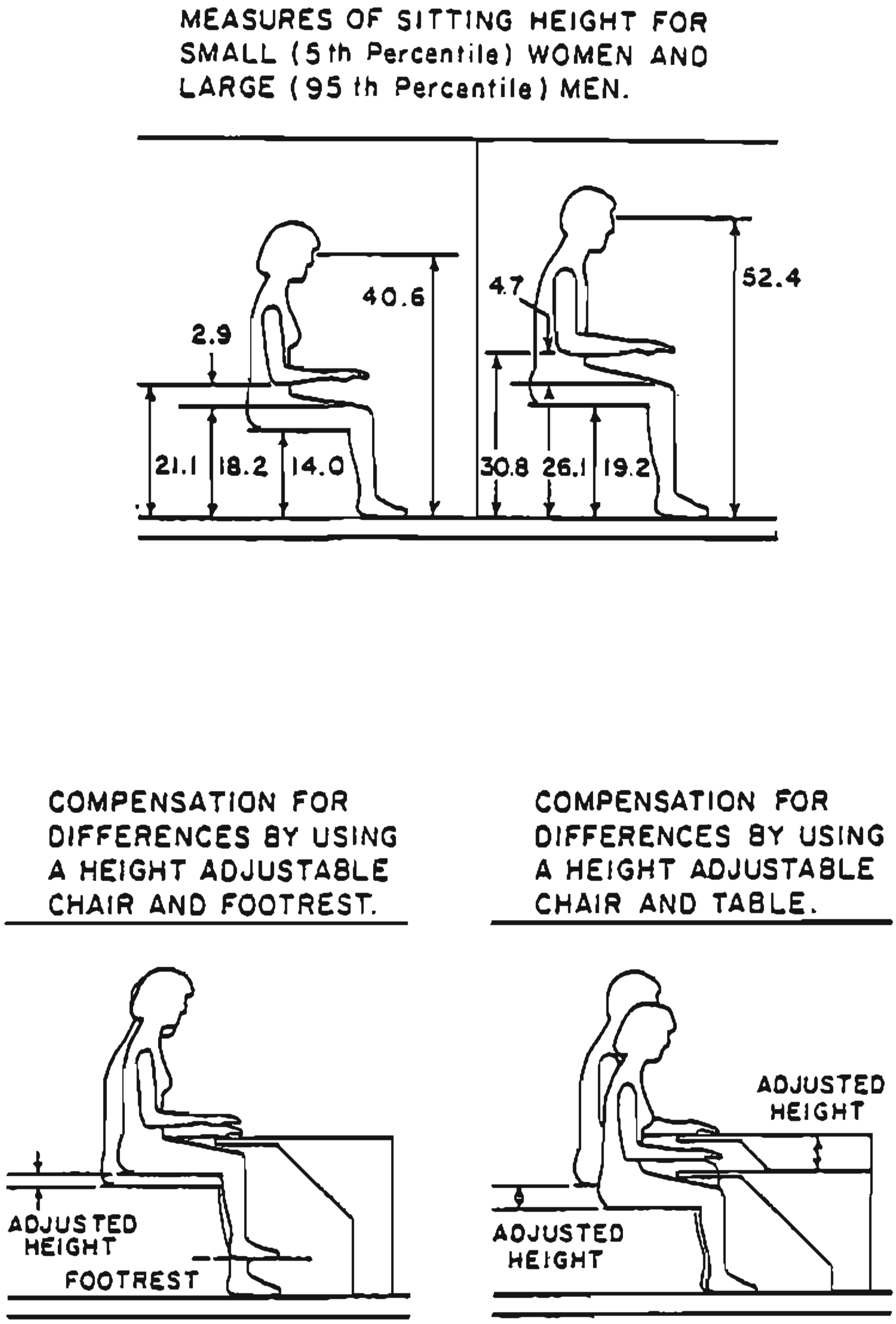

Figure 10. Anthropometric comparisons of 5th percentile (small) woman and 95th percentile (large) man. (Body measures are inches.)

display, characters are generated by a dot matrix technique. One of the main issues has been to investigate how many dots should be used and what kind of font has maximum legibility. A dot matrix of 5x7 is presently considered a minimum in most standards for VDT design. In the future, it seems likely that high resolution screens will be fairly frequent. A matrix size of, say, 20x30 may then be used, which will have the appearance of ordinary printed text.

Another commonly debated issue is the best color of the characters on the screen. There is a variety of alternatives, the most common of which are: green, orange, yellow, or white characters on dark background, and dark characters on a white background. The research provides no support for any of the alternatives; it is mostly an issue of personal preference (Helander, Billingsley, and Schurick, 1983).

Design of Office Illumination

Screen reflections are one of the most common causes of VDT operator complaints. The source of screen reflections includes windows, light fittings, and bright objects in the room.

There are two types of screen reflections: specular reflections and veiling reflections. Specular reflections produce mirror-like images of an object on the screen. Examples include reflections of the face of the operator and objects in the room.

Veiling reflections are diffuse reflections generated by a diffuse reflector like the screen phosphor or a sheet of paper. Matte treatment of the screen surface, e.g., etching, also produces veiling reflections. Veiling reflections increase the luminance of the screen background and the characters alike, thereby reducing the contrast ratio.

To enhance legibility and reduce operator discomfort, veiling and specular reflections should be minimized. There are different ways of doing this, for example, by using screen filters, an etched screen surface, or micro-louvers. The advantages and disadvantages of several measures for reducing screen reflections are shown in Table 9. Observe that the optimal combination of measures depends on the particular office environment and type of VDT.

Table 9. Measures for Reducing Screen Reflections

Measure	Advantage	Disadvantage
At the Source		
1. Covering windows		
Dark film	Reduces veiling and specular reflections	Difficult to see out
Louvers or mini blinds	Excludes direct sunlight, reduces veiling and specular reflections	Must be readjusted in order to see out
Curtains	Reduces veiling and specular reflections	Difficult to see out
Cover windows permanently	Eliminates reflections from outside illumination	Not appreciated by employees
2. Type of Luminaires		
Control of location and direction of illumination	Reduces veiling reflections, may eliminate specular reflections	None
Indirect lighting	Reduces specular reflections, economy of office space by moving workstations closer	None
Task illumination	Less veiling reflection, increased visibility of source document	None
At the Workstation		
3. Moving the workstation	Less veiling and specular reflection	None
4. Tiltable screen	Less specular reflection	Readjustment necessary
Tilted screen filter	Eliminates specular reflection	Bulky arrangement for large screens

Table 9 continued.

Measure	Advantage	Disadvantage
5. Screen filters and treatments		
Neutral Density (gray) filter	Less veiling reflection, increased character contrast	Less character luminance
Color filter (same color as phosphor)	Less veiling reflection, increased character contrast	Less character luminance
Micro mesh, micro louver	Less veiling reflection, increased contrast	Limited angle of visibility, non-embedded filters get dirty
Polaroid filter	Less veiling reflection, increased contrast	Decreased character luminance
Quarter wavelength antireflection coating	Eliminates specular reflection	Expensive, difficult to maintain
Matte finish of screen surface	Decreases specular reflections	Increases character edge spread (fuzziness), increases veiling reflections
CRT screen hood	Less veiling and specular reflection	Difficult to avoid shadow on the screen
Sunglasses (gray, brown)	None - Contrast unchanged	Less character luminance
6. Reversed video	Reduces specular reflections	Increased flicker sensitivity
Between the Source and the Workstation		
7. Screening of luminaires and windows	Reduces specular reflections	Might create isolated workplaces

Use of Speech Recognition Systems

Systems for speech recognition understand a limited vocabulary of words, thus, allowing spoken data or control commands to be entered into a data processing system.

Automatic speech recognition offers several advantages over other data-entry techniques (such as keyboards and paper-pencil communications). It frees the operator's hands and eyes so that he/she may perform other tasks simultaneously. It allows greater mobility, since the operator may walk away from his/her desk while continuing to enter information into the speech recognition system. Finally, it may be easier to train operators, since speech recognition systems offer a data entry medium with which users are familiar. As with most technological inventions in the working environment, there are also potential problems which may make a speech recognition system difficult to use. Some of these problems are summarized later in this text.

A typical speech recognition system utilizes a series of data processing stages that converts an acoustical analog signal to a digital signal. Certain features are then extracted from the signal (for example, formants, frication, voicing or pitch tracks) and stored in a language lexicon, which contains templates of a limited number of words, usually around 100. The recorded word is then compared to the characteristics of the words stored in the lexicon, and the best match is chosen for presentation. The recognized word may be presented to the speaker using several different modes, for example a CRT screen or a digital recording or speech synthesizer. Thereby, it is possible for the user to verify that the system recognized his/her spoken words.

There are three different types of speech recognition systems:

1. Isolated word, speaker-dependent
2. Isolated word, speaker-independent
3. Continuous speech, speaker-dependent

Speaker-dependent systems are the most frequently used. These systems can recognize only one speaker at a time. The speaker must first "train" the recognizer by repeating a prearranged list of words several times. The computer constructs a phonological representation of each word, which later can be used to compare spoken words against. Unfortunately, this is not the straight forward process many people may believe it is. Typically, during the day, an individual's voice patterns keep changing. Therefore, the computer may have to be updated or "retrained" at regular intervals.

Most systems available on the market can recognize a vocabulary of up to 100 words and manufacturers often quote an accuracy rate of about 98%. Such information may be misleading, however, since there are yet no standardized testing procedures for speech recognition devices. Performance ratings achieved for one particular speaker and one particular set of words are, in fact, not easily duplicated under different circumstances.

There are also systems for isolated word, speaker-independent recognition. These systems, which may be attached to a telephone, have a much more limited vocabulary and are considerably more expensive than speaker-dependent systems.

Systems for continous speech, speaker-dependent recognition treat word sequences as a series of phones or speech sounds represented by a phonetic graph. Since continuous speech contains few pauses between words, these graphs do not necessarily indicate word beginnings or endings. Some sound sequences may be interpreted improperly even by the human ear. Researchers have not yet found a solution to this problem. Obviously, interpretation of the phrases below depends on the context in which the speech was produced, yet, phonetically, they sound about the same:

"Recognize speech."

"Wreck a nice beach."

The best publicized use of continuous speech systems is by the U.S. Post Office which is using voice recognition for sorting mail by zip codes.

There are not yet any systems available for continuous, speaker-independent speech. This development might well be beyond the capabilities of computerized algorithms.

Speech recognition has several disadvantages. One of the main problems is that the phonological characteristics of speech vary considerably among individuals. Male and female voices produce speech patterns that are distinctly dissimilar as do regional dialects and accents. This makes it difficult to develop speech recognition systems that can understand several individuals, so called speaker-independent systems. Although such systems exist, the vocabulary is typically more restricted than for speaker-dependent systems.

Research performed by Chapanis, Parrish, Ochsman, and Weeks (1977) at John Hopkins University has shown that most work situations can be managed with a vocabulary of about three hundred (300) words. The present limitation on the number of words (about 100) is therefore inadequate, although less so than many believe. It is predicted that as algorithms are improved to allow larger vocabularies with improved accuracy, speech recognition systems will become increasingly common. Presently, the market is fairly small. The annual sales in the U.S. are estimated to be about $20,000,000. However, market projections are generally optimistic with forecasts varying between $130,000,000 to $995,000,000 annual sales within five years.

Presently, there are several applications of voice recognition technology (see Table 10 and Figure 11) and the list is growing rapidly. The most obvious applications involve so-called "hands-busy, eyes-busy" tasks in which the operator is usually required to simultaneously record information about an object while manipulating the object. Examples of such tasks include inspection, logistics, production control,and sorting. The use of voice recognition makes it possible for the operator to report his/her findings as they are observed without the use of a keyboard or writing materials that might distract attention from the primary task.

Inspection can be accomplished with voice systems either online or offline. Online inspection might be used on an automobile assembly line where the product must be inspected before leaving certain areas. For instance, the engine mounts should be inspected before the automobile is moved on to body assembly. On the other hand, offline inspection would be best utilized for inspecting and certifying completed products, such as circuit boards, appliances, etc.

Logistics, or the procurement, maintenance, and transportation of materials, personnel, and facilities has been much advanced with the advent of computers and voice recognition. Invoicing, product receiving inspection, and inventory control are all prime candidates for voice systems. Traditionally, these activities involve at least one person counting or checking items and manually recording information about the product. The use of voice recognition not only speeds up the process by freeing the operator's hands but automatically enters the information into the computer, updates old records, identifies deficiencies, and initiates billing and ordering.

The use of voice recognition in production control is much more efficient than the traditional method of hand recording. For example, scheduling of productivity data can be made immediately available and may help improve productivity or reduce production costs.

A direct use of voice recognition in production is material sorting. United Airlines uses a voice system for sorting baggage. Operators simply say

Table 10. Some Applications of Speech Recognition Systems

Application	Example
Factory Inspecton	General Electric - circuit boards
Quality Control	Datsun - automobiles
Mail Sorting	U.S. Post Office
	United Parcel Service
	United Airlines
Medical Laboratories	Abbott Laboratories
	Mount Sinai Hospital, Miami, FL
Office Work	U.S. Geological Survey - cartography
	Calma - Computer Aided Design
Command and Control	U.S. Naval Air Development Center
	Lockheed Corp. - cockpit applications
Driving	Control of radio and air conditioning
Home Appliances	Control of television and video cassette recorder
	Microwave Oven
Computers	Control of CAD, CAM
Office Products	Control of photocopiers
	Typewriter
	Keyboard special function keys
Handicap Aids	Control of beds, wheelchairs, etc.
Telephone Users	Telephone banking
	Telephone reservations
	Control of PABX functions
	Control of voice mailbox system
	Speaker verification to control network access
Telephone Companies	Customer billing information
	Switching control center and other routines

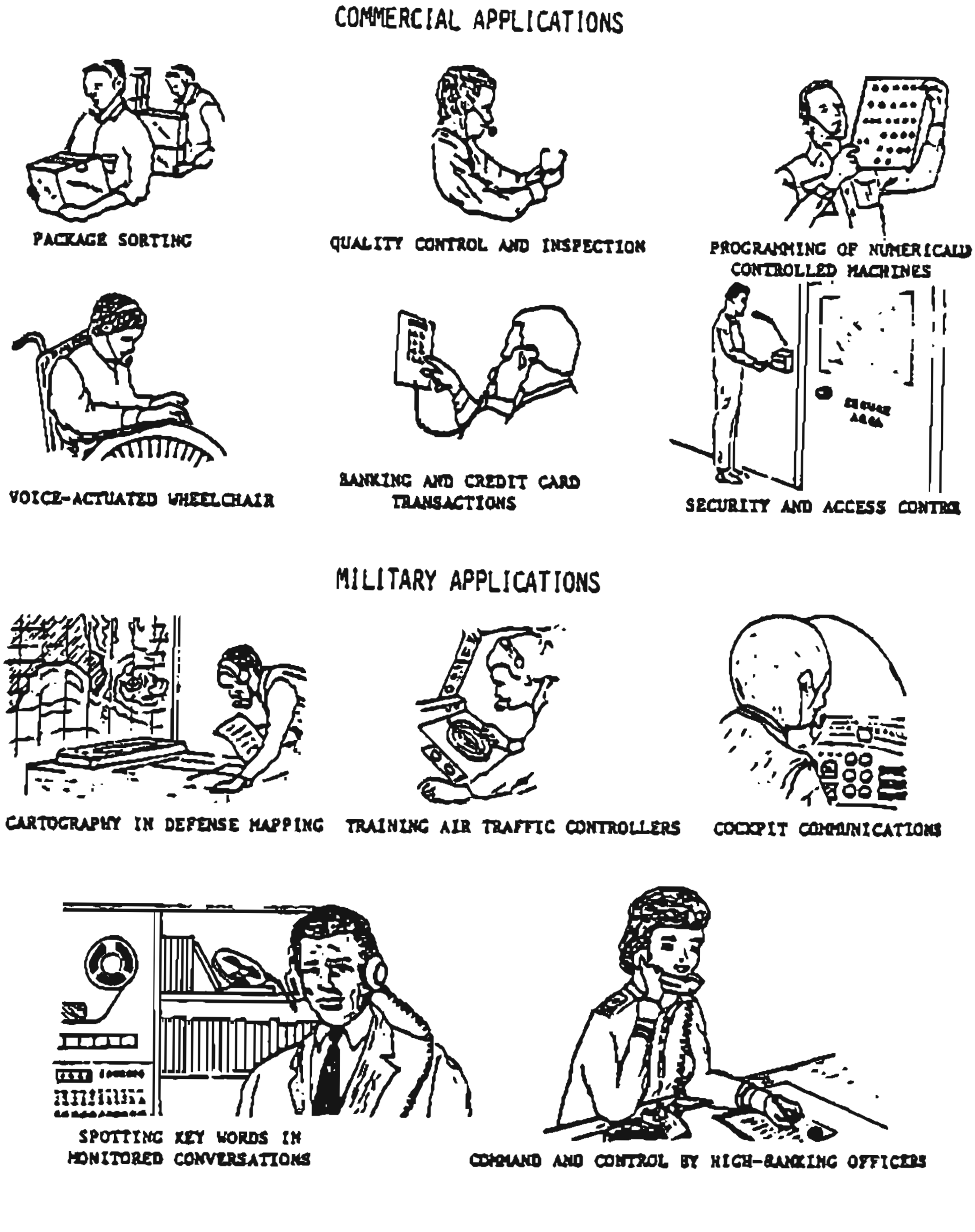

Figure 11. Commercial and military applications for speech recognition. (Source: Lea, 1980)

the bag's destination into a microphone and it is automatically routed to the correct flight. Not only does this speed up processing time, its implementation has greatly reduced the number of encoding errors. Similarly, the U.S. Postal Office and United Parcel Service use voice systems for sorting mail and packages by zip code.

Two other unique tasks that use voice recognition systems are the pathological analysis of slide preparation and map drawing. For some time, Abbott Laboratories in Boston, Mass. has been using speech recognition for reporting the findings of laboratory analyses. This has an advantage in that the operator does not have to remove his/her eyes from the microscope, but may continue to report the findings into a microphone attached to the microscope. This procedure has increased productivity by approximately 30%.

Cartographers at the U.S. Geological Survey use voice recognition as an aid to producing maps. Information obtained from photographs of an area is displayed on a CRT. While the cartographer performs a visually demanding search of this information, he uses a track ball to control a cursor around the screen. Using a voice system, the operator is able to identify features that will later be labeled on the map, for example, altitude data (mountains and valleys) and physical features (e.g., bridges, buildings).

There are several telephone applications of speech recognition systems. Banking transactions and ticket and hotel reservations are among the most familiar. In addition, speech recognition systems may be used to control PABX functions and voice mailbox systems. Telephone companies may also use speech recognition systems for the management of telephone networks. These possibilities are currently under investigation by Bell Telephone Laboratories in Naperville, Illinois.

In the future, as the price of speech recognition devices comes down, there will also be domestic applications of speech recognition, such as control of air conditioning and car radios.

Human Factors Problems in Speech Recognition

A driving factor for the introduction of speech recognition systems is increasing productivity, especially for tasks where it is important to free the operators hands or where visual attention to the task is critical. A recent study, however, demonstrated that, as a result of increased productivity, the operator's total workload also increased, and the capacity to perform a simultaneous task decreased. This might have implications for safety, since operators may not be able to attend to safety hazards that are peripheral to the work. In addition, increased workload may produce an increase in fatigue; it should be investigated whether fatigue is mostly mental, and if the increased use of one's voice produces vocal fatigue, hoarseness, or other symptoms.

Unfortunately, there has not yet been much research on human factors and social problems with voice recognition systems. Several potential problems are mentioned below.

One common characteristic of speech recognition systems is their inability to understand normal changes in the operator's voice. During the course of a work day, an operator's voice may change dramatically. The morning hoarseness disappears and an increased articulation often develops as the muscles in the mouth become exercised. Such sensitivities might lead to difficulties in communicating with fellow workers, chewing gum, or smoking because these might distort the voice. In addition, non-planned speech and noises, such as coughing, lead to misrecognitions. Table 11 presents a list of speaking rules for speech recognition systems.

It is usually necessary to provide visual or auditory feedback to the user of speech recognition. For visual feedback, a CRT may be used to display the words recognized. The monitor should be positioned in the operator's primary visual field. (In practice, displays are often positioned at locations where they are difficult to monitor.) Auditory feedback, either digitized or synthesized speech, might sometimes be preferable. One of the main drawbacks, however, is that auditory feedback can be tiring or distracting to listen to. One issue that requires investigation is whether feedback should be chunked; grouping data often facilitates comprehension.

Voice recognition systems can only understand a limited number of words. For some tasks, the number of words can be increased by subsetting the words. There are several implications for human factors: how many decision alternatives should be used and how large can the branching network be. More importantly, however, might be to investigate the effects of standardizing task performance on job satisfaction. It has been suggested (Nye, 1982) that job rotation and job enrichment techniques might be particularly important for highly repetitive voice tasks.

Voice recognition might create other social problems. Many people are afraid to talk into a microphone ("mike fright"). This might have an impact on the acceptance of voice recognizers in the workplace. Many systems can

Table 11. Speaking Rules for Use with Speech Recognition Systems

- Speak each word quickly and crisply, yet in a normal tone of voice
- Do not exceed 20 utterances per minute
- Enunciate words clearly
- Do not overenunciate
- Unnaturally slow speaking rate distorts signal
- Take deep breath before each utterance
- Pause between breathing and speaking
- Speak several utterances with a single breath
- Lip smacking, clearing throat, coughing, talking to others may cause rejections and errors
- No loose dentures, chewing, smoking, or eating
- Short words are usually more difficult to recognize
- Stress usually reduces pauses and enunciation, creates breathing problems, and generally degrades performance
- Turn off microphone when not speaking directly to the computer

recognize speech only if the utterances are separated by a brief pause. If these "discrete speech" systems become prevalent, operators will need to learn how to speak using discrete utterances. Speaking discretely not an easily acquired skill; one must learn to speak crisply and to leave the required gap, plus a safety margin, between words.

Some languages are easier to understand with voice recognition devices than others. For example, the Japanese language is more amenable than English to machine recognition since it is composed largely of consonant vowel pairs. One might speculate that Japanese firms will maintain yet another edge in enhancing productivity.

Motivational factors seem to effect voice recognition performance, and users who are anxious or tense often have serious problems with voice systems. It also appears that voice recognition systems perform better with men than women. In addition, regional dialects and foreign accents are often difficult for a speech recognition system to accommodate. This raises the fear that speech devices might adversely discriminate against certain groups of people.

This brief review of applications and potential concerns of voice recognition systems is meant to convey two points: first, that the implementation of devices that speak and/or recognize and respond to speech may present a cultural change of some significance, and second, that the range of potential social repercussions seems very wide. The time is right, when these technologies are still in their development, to begin examining their implications. Much research remains to be performed in the human factors and industrial sociology areas.

8. MEETING AND CONFERRING

Meetings occupy approximately 50% of the time of managers and executives and perhaps represent the single most important activity in an office. There are two main types of meeting: informal and formal. Informal, nonplanned meetings are more common than formal meetings.

It, therefore, seems that automating meetings or at least some aspects of meetings through the use of electronic mail or teleconferencing could lead to gains in productivity. Some types of meetings, however, are difficult to automate, especially those involving negotiations, counselling, personal support, and so forth.

Brecht (1978) analyzed common purposes of meetings. The results were surprising since there was seldom agreement about the purpose of a meeting. On the average, participants in the same meeting listed 8 and as many as 21 different purposes for the meeting. Clearly, the assumption that meetings are conducted for a distinct purpose is highly questionable.

Brecht collected much data in order to quantify interactions during meetings, for example, the number of topics discussed, the proportion of time spent communicating, etc. Altogether, 15 variables were analyzed with respect to differences among meetings conducted in private business, government, and at universities and there were no significant differences. In other words, the basic structure of the meetings was independent of the environment. The only variable that was significant was the size of group. Small meetings, typically with two persons, generally lasted less than 30 minutes and usually discussed one or two topics. Medium sized meetings involving about six participants lasted, on average, one hour. While the chairpersons in small meetings dominated the communications, they played a much less dominant role in medium sized meetings. These meetings were also characterized by more topics of discussion and greater use of communication aids. Finally, large meetings differed from the small meetings in much the same way as did the medium sized meetings, only more so. These meetings could last up to five hours and included more people, topics, and aids.

One characteristic that applied to all meetings was that one meeting often led to another. Following the conclusion of a meeting, several mini meetings were spontaneously formed among smaller groups of the assembled participants. These meetings were regarded as essential for interaction and exchange of information.

Business meetings tended to be information self-sufficient, and all participants shared in contributing necessary information. In contrast, government meetings, which often involved the general public, were dependent upon outside sources of expertise. Brecht concluded that several aspects of these meetings, such as bringing in outside support and holding mini meetings, are difficult to perform in teleconferencing. However, much more research is needed on these issues.

Hough and Panko (1977) analyzed the contents of meetings. The most common activities involved seeking information (49%), giving information (48%), and problem solving (48%), see Table 12. It may be concluded that most meeting activities require active group participation. Only giving information can be performed on a non-interactive medium, such as electronic mail.

Table 12. Common Meeting Activities (Source: Hough and Panko, 1977)

Activity	Percent of Meetings
Information seeking	49%
Giving information	48%
Problem solving	48%
Discussion of ideas	26%
Delegation of work	12%
Negotiation	11%
Forming impressions of others	9%
Policy making	8%
Presentation of report	8%
Inspection of fixed object	7%
Conflict	4%
Disciplinary action	1%

Group interaction is becoming increasingly important. In a democratic environment, decisions are often made by groups rather than individuals. Regardless of the media by which they interact, new groups usually do not work well together. With time, as participants get to know each other and get to know their roles in the group, effectiveness increases. This has implications for the appropriateness of teleconferencing since it is more difficult to get to know each other using the teleconferencing. These issues are discussed in the next section.

Teleconferencing

A teleconference involves two or more individuals at different locations with discussions being transmitted through audio, digital, or video techniques. Each of these communication modes is treated separately below under the headings of videoconferencing, audioconferencing, and computerconferencing. Some research studies of general interest are first summarized.

Several studies have compared the efficiency of different types of teleconferencing. Ochsman and Chapanis (1974) compared the efficiency of ten different communication modes in solving real world problems. The results are shown in Figure 12. The authors pointed out that the major gains were obtained for those communication modes that used voice.

The addition of a video channel had little or no effect on problem solution time. Voice and video was only slightly faster than voice only, and typewriting only was almost identical to typewriting and video.

Chapanis, Parrish, Ochsman, and Weeks (1977) used two problem solving tasks, an assembly task and a map finding task, to investigate different communication methods. In the assembly task, the information seeker was given several pieces of hardware to fit together. The information giver had a drawing, a description of the product, and instructions of how to put it together. Conversations were carried out in one of four modes of communication: typewriting, hand writing, voice, and face-to-face. Some of the major findings were:

1. Problem solving took about the same time for face-to-face and voice modes.
2. Problem solving took twice as long for typing and handwriting as compared to the other modes.
3. Spoken communication is characterized by unruliness with more than ten times as many words, and about 4 times as many unique words as for the other modes of communication.
4. For the voice mode, the average number of unique words was 446, but the maximum required was 123.

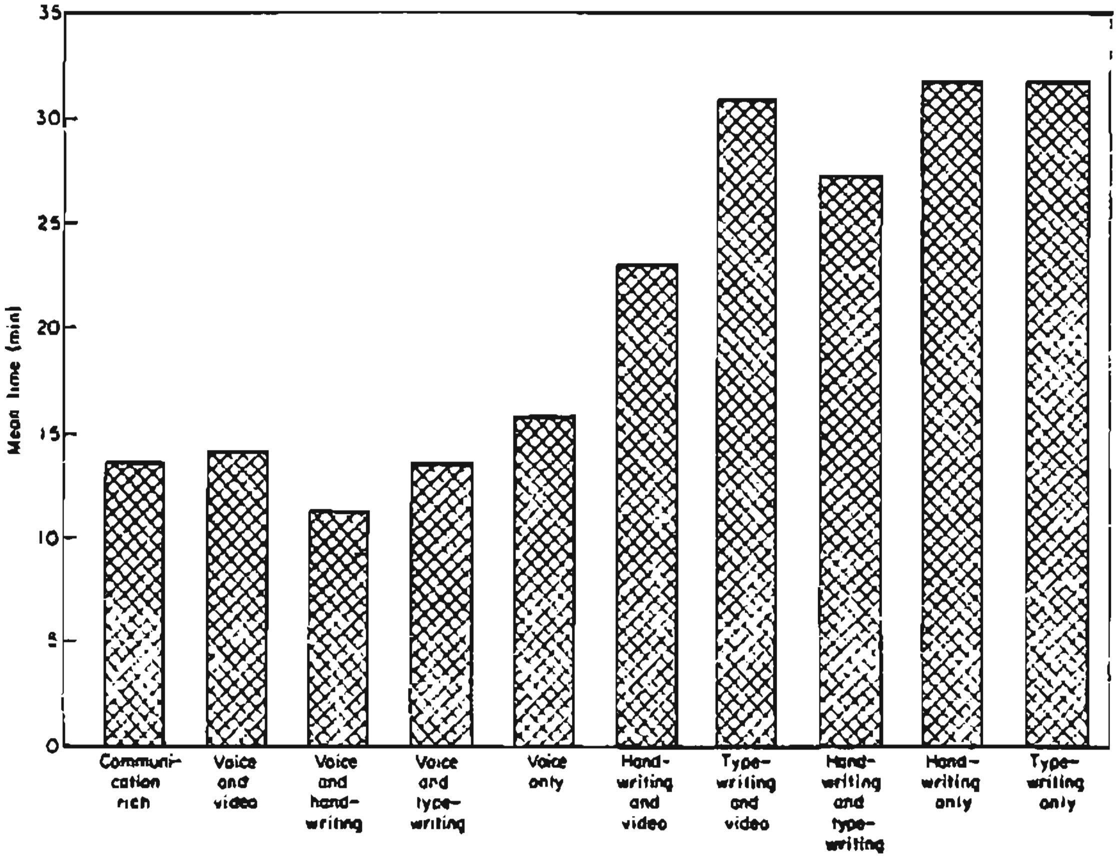

Figure 12. Mean solution time for 10 modes of communication. (Source: Ochsman and Chapanis, 1974)

5. Only 1/3 of the time was spent communicating; searching for information took longer.
6. Typing skill had no effect on the amount of time for solving the problem. Quite unexpectedly, skilled typists decreased their typing rates to an average of 18 words per minute. The explanation for this lies in the difficulty typists had in formulating the problem. It still remains to be investigated whether managers who are also experienced typists have an advantage over other users.
7. Typed sentences were longer than spoken sentences.
8. For this task, microphone voice communication was as good as face-to-face communication.

It seems that adding a visual channel to an auditory channel has little influence on problem solving time. Therefore, one may ask if the additional costs for video conferencing are justified. For most types of tasks investigated, the advantage seems, at best, marginal.

Several studies have investigated the attitudes and preferences towards teleconferencing and face-to-face conferencing. In general, teleconferencing was preferred when participants were separated by a long distance and when the discussions were expected to be of short duration. Sheridan et al. (1981) showed that teleconferencing is preferred by persons who know each other and when the discussion is neutral. Conversely, face-to-face communication is preferred when dealing with strangers and when there are sensitive issues being discussed.

Videoconferencing

Videoconferencing has been on the market for several years. It is increasingly used by large corporations in the United States. IBM, for example, has videoconferencing capabilities between 30 different plants throughout the world (IBM, 1982a). In addition AT&T leases videoconferencing centers in several major cities.

Most experts and researchers recognize that neither videoconferencing nor any other teleconferencing technique can fully substitute for face-to-face interaction. However, it is an effective substitute for many types of meetings that involve problem solving, educational conferences, task force reviews, announcements, and emergencies.

Duncanson and Williams (1973) rated the productivity, efficiency, and enjoyment of video versus face-to-face conferences, see Figure 13. The system connected two New Jersey facilities of Bell Laboratories. Overall, users of videoconferencing gave it very high ratings, and 90% said that they would rather use it than travel 50 miles.

Galitz (1980) pointed out that teleconferencing seems appropriate for simple information exchange and that it is not known if this media is also appropriate for more complex problems. IBM (1982b) noted several factors that facilitate videoconferencing:

- One person should be identified as the conference leader
- All participants should be introduced at the beginning of a conference
- Don't cough or sneeze in the microphone, and avoid side conversation
- Be as natural as possible; do not wear any special clothing or makeup
- Try to address individuals by name in the remote conference room; this causes them to respond and eliminates confusion

- It is good courtesy not to interupt a speaker
- The speaker should always identify him/herself unless there is absolutely no question that the people in the remote room know who is speaking.

One problem with video conferencing systems is the design of the video switching mechanism. Unlike audio-only conferences, in which all microphones are continuously blended, the video portion must be switched in videoconferences. For conferences involving only two sites, it is possible to use voice switching, with the camera rotating between speakers. However, with three or more conference sites, it is impossible to use voice switching.

Pagerey and Chapanis (1982) compared the use of several simultaneous video channels with manual switching by a central operator who could monitor the activities in each location. Each of the participating studios had a "request to talk button", and the operator at the central site responded to requests by activating the camera at the appropriate site. This system was compared to one in which there were several TV monitors, one for each conference site. The greatest difference between conditions was in number of words per message. In the switched condition, subjects used about 50 words per message, which was almost 5 times as many as the non-switched condition. In addition, problem solving took about 30% longer for the switched condition. The authors concluded, however, that the higher cost of the system with several monitors did not justify the slight increase in performance. Hence the switched system was preferred.

Although videoconferencing has been a technical success, it has not yet become popular (Gupta, 1982). So far, most videoconferencing facilities have been used at a financial loss. But, as energy prices soar and travel becomes increasingly costly, videoconferencing may offer a viable alternative. However, many researchers feel that video meetings, although suitable for a range of communication tasks, are unsuitable for communication between strangers or people of different ranks (Sheridan et al., 1981).

<u>Audioconferencing</u>

Audioconferencing involves the use of telephones and loud speakers connecting several locations. Compared to other conferencing modes, telephoning is simpler, less costly, and currently accessible to more people. There are several human factors problems in audioconferencing, including speaker identification, speaking order, and acoustics. Just as with video

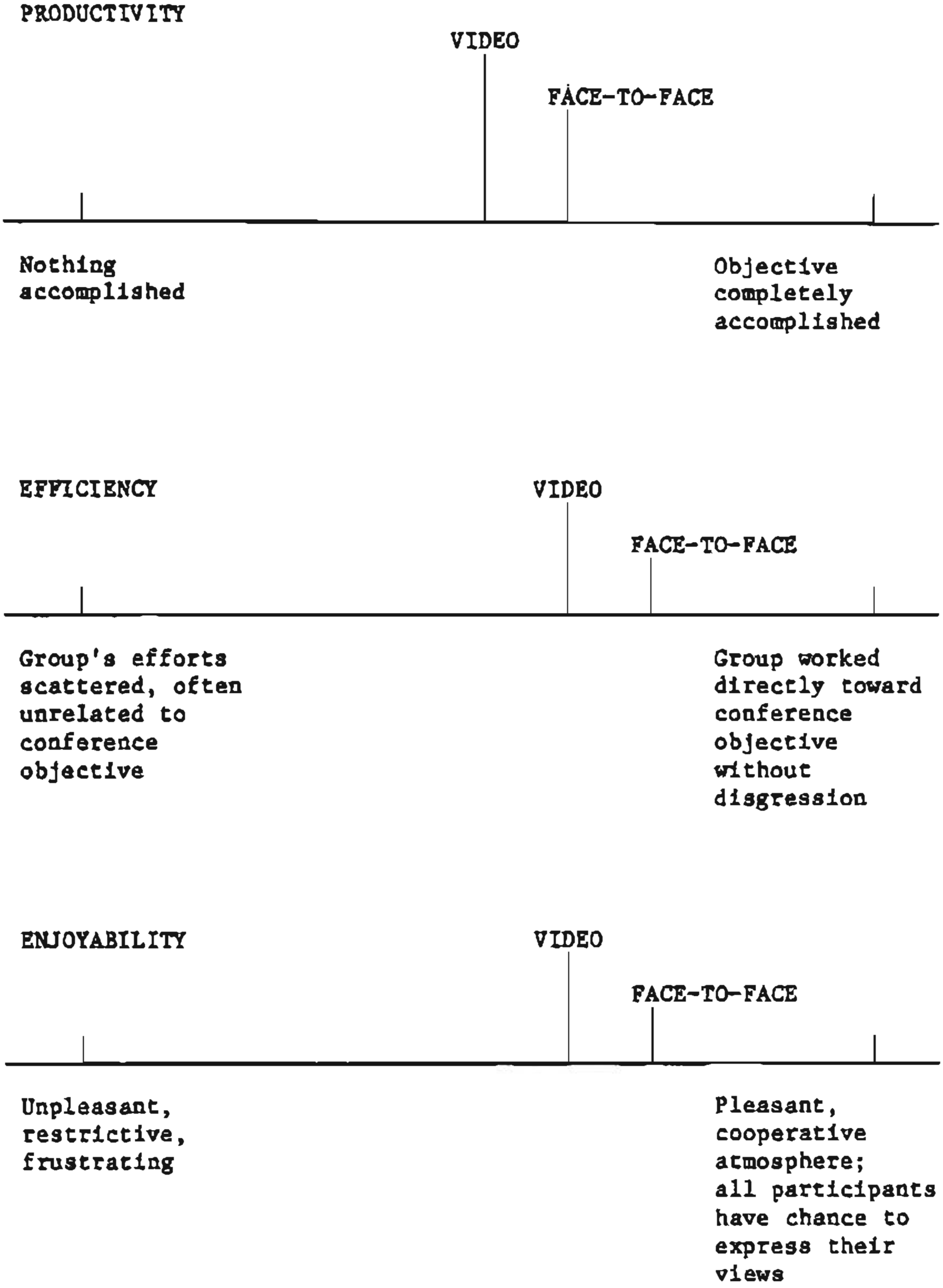

Figure 13. Comparative ratings of 1 MHz video and face-to-face conferences. (Source: Duncanson and Williams, 1973)

conferencing, there is difficulty in establishing speaking order. In personal face-to-face communications, body signals and interrupted sentences are sometimes used to establish speaking priority. On the telephone, however, this is not possible and many participants find themself playing a less active role than they would in a face-to-face situation. There is also a problem with identifying the speaker. This is particularly noticeable in large groups of people who sit at a greater distance from the microphone. It is, therefore, necessary for each speaker to identify him/herself repeatedly. It may also be more difficult for listeners to keep track of the train of thought of different contributors over an extended period of time.

Computer Conferencing

Under this heading, we will briefly describe both computer conferencing and conferencing using VDTs. Computer conferencing is distinguished from VDT conferencing by the use of software and computer memory for storing and sorting information. In VDT conferences, there is no specific use of computer power other than for routing the messages between participants.

Lerch (1983) recently summarized the state of the art of software availability for computer conferencing. There are now approximately a dozen commercial conferencing services available in the United States. Some of these use central computers and can be accessed by terminals via package switching networks such as TYMNET and TELENET. Generally, the computer is used for storing and sorting information. It is thus possible to branch a computer conference and develop subconferences or subcommittees. Although most of the systems share several features, there are some differences in their functions.

The EIES system, which runs on TELENET or UNINET, furnishes special information through an electronic marketplace for buying and selling information and a "paperfare" which is a repository of research documents. Another system called AUGMENT was developed by TYMSHARE and uses TYMNET. AUGMENT gives a subscriber control over various textual operations, including word processing and the generation of multi-color graphics. This system requires a high degree of user knowledge and skills.

COM, a program developed by the Swedish National Defense Research Institute enables participants to track related messages as a discussion grows. A single command is all that is needed to trace the complex branches of an involved discussion. HUB, developed by the Institute for the Future, runs on UNINET and supports four basic activities: graphics, programming, documenting, and balloting.

One main advantage with computer conferencing is that it is possible to accommodate many more participants than audio and videoconferencing. Strom (1982) cites several reasons for the growing interest in computer conferencing:

- It reduces travel costs
- Written communication may be more concise and precise than oral communication
- The system provides its own conference notes and accurate minutes of the sessions
- It allows conferees to work according to their own style and pace
- Items may be discussed in parallel rather than serially
- There is no need to attend an entire session since one can rapidly review the contents of a session afterwards
- It is possible to provide a continuous conference to replace periodic conferences; thereby, the discussion of various issues may develop over an extended period of time
- It can provide background information on topics being discussed, including research papers, company information, and other documentation that may be stored in a computer medium.

It is obvious that through the use of computerized information storage and decision making aids and voting procedures, this medium allows discussion of many items that are not appropriate for ordinary conferencing using VDTs. Some of the features available in computer conferencing are summarized in Table 13.

There has not yet been much research on human factors designs of computer conferencing. One study was performed by Sheridan et al. (1981), who reported the results of an 18 month field study of electronic information exchange. Approximately 30 U.S. and Canadian human factors professionals communicated from their offices and homes using computer terminals. The objective was to create a continuous conference on "mental workload" and papers could be submitted to an electronic journal. The EIES system on TELENET was used. Although there was no statistical testing of results, several observations were made:

Table 13. Common Features Available in Computer Conferencing (Source: Strom, 1982)

Feature	
Conference items	Documents may be accessed by athorized conferees. Documents may be marked and sorted by author, creation date, modification date, key words, etc.
Bulletins	High priority issues, e.g., message of the day
Notes	Private notepad for individuals. Information not accessible to other participants.
Mail	Information directed to one or a subset of conferees.
Biographic	List of participants with information such as phone number and professional background.
Voting	Voting is simple to implement with any computer.
Other features	Several features including: word processing, test formating, spelling, graphics, etc.

1. A majority of the participants saw EIES as a viable substitute for travelling to remote conferences and for telephone conversations. However, it was judged as less appropriate for keeping personal paper files.
2. Most felt that face-to-face discussions were still preferable when possible.
3. The majority of users had mixed feelings regarding computer conferencing as an effective medium of information exchange.
4. Three types of interaction developed:
   - Social interaction - 15% of the time.
   - Procedural clarifications - 20% of the time.
   - Substantive interaction - 65% of the time.

Social interactions took the form of jokes and cheery greetings, fulfilling a need for personal recognition and encouragement. Such interaction was encouraged by a computerized "cocktail party". However, after some time, people had difficulty entering their comments rapidly enough to engage in conversation and many people could not break into the discussion as it was progressing (because they found themselves having to read all previous comments). The overall impression was that participants sometimes seemed to be talking to themselves in the dark (often true even for real cocktail parties).

Procedural clarifications were generally instructions concerning the development of the conference including the organization of contents.

The substantive interaction included most of the technical information exchange. Six of the participants dominated the discussion by providing 76% of the comments and the three most active members contributed 54% of the comments. (This phenomenon is commonly refered to as Zipf's Law.)

5. The logical design of EIES was difficult to understand. EIES is a confusing mixture of menus and inadequately documented control language, and negotiation through the menu heirarchy is difficult. In addition, the TELENET logon procedure was unnecessarily complicated. Based on these observations, several design improvements of the EIES systems were proposed:

   - Make it easy for the user to send and receive messages
   - Tell the user what he can do and how to do it at each step; ensure that the user can find his way through the menu tree and does not get trapped in a menu loop, from which it is possible to escape only by disconnecting the TELENET
   - Make it easy to find out what information is available on TELENET
   - The multiplicity of terminology, e.g. "scratch pad", "notebook", "conference", is not useful, user convenience is important - not the convenience of the software designer.

9. TELEPHONING

This section reports some fairly recent advances: the private automatic branch exchange (PABX) and voice store and forward (voice mailbox).

PABX

The automation of telephone networks was made possible when the U.S. Supreme Court in 1969 allowed companies, other than telephone companies, to market equipment that could be attached to telephone lines. Features such as call forwarding and call waiting came into common use. Later, the introduction of computer power to the private automatic branch exchange (PABX) made it possible to keep records of calls and to choose the least expensive routing for a call. The most recent PABXs, sometimes called computer branch exchanges (CBX), electronic private branch exchanges (EPBX), and integrated computer based branch exchanges (ICBX), can provide detailed reports on telephone usage.

The combined voice-data PABX makes dual use of switching circuits and wires to carry both kinds of information. The simplest version is a data terminal connected to a telephone line using a modem (modulator-demodulator). It changes electrical signals into tones that can travel over telephone circuits. The data rate of this type of system is limited by the bandwidth of the telephone line and by noise introduced in the circuits from switching equipment. Normally the data rate is not over 4800 bits per second, but some specially designed circuits may carry data at speeds up to 9600 bits per second.

A modern PABX is composed of several sub-systems: a minicomputer with a microprocessor CPU, and a random access memory switching unit and associated electronics such as tone generators and rotary to digit translators. The use of digital-switching techniques implies that a PABX is capable of a range of digital communications including voice and facsimile transmission between different computers. Through software, the PABX may handle a variety of terminals, including printers and CRT displays, which can be included in a local area network. For regular telephone services, the PABX offers several advantages, including:

- Call queueing - the PABX queues a call to a busy extension until the extension is free, and then completes the call

- Cost control - the PABX can automatically restrict the placement of certain types of local or long distance calls from selected telephones
- Statistics - the PABX can provide statistics for individual telephones.

To the individual user, a PABX system has several advantages:

- Telephone users can access company or public networks without going through the company telephone operator
- The system can automatically dial telephone numbers and keep dialing the number until a connection is made
- Individuals may program the telephone to be answered by another telephone
- Conference calls can be arranged by dialing a particular code
- A tone may notify users that another party is attempting to get through.

These advances are only the beginning of automated telephone calls. Another major impetus is voice store and forward. With this system, it is possible to program not only the access of telephone lines, as described above, but also the contents and delivery of messages. Voice store and forward systems, or voice mailbox, are described below.

Modems

Data systems that communicate over telephone lines need modems, which translate digital signals into audio signals in the form of AC voltages. There are several kinds of modems. Radio frequency modems convert information into radio signals that can be sent over coaxial cables or into free space as radio waves. Fiber optics modems convert the signals into light, which are then transmitted through fiber optics cables.

The signaling between a modem and a computer is normally based on the standard RS-232-C. For a low speed modem operating at 300 baud (the Bell 103 standard), the station originating the call uses a tone of 2225 Hz to represent a 1, and 2025 Hz to represent a 0. Simultaneous 2-way transmission over the telephone line is made possible if the answering equipment uses different frequencies; for example, 1270 Hz for 1, and 1070 Hz for 0. A modem may thus transmit one set of tones while simultaneously receiving another set.

Other standards such as the Bell 202 and Bell 212 provide higher signaling rates. For the Bell 212 standard, the originating modem transmits a

1200 Hz tone and the answering modem transmits a 2400 Hz tone. The Bell 212 uses a change in phase of the signal rather than a change in tone. Since a phase change can be detected more readily by electronic equipment, the transmission rate may be increased.

Baud rate is the measure of transmission speed. It can be calculated as the reciprocal of the time duration of the shortest signal element in the transmission. For example, the time to transmit one element of information at 300 baud is about 3.3 milliseconds.

$$\frac{1}{0.0033} = 300$$

Bits per second (bps) is a measure of information transfer. The information element in most systems is either a 7-bit character in the American Standard Code for Information Exchange (ASCII) or an 8-bit character in the IBM EBCDIC. Characters per second (CPS) is a more practical measure of information than bits per second. Characters per second may be easily translated into words per minute, with a word consisting of 6 characters. A person can comfortably read words appearing on a screen at 300 baud (about 300 wpm). At 1200 baud, the words appear too quickly.

Terminals in close proximity to computers and connected directly to them may operate at speeds of up to 9600 baud. Even such speeds are considered slow in terms of computer to computer communication. Ten million bits per second (10 Mbps) is the standard rate for modern networks.

Voice Mailbox

A study recently performed by AT&T showed that using the telephone is one of the major activities in office work (Knopf, 1982). On the average, executives spent 16% of their time, and secretaries 20% of their time on the telephone, see Table 6. Sixty-eight percent of the calls investigated were made within the company, 32% outside the plant, and 42% to some other plant. For 24%, there was an immediate urgency to reach the other party. The remainder of the calls were less time critical, varying in urgency from a few hours to the next day, see Table 14.

Most of the telephone calls made were unsuccessful, see Table 15 . In 50% of the cases, the receiver was out of the office and in 18% of the cases, the telephone was busy. In many cases, there were ongoing meetings in the receiver office so the receiver had to call back at a later time. For calls

Table 14. Location, Purpose, and Urgency of Business Telephone Calls within the Same Company (Source: Knopf, 1982).

Location	
Same location	58%
Other location	42%
Purpose	
Sending Information	49%
Exchanging Information	45%
Receiving Information	6%
Urgency	
Immediately	24%
Within a few hours	20%
Before end of day	29%
Next day O.K.	14%
Not time sensitive	13%

not successfully completed, the caller usually left a message. For 46% of all messages, the name and phone number of the caller were left for a return call. In 26%, the name, number, and purpose were stated; in 9% the caller left a complete message; in 10%, the name only was left; and in 9% of the cases, there was no message. In addition to the problems of reaching the intended party, there were frequent interruptions of calls that were successfully made. Obviously, the use of a voice mailbox makes it possible to place a message regardless of the availability of the other party.

An IBM study of 2,280 telephone calls showed that for 49% of the telephone calls, the main objective was to transmit information and for 45%, there was an exchange of information (IBM, 1982a). Obviously a voice mailbox would be adequate for those sending information but less suited for information exchange. Voice mailbox also makes it possible to concentrate calling and reception of messages to one part of the day, thereby decreasing interruption of other activities.

Table 15. Percentage of Successful Telephone Calls (Source, ATT, 1982)

Receiver Activity	Percent of Time
Out of office	50%
Meeting in office	14%
Working at desk	12%
On the phone	18%
Other	6%

Voice Mailbox Characteristics

A voice mailbox is used to store a voice message for delivery at a later time. Most systems digitize the message to be sent and store it on disk or some other random access memory device, see Figure 14. The system can stand alone or be connected to a CRT terminal, in which case it is possible to get a list of messages and select only those that seem important. Most systems also compress messages by removing pauses between words and by replaying the message at a faster rate (while maintaining pitch). For many systems, it is possible to call in from locations outside the office so that the system can be used as a telephone answering service. Some systems may be used only with a touch-tone telephone while others are usable with any type of telephone. Some systems make it possible to deliver a message at a predetermined time. Users can also request verification of message reception. In summary, voice mailbox systems may incorporate many additional features, depending on the manufacturer. Table 16 provides a list of some features available in voice mailbox systems.

Some Ergonomic Problems with Voice Mailbox Systems

Research by IBM stressed the importance of constructing a system that provides guidance to the user (IBM, 1982a). Two important goals in designing a user-oriented system are to assist a new user in learning the system, and to help an experienced user learn more about the system. Specific codes for help and user guidance are desirable.

User guidance should provide information that is sensitive to the function being performed. A special help button should be available to provide information that is most likely to help the user at any given time.

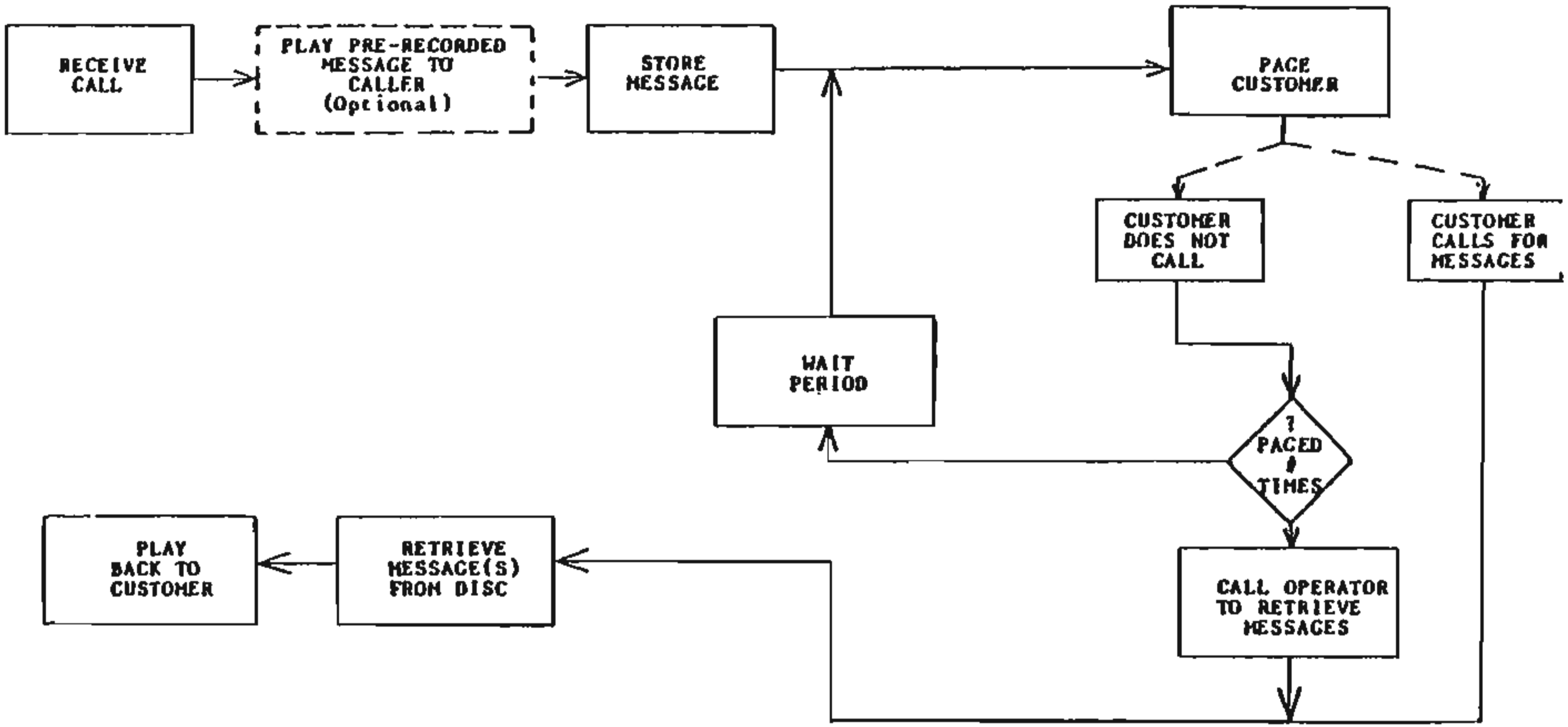

Figure 14. Example of system for voice mailbox.

Table 16. Some Important Characteristics of Voice Mailbox Systems

SYSTEM CHARACTERISTICS:
Systems Boundary: stand alone, with PABX
Rotary and/or touch-tone telephones
Number of subscribers
Number of simultaneous recordings
Number of messages per subscriber
Recording time per message
Total recording time
Message retention time
CALLING CHARACTERISTICS:
User HELP function available
Calling numbers or calling names
Group calling
Verification of message receival
Preprogramming of calling time and frequency
RECEIVING CHARACTERISTICS:
Ease of message access
Prescreening of messages (on screen) possible
Message entry date and time noted
Paging possible — time, voice, radio
Message and pause compression
Preprogramming of reception time

Subsequent presses of this button should provide more detailed information. The help button should also provide information on available commands and keep track of what the user has done and what the user can do.

Feedback and prompting are important, especially for new users. Systems should, for example, provide the user with confirmation of message transmittal, for example: "Message received by Dr. Ostberg October 22, 1982." It should also provide voice information that might reassure the user, for example: "record the message" or "listen to the message." Prompting can be used to avoid errors, for example: "Message is unchanged. To transmit press 1, to not transmit press 2."

In order to save space on the disk, pauses in speech are usually reduced. However, to maintain prosody it is desirable to maintain a small pause which is proportional to the original pause. IBM, for example, plays out 1/8th of each pause. Likewise, it is possible to remove long vowels without losing the meaning. A useful feature of voice mailboxes is the ability to annotate a message by inserting a comment at any point in the message. The original message plus the annotation may then be sent back as a response.

It is important to prevent users from making errors, such as sending a message to the wrong person or sending the wrong message. Some of these errors may be avoided by using a distribution system that sends to names rather than to telephone numbers (it is easier to make a mistake with a number than with a person's name).

As with all new systems, it is important to train users and to give them time for familiarization. Inexperienced users may be unaware of new mail which may keep accumulating until both the sender and receiver lose confidence in the system. It is also important that the voice mailbox be designed so that it doesn't unnecessarily disturb the user. Most users seem to appreciate a couple of quiet hours after coming to work and would rather take their own initiative to call the mailbox. Some complaints with voice mailbox systems are given in Table 17. Maybe these and other problems will inspire research on user acceptance.

Social Impact of Voice Mailbox Systems

The use of voice mailbox systems will most likely increase in the future. Several potential services besides office communications are available, such as delivery of company information, use of a dictaphone tied to a word

Table 17. Some Complaints with Voice Mailbox Systems (Source: IBM, Probe Research Seminar, New York City, 1982)

It's impolite not to tell about co-recipients
I entered my name on a long distance call
System messages play out too fast
System messages play out too slow
Can I get hardcopy of a message
I don't like to hangup on the system
Broadcast capability for system operator
Tell sender when message is received
Automatic translation of user messages
Why did the system tell me I had no message to listen to after calling me?
I want an easy way for my family to send me a message
I want the system messages in a male voice

processor, delivery of financial news, and storage of calendar information reminding users of important appointments. It is not yet clear, however, which services will be amenable to electronic mail and the relative importance that traditional mail and telephones will serve. For inter-office communications, there are obvious advantages with voice mailbox. For example, it has been shown that an average telephone call takes approximately six minutes whereas the average length of a voice mailbox message is about one minute. Despite such time savings, there are some negative aspects of the system which must be considered. For example, users may become frustrated by the impersonal interaction with the voice mailbox. Perhaps the short message time is an indication of user discomfort.

Some applications may have undesirable social consequences. For example, if voice mailbox is used for remote dictation, the typist can remain at home, listening to the dictation over the telephone line and typing at a visual display terminal. Such usage may have profound social effects since there may be no interaction with the employer or other employees. Due to increasing costs associated with office space, there is the temptation to encourage more home work. This might have adverse effects on job satisfaction for several individuals.

10. DOCUMENTING

Several novel types of office automation devices may be used for producing and storing documents, see Figure 15. Wordprocessors are used for typing and editing; text may be entered into a computer using optical character recognition (OCR); tables and graphics may be created from a data base using a data base management program; and images may be integrated with a report using facsimile equipment. After a document has been created, it may be reproduced as a paper document, sent as electronic mail, or filed on an electronic medium.

This section gives a summary of some of these devices: electronic filing, optical character recognition, facsimile, and electronic mail. It should be observed that most of these processes have other uses as well. Wordprocessers (VDT's) were dealt with previously under the heading of Transacting.

Electronic Filing

A study performed by Malone (1983) analyzed the way professionals and clerical office workers organize information in their offices. Two of the most important units of desk organization are files and piles. Both are ways of arranging groups of information. Files are units in which the elements (e.g. individual folders) are titled and arranged in a systematic order (e.g. alphabetic or chronological). In piles, individual elements (papers, folders, etc.) are not necessarily titled and are usually not arranged in any particular order. The ways piles are created often gives them a haphazard, inverse chronological order.

In addition to the problem of finding information, an equally important function of most desk organizations is reminding. Much of the information that is visible on top of desks is there to remind the user to do something. A deliberate attempt was noted for office users to prioritize information so that they could remind themselves, e.g., "If I don't put it here where I can see it, I won't do it".

One of the reasons individuals use piles rather than files is the time and effort it takes for classifying information into files. Malone made the observation that computer systems can help by creating classifications and retrieving information. In addition, a computerized system may be used to

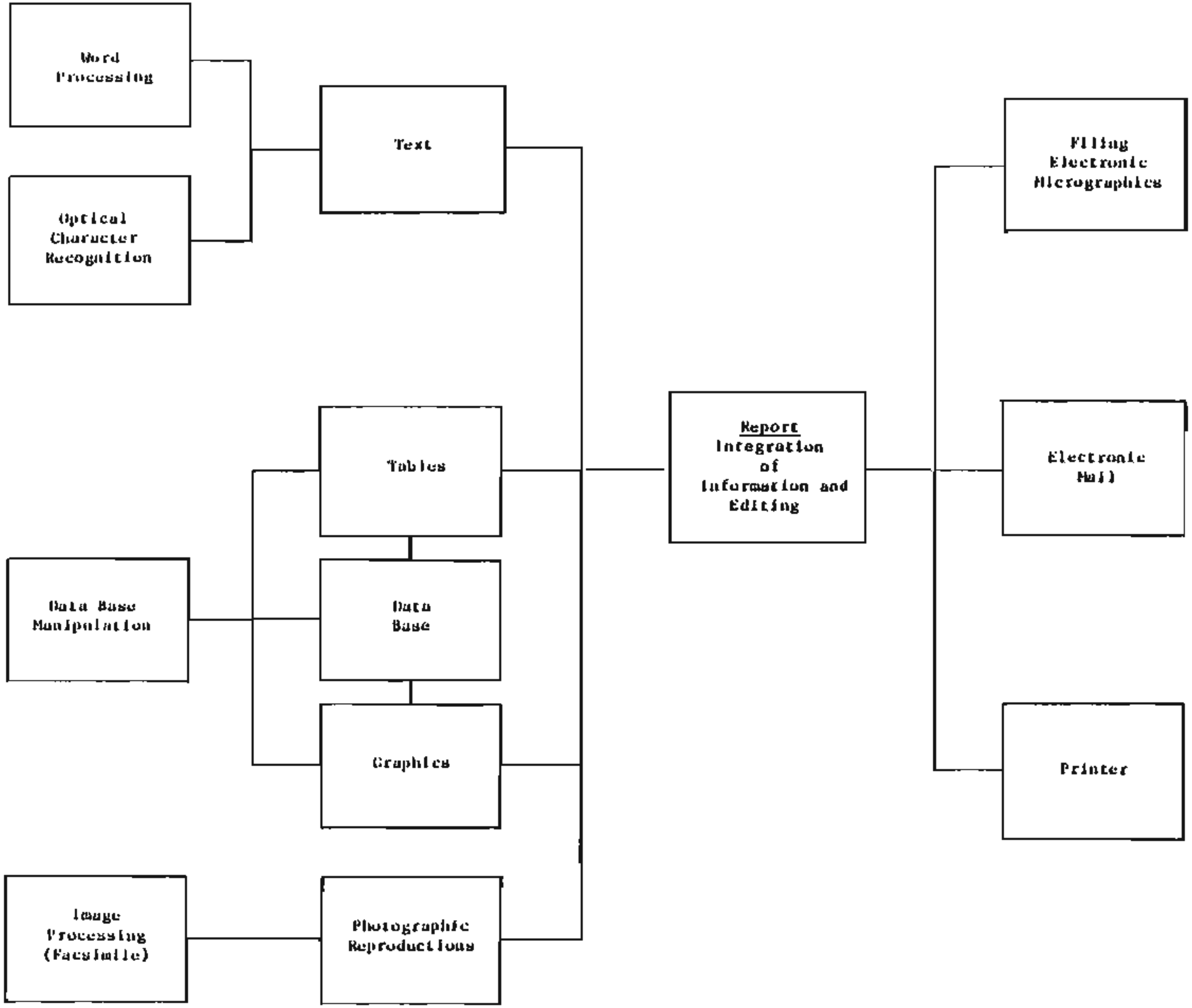

Figure 15. Process for creating, mailing, and storing documents.

remind individuals about tasks to be done and to prioritize information so that frequently used information is easily accessible.

Malone pointed out that, depending on the type of job, the organization of the desk may vary considerably. Neat desks seem to be more common among people with routine jobs than those with non-routine jobs. Whether or not it is worth the effort to keep an office neat, it is clear that there is perceived social value in having a neat office. The study gave some support to the claim that people with messy offices do, indeed, have more problems finding information and remembering tasks than people with neat offices.

The results of this study were used for designing the Xerox Star Computer, where files and piles may be manipulated on the screen. Considering the application, the results seem valid and appropriate. Overall, however, the research is just in its embryonic stage. Much more work needs to be done in order to develop a task taxonomy that is useful for describing office work and, at the same time, may be used to design computerized office aids. Some of the research results are synthesized in the following sections.

An important issue for electronic filing is how to organize information so that it is easily retrieved. A common approach involves the assumption that the type of information impacts how it should be filed. Several research projects have observed the behavior of individuals while filing and retrieving information. The intent of these studies was to create a model of filing behavior, so that electronic filing systems could be designed to mimic and enhance individual filing habits. Cole (1982) classified information according to the urgency or immediacy by which it needed to be accessed. Accordingly, there seems to be a continuum from action information to archive storage, with personal work files considered a hybrid of the two extremes, see Table 18.

Facsimile

Facsimile systems are used to transfer pages of documentation over the telephone network and for integrating photographic reproductions into reports created by computer. Facsimile equipment has been used in the U.S. since 1954 when acoustic couplers became legal. The real growth of facsimile equipment started, however, in the mid-sixties. Today, the equipment is most popular in Japan due to the fact that most Japanese letters are handwritten (the Japanese script has 10,000 characters requiring 2,500 keys on a typewriter). There have been recent predictions that facsimile communications will become common

Table 18. Classification of Information Based on Relevance and Immediacy (Source: Cole, 1982)

Action Information	Archive Storage Information
Has immediate relevance to present work	Rarely relevant to present work
Small amount of information	Large amount of information
Usually spatially arranged at the workstation	Usually arranged in rigid filing system
Short and longterm memory helpful for retrieving	Longterm memory helpful for retrieving
Requires little organization	Requires extensive organization

in Japanese homes. It seems unlikely that it will ever be popular in western countries.

There are facsimile standards set by the International Consulting Committee for Telephony and Telegraphy (CCITT). Commonly 100 lines per inch (4 lines per millimeter) are used for type not smaller than an elite typewriter, and 200 lines per inch for higher densities. NEC (a Japanese company) has recently released a combined highspeed facsimile and office copying machine with a resolution of 400 lines per inch (Kitahara, 1982).

One of the main problems with facsimiles is the large amount of data for each page of transmitted information. For example, 300 lines per inch requires 8,415,000 bits per page. At 1.2 megabites per second, it would take seven seconds to transmit this document using a local area network. Using a telephone network at 9,600 bps, it would take 97.4 seconds. The most recent equipment is capable of speeding up transmission time by reducing redundancy and compressing data. A 1:9 reduction at 300 lpi (lines per inch), for example, decreases transmission to about 10 seconds (Walter 1983).

Depending upon the required resolution, the transmission time required for telephone networks might be excessive. For example, a photograph with a resolution of 1000 lines per inch and a 9600 BPS transmission rate, requires transmission time of more than one hour, see Table 19.

In the future, there will be a convergence of facsimile and computer based mail systems. The ideal hardware system for this purpose should be capable of scanning, displaying, printing, and transmitting messages over a

Table 19. Transmission Times for Different Resolutions Using a Telephone Network with 9600 bps

Item	Resolution lines/inch	Transmission Time minutes
Photograph	1000	170
Halftone	200	16
Commercial Facsimile	100	4
Television	50	0.7

network. Prototypes are already available, and the system will become common in the second half of the 1980s.

Optical Character Readers

Optical character readers (OCRs) may be characterized by the following parameters:

- Speed of reading
- Accuracy of reading
- Type of fonts recognized
- Colors recognized
- Type and weight of usable paper
- Information storage facilities.

Ordinary handwriting cannot be read with great accuracy, although one device manufactured by Scandata Corporation can read hand printed alphanumeric characters. The products range from simple OCRs which can only read numerics in one particular font to those that can read more than 2000 documents per minute.

Electronic Mail

Electronic mail is now possible not only through a terminal attached to the telephone network, but also through the U.S. post office. The E-COM (Electronic Computer Originated Mail) allows mailers to transmit messages to any of 25 specially equipped post offices throughout the country (Bolger, 1983). Messages which are transmitted by midnight are automatically printed and inserted in E-COM envelopes for delivery as first class mail within one to two days. E-COM messages cost 26¢ for one page and 31¢ for 2 pages.

Regular electronic mail has also found its use within companies, but its introduction has been slow. McQuillan (1983) blames the lack of strategic planning. Without strategic planning, including specification of system architecture and a pilot test, it is difficult to raise enthusiasm for electronic mail. In order to be a success, an electronic mail system must fulfill a need to communicate, otherwise, employees will reject the system (Bair, 1979). Morgan (1979) points out that a minimum number of users in a company is between 8 and 15.

Galitz (1980) reports several important social issues associated with electronic mail: communication patterns, etiquette, privacy, keying, and softcopies. According to Galitz, most communication in an office using electronic mail is vertical, that is, flowing down from management to subordinates or up from subordinates to management. It is rarely used for horizontal communication. One of the reasons might be the ease by which management can send the same or similar messages to several employees.

One disadvantage with electronic mail is the difficulty of prioritizing messages. Previously, secretaries could sort incoming mail according to priority. With electronic mail, this seems less likely, at least until office routines have been established which encourage secretaries to use display terminals.

Electronic mail is usually proposed as a substitute for telephone calls and business letters (Galitz, 1980). However, there are certain differences in the type of communication. Telephone messages tend to be informal while business letters are formal. Electronic mail has been classified as something in between, with a language less formal than a business letter. This might suit some users more than others. Maybe a fast typist would profit from the use of electronic mail, whereas good verbal communicators might prefer to use the telephone. As has been pointed out by Chapanis et al. (1977), however, proficiency in keying is not necessarily required for efficient communication. In order to succeed, the privacy of communication must be guaranteed. It is unlikely that employees will use electronic mail if management is listening in.

II. CHANGES IN THE WORKPLACE -SOME TRENDS AND PREDICTIONS

Several years ago, C. P. Snow (1966) foresaw the development of computer technology and the great impact it would have on working life:

> "The computer revolution is going to be the biggest technological revolution men have ever known, far more intimately affecting mens' daily lives, and, of course far quicker than either the agricultural revolution of neolithic times or the earlier industrial revolution."

He also foresaw the need for sociological, psychological, and human engineering studies to investigate and control the effects of computer technology on humans.

At this time, it seems likely that the greatest impacts of automation will take place in the office, and not on the factory floor. Most robotics applications are specific to the product manufactured and require tailored software. In contrast, much office work relies on general applications software. The major point, however, is that office work is far more common than manufacturing. In 1950, approximately 17% of the population of the United States were employed in information jobs. Today, this figure is close to 60% and includes such jobs as creating, processing, and distributing information in banks, stockmarkets, insurance companies, schools, and government. Chapanis (1982) noted that 200 years ago, about 90% of the labor force were farmers. Fifty years ago, factory workers dominated. Today the number one occupation is clerk. One may speculate what comes next.

Office automation started in the second half of the 19th century. By 1900, there were a number of mechanical devices found in the office, for example Morris' Telegraph, Bell's Telephone, Edison's Dictating Machine, and the typewriter. By 1900, more than 100,000 typewriters had been sold and about 20,000 new machines were manufactured each year (Giuliano, 1982).

With the typewriter came an increase in the number of offices, variety of jobs, and personnel. With the introduction of typewriters and the telephone, new jobs for females as secretaries and telephone operators were created. According to some employers, women's ability to greet strangers pleasantly and their reliability and tolerance for repetitious work made them ideal receptionists and secretaries. In fact, it was said that "women's fingers raised as deftly over the typewriter keys as they had been playing the piano"

(Scott, 1982). Both of these occupations were destinated for single women and age limits of between 18 and 25 were usually enforced.

The segregation of occupations by sex has persisted. Presently, 97% of all secretaries, 96% of key punch operators, and about 92% of telephone operators are female. It seems likely that as duties expand in the automated office so will recruitment of male employees to these jobs.

Office automation, as we have already noted, is occurring extremely rapidly. Ian Ross, President of Bell Laboratories has expressed concern: "We are being led by the technology at the moment, and I think that we should never loose sight of the fact that technology should be serving people, not people serving technology" (Straw, 1982). With decreased time spent for product planning and decreased product lifetime, it will inevitably become more difficult to investigate the human factors consequences of new products, unless of course, human factors design rules are used during the conception of the product. There is increasing evidence that this might be the case. Wang Laboratories, an emminent manufacturer of office automation products, defines human factors as one of the six information technologies (the others are data processing, word processing, audio processing, image processing, and networking). According to Wang's definition, efficient operation may be achieved by considering the physiological, behaviorial, psychological, and sociological effects of office automation on humans. "The foundation of human factors is based on the understanding that users are the beginning points in all machine activity, regardless of how complete and powerful the equipment becomes".

Implementation of ergonomics and product design has become a selling argument. It still remains to be seen to what extent human factors is taken seriously and the extent to which research becomes public knowledge. There is already a tendency for manufacturers to not disclose results of human factors research. Although a majority of manufacturers claim to manufacture only ergonomically designed products, the findings they base their designs upon often remain obscure; sometimes because the manufacturers know little about ergonomics and sometimes because they consider their findings trade secrets. Maybe increased competition and enhancement of ergonomics as a selling argument will lead to futher non-disclosure. Human factors professionals do not sympathize with this trend; any findings with ergonomic implications must be published openly.

Labor unions in the United States seem to have lost much of their political power in recent years. In 1950, more than 30% of the workers in the U.S. were members of unions. The percentage has now decreased to 19% and it seems to be headed even lower. The dissolving borderlines between blue collar and white collar work might even accelerate the trend. Individuals who were formerly blue collar workers will find themselves in new occupations where they have to maintain and program robots and supervise the work of automated systems from an office. As a consequence, there will be a considerable migration of workers from manufacturing into information types of jobs. Finally, work that can be done at home on a VDT will become increasingly common. Such work arrangements will most likely reduce the accessibility of workers to unions and reduce recruitment practices.

One of the few burgeoning unions in the United States is the Communications Workers of America (CWA), which now organizes about 500,000 workers, mostly in the telecommunications industry. Glen Watts, President of CWA has observed the impact of technolgical changes for many years (Straw, 1982). According to his observations, the introduction of new technologies and telephone systems has not reduced the number of jobs but rather increased the versatility of telephone systems and the expansion of communications, which has made it possible to maintain the number of workers in this area. However, there are also negative effects of new technology. According to Watts: "The advancements of technology can have strong adverse effects on workers by reducing skill requirements, fracturing and eliminating jobs, fostering mental and physical stress, and creating health and safety problems".

Some of these problems have been attributed to the use of visual display terminals (VDTs). Although VDT's do not seem to promote visual fatigue to any greater extent then printed text on paper, nor seem to present a radiation hazard, user complaints are fairly frequent (Helander, Billingsley, and Schurick, 1983). Perhaps VDTs, as the most obvious reminder of automation, have become a symbolic focus for discontent. Other less visible aspects of office automation are, however, probably more consequential than VDTs. Software, for example, provides the primary interface between humans and automated machines. The design of software, therefore, deserves considerable attention and should take the users' needs and desires into account. Just imagine, through the rewriting of a couple of lines of software, it is possible to restructure a job, for example, by making it self-paced rather than computer-paced. Unfortunately, "user friendly" software has largely been neglected by computer scientists and ergonomists. Salvendy (1982) is among the few who point out the importance of feedback and selfpacing (rather than computer pacing) to reduce worker stress and enhance job satisifaction. By incorporating such details, it is possible to create jobs that are far more satisfying.

Another important design aspect of automated systems is computer response time. Several investigations provide evidence that long or variable response times increase the level of operator stress considerably. In fact, this issue has raised such interest that the U.S. Department of Defense has recently adopted recommendations to regulate these issues, see Table 20.

The Inexperienced User

With the increased use of computers at the workplace, there will also be wider recruitment of employees to handle computerized tasks. It should be recognized that the potential users represent a wide range of the general population: males and females, 20-65 years of age, minority groups, and different educational backgrounds. Although almost everyone has had some contact with computers in our society, very few have direct experience. The major human factors challenge is how to design computer systems that are adaptable to the range of skills and backgrounds of people who use them. There are two major issues: the problem of negative attitudes and acceptance of innovation, and the design of training programs.

The Problem of Attitudes

Most computer designers have experienced wide differences in attitudes, both positive and negative. Many of the negative attitudes seem to stem from that fact that prospective users might perceive the computer as a device that will depersonalize and dehumanize their work. These attitudes, however, typically change with increased experience with the system. O'Dierno (1977) cited an illustrative example of attitude change during the conversion from a batch-oriented data collection system to an on-line, terminal-oriented system. As can be seen in Figure 16, attitudes differed markedly as a function of organizational level and phase of implementation.

Table 20. System Response Times (Source: Hendricks, Kilduff, Brooks, Marshak, and Doyle, 1982)

Activity or function	Maximum response time Seconds
1. Systems activation	
a. Engaging ON button	2.0
b. Request to contact the system	5.0
2. Response to control activation such as change in control force after moving a key past a detent position, the appearance of a line when a light pen is used as a stylus, or the appearance of a printed character on the screen or page	0.1
3. Feedback	
a. To mechanical insertion of ID card	0.5
b. That ID number is correct in length and correct in alphanumeric format	0.5
c. That ID is accepted	2.0
4. Request for service (from command to beginning of the display	
a. Simple (frame already exists)	2.0
b. Complex command	5.0[a]
5. Error feedback	2.0
6. User intervention in an automatic process	
a. Acknowledgement of command	2.0
b. Able to execute command	5.0

[a]If processing will take more than 15 seconds, give the user an estimate of the length of time needed for the system to comply with the command(s) and provide an acoustic signal when the terminal is ready for the next command.

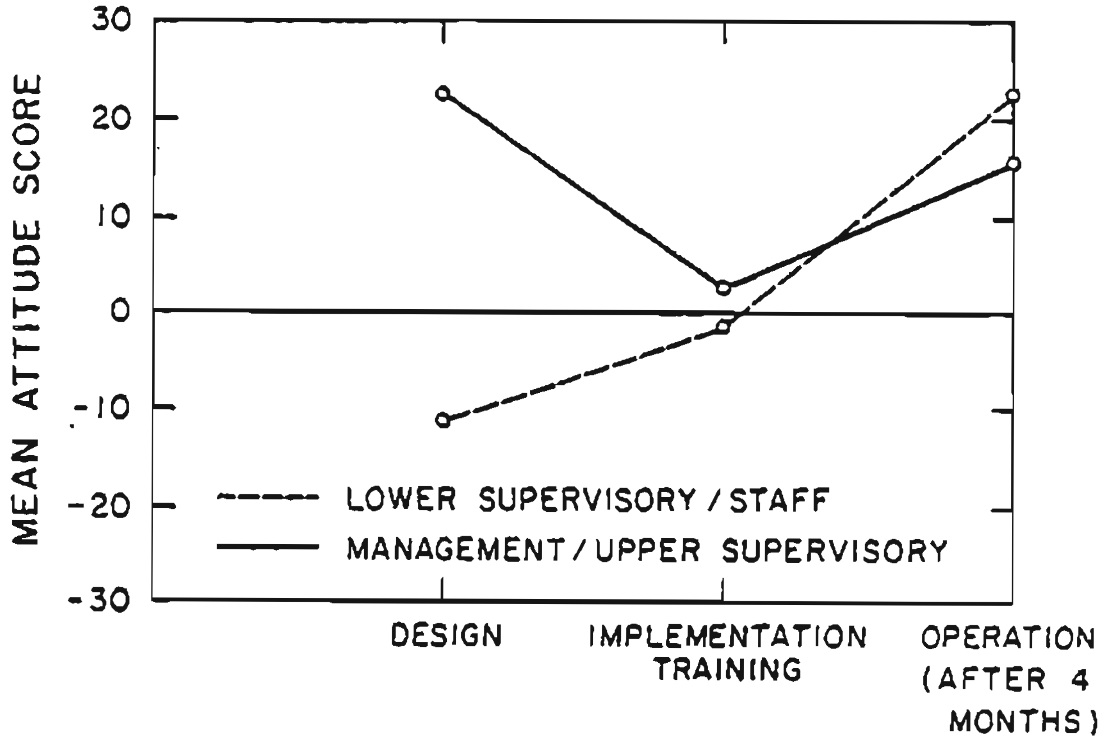

Figure 16. Attitudes towards a computer system depend on organizational level and phase of implementation. (Source: O'Dierno, 1977)

Initial positive or negative attitudes generally depend on several aspects:

- perceived features of the innovation
- prior experiences with similar developments
- estimates of relative advantage
- compatibility and complexity
- perceived personal risk.

The process of acceptance or rejection is, as illustrated by O'Dierno, a dynamic phenomenon that takes place over days, weeks, or even months. The initial inclination toward acceptance or rejection is more refined as further information is received during the course of system development. In the case of automation, it is particularly important that the individual be informed about all aspects of the new system. There are several rules for presenting this information:

- information must be comprehensive and factual
- misconceptions must be recognized and corrected

•problems associated with similar systems must be addressed
•design inputs from users must be considered.

Some User Considerations for Computers

It is likely that many basic human factors considerations found to be fundamental to good systems design in other applications will be equally important in the design of computer-based systems. The human factors principles that seem to be particularly important in specifying a human-computer dialogue include the following (Williges and Williges, 1982):

•compatibility of computer input and output
•consistency in human computer dialogue in order to help the operator develop a conceptual model
•brevity of input and output in order not to exceed the capacity of the human short-term memory
•flexibility to accommodate both inexperienced and expert users
•immediate feedback on the quality of operator performance and the condition of the system

Principles like these have been used to formulate guidelines for the design of human-computer dialogues. A considerable amount of information is presently available. For a brief review of these guidelines, the reader is referred to Hendricks et al. (1982).

Unfortunately, most designers of computer systems remain unaware of the research in this area. "User friendliness" is a popular word now, but few people realize exactly what it implies, and how research can be used to support the development of user-friendly design concepts. The editorial column of the Byte (April, 1983) gives a typical example of such lack of understanding: "The air is filled with claims and promises about the merits of each company's products, but nobody knows what makes software easy to use; the final answer will be in what the people buy." The situation is really not all this bad. Research can suggest answers, and there is plenty of existing information that may be applied to the design of user-friendly systems. The problem is getting designers to use the available information.

The Need for Training

With increased use of computers comes the need for training workers. The Communications Workers of America emphasizes several points (Straw, 1982):

1. The massive retraining that must occur if the benefits of a new technology are to be shared equally will need federal stimulation.
2. When new technology is implemented, workers must receive adequate training to enable them to improve their skills to work with new technology.
3. Vocational and technical schools should update their curricula so that students are taught how to use the new technology and how to understand it.
4. Public education at the primary and secondary levels must become more active. Although computer terminals are no longer rare in primary schools, they are more frequently found in prosperous school districts than in poorer districts. If this trend continues, it will introduce a predictable bias in the recruitment of labor.
5. Workers and union representatives must have access to all necessary information when new technologies are introduced. This includes a rationale for the technological change and an assessmemt of the impact on total employment, skill requirements, mental and physical stress, social isolation, and safety and health.

The answer to some of these demands might actually lie in the computer itself. The flexibility of computer systems allows for human aids to be a basic part of the system. It is not uncommon to see training incorporated into the system itself. This is particularly frequent in advanced control systems in which inexperienced users learn to perform complex tasks. The choice of computer aids for human operators, however, should depend upon the users' needs. In some advanced systems for computer aided training, the computer can make intelligent decisions by monitoring the progress of the trainee. Computer aids may, therefore, be used less and less as operators learn the new tasks. It might be worthwhile to develop a short computer based diagnostic routine for new operators. This kind of information exhange could bring new meaning to the term interactive computer systems (Muckler, 1981).

Working in the Home

The Swedish Labor Union, TCO, which organizes most white collar workers in Sweden has disallowed remote work in the home whereby communications are maintained via terminals. Many people consider this to be a return to "cottage industries" with the risk that employees are being mistreated. Compounding the problem is the feeling that reimbursement for remote work should be based solely on work produced. This provides the opportunity for exploitation of office workers (Olson, 1983). Maybe even more serious is the social isolation of home workers. The decrease in professional contact is likely to affect work motivation, job satisfaction, and opportunities for professional development and advancement (Working Women, 1980). Even for a manager who chooses to work at home, there is no assurance that the decrease in human interaction will not affect his or her long term carrier path, since visibility is often a key to promotion (Olson, 1983).

There are other cost-effective alternatives to working at home and at the office: satellite work centers, neighborhood work centers, and flexible work arrangements. A satellite work center is a relocation of an organization to a geographical location selected to minimize commuting distance. Again, there might be problems of remote supervision and social isolation from professional peers.

Neighborhood work centers provide another option. In this case, remote supervision of employees is assumed to be effective. Employees from different organizations can share space and equipment in the work center close to their homes. This concept might be difficult to implement on a large scale, however, because it requires a great deal of cooperation among different organizations.

The most appealing option (maybe the only viable one?) is a flexible arrangement whereby individuals can work at home or in the office as they see fit. Many companies now encourage employees to stay at home when they can, thereby removing themselves from the distractions of the office. Likewise, employees might have terminals at home in order to work at night or on weekends during non-peak computer hours.

Impact on Employment

The impact of office automation on employment is uncertain. Although there exists a great potential for automating various tasks in the office, the resistance to innovation may introduce a time lag in the implementation of new office procedures that will delay any trends towards unemployment. The creation of several new computer associated job positions will also absorb many individuals who might otherwise be laid off.

Office automation will doubtless have an impact on organizational structure. According to Goleman (1983), there is likely to be a gradual shift in the shape of the organization, from a pyramid to a diamond with a decrease of clerical support staff, incrase of professional and middle managers, and an unchanged number of senior managers. Not necessarily is this development unfavorable; several clerical staff members might be promoted into management positions which will change work organization. Giuliano (1982) made the observation that the production line approach to office work, which has been common for transaction-rich offices (e.g. banks, insurance companies, credit card companies) must be reorganized. Drawing upon methodolgies for job enrichment and job expansion developed in industrial environments, many organizations have now recognized the limitation of production line types of tasks. A few progressive banks and other service organizations with many transactions have converted some of their departments to a mode of operation more appropriate to the information age. The office machines are paced to the needs of the operator rather than the computer. Instead of executing a small number of steps for a large number of accounts, one individual now handles all customer related activities for a few accounts. Each worker has a terminal linked to a computer that maintains a database of all records which are updated as information is entered into the system. The clerical worker has been promoted to an account manager, works directly with the customer, and is fully accountable to the customer.

For many types of jobs, tedious data input will probably disappear entirely. This is possible by using portable terminals that can be used in the field; then, field representatives can input all of the required data in the required format. The information can then be transmitted to the main office via the telphone network. The tedious data input work, with operators inputting data from standard forms filled out by the field representatives, is thereby no longer necessary. Other electronic devices such as optical character recognizers and word processors will doubtless increase the efficiency of office work, reducing the demands on secretaries and clerks.

Porter, Rossini, Jenkins and Cancelleri (1982) give examples of three different possibilities for future employment. In the "displacement - reabsorption" scenario, technological developments will displace workers. The process of displacement will have been planned so that the loss of jobs in one sector coincides with opportunities in others. While the displacement process is not entirely smooth, its worst effects are mitigated by policies such as reduced work weeks. The information age world has fewer workers. However, the number of skilled positions are about the same, though these require different skills. Because of the declining birth rate, unemployment is low and people enjoy more flexible work environments due to electronic communications and flexible work arrangements. While uncertainty remains and many social tensions are unresolved, there is a sense that the worst is behind and that the automation process has been generally beneficial.

The "hourglass" scenario involves a massive loss of skilled jobs due to automation. The U.S. middle class will be squeezed in two directions. A minority moves to higher technical and supervisory positions while the majority is forced into the unskilled labor pool, where supply is greater than demand. These masses of unemployed people scramble between welfare and menial work with low self-esteem and little hope for improvement. There is a great deal of political activity among this group pointing toward revolution, and martial law has to be instituted.

In the scenario called "post industrial plenty", almost all industrial and clerical workers are replaced by automation. Increased productivity is translated into decreased work hours and increased benefits. Retraining and early retirement reduce much of the unemployment. There are overwhelming positive changes, including undersea exploitation and the industrial development of space, which create an economic boom with increased prosperity for everyone. Demanding and undesirable jobs are taken over by automated devices and robots, and human beings are beginning to contemplate the importance of non-economic pursuits.

Any of these scenarios will require research to develop human factors and ergonomics principles for the design of the automated office. Let's hope we will be prepared.

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Telestyrelsen beslutade 1980 att under fem år fördela ett särskilt anslag med syfte att medverka till snabb och lättillgänglig dokumentation av teleanknutna informationssystem. Detta anslag förvaltas av TELDOK och skall bidraga till:

- dokumentation vid tidigast möjliga tidpunkt av praktiska tillämpningar av teleanknutna informationssystem, företrädesvis för kontorsfunktioner
- publicering och spridning, i förekommande fall översättning, av annars svåråtkomliga erfarenheter av teleanknutna informationssystem, företrädesvis för kontorsfunktioner, samt kompletteringar avsedda att öka användningsvärdet för svenska förhållanden och svenska läsare
- studieresor och konferenser i direkt anknytning till arbetet med att dokumentera och sprida information beträffande praktiska tillämpningar av teleanknutna informationssystem, företrädesvis för kontorsfunktioner.

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