Jets and Nets:
The Emergence of the Virtual Airman

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Abstract

Currently, the Air Force - along with the majority of industry - implements virtual employment at the mid-level of technology; telecommuters work at a level of sophistication that is constrained by e-mail and telephone conversations. Although this is certainly sufficient for some tasks, it doesn't address tasks that require that the worker "almost" be present. This paper explores the state of technology in the virtual organization. Specifically, it examines the prevailing models of virtual work, the types of tasks that are suitable for virtual implementation, the infrastructure required to support virtual efforts, and the role reservists can play in the virtual military.

> We should note the force, effect, and consequences of inventions which are nowhere more conspicuous than in those three which were unknown to the ancients, namely, printing, gunpowder, and the magnetic compass. For these three have changed the appearance and the state of the world.
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> Francis Bacon, 1620, *Novum Organum, Aphorism 129*

Introduction

As little as 25 years ago, consumer computers were a novelty, the Internet a research project, and cellular phones a dream. Today, 610 million personal computers are in the hands of the world's citizenry.[1] The Internet community encompasses an estimated 400 million people across more than 200[2] countries, and is growing at such a geometric rate as to reach saturation by 2010.[3] One billion cell phones are projected to be in use within the next two years, up from 450 million today.[4]

The magnitude of these numbers gives us a glimpse into the pervasiveness of digital information technologies; but, the true Baconian significance of these innovations comes from how they have "changed the appearance and state of the world." They have fostered what the philosopher Marshall McLuhan terms a "global embrace"[5], the ability to gather information from across the planet with the same relative ease with which we can get it from our local vicinity. Computer and communication technology gives us, in effect, the tools to shrink distance and time: we can access information regardless of its physical location, and we can react to global events at the same pace we react to local ones.

The transformational aspect of this technology is the notion that work can be detached from the physical location in which the work is performed. Workers don't necessarily need to "go to

work" in the sense that they travel to a place of employment; instead, they "go to work" by accomplishing a task wherever they can best do the job. For instance, armed with software and hardware commercially available today, an arms inspector in Kansas can monitor the events of a nuclear reactor in North Korea, a soldier on horseback in Iraq can wirelessly uplink to a command center on an aircraft carrier the geographical coordinates of a illicit anti-aircraft battery, or a operator seated in Turkey can fly an unmanned aircraft over Afghani mountains.

Processing RC-135 intelligence data on the ground. (U.S. Air Force photo)

The strategy of uncoupling work from a physical location plays a fundamental role in the Expeditionary Aerospace Force, the doctrine by which the Air Force trains, equips, and deploys its resources in times of need. The EAF concept recognizes that the assets of the Air Force must be balanced carefully, especially in an era in which the force structure is relatively small. In circumstances requiring deployment, a percentage of the force is distributed physically to fight in place and a percentage of the force supports the expeditionary operation remotely. Viewed another way, part of the force is real and part of the force is virtual.

Emergence of the Virtual Worker

Divorcing work from physical location is not new. Legend has it that Phidippides ran the 26 miles from Marathon to Athens to deliver instructions to the Athenians regarding the approach of an invading army. The Sixth-century B.C.E. Greek, Histiaeus, collaborated long distance with his son-in-law on foiling the incursion of Persia into Greece. Conscious of security, he tattooed instructions on the shaved head of a servant then sent the servant forth once the hair grew back.[6] Xerxes conducted the affairs of fourth-century B.C.E. Persia remotely through communiqués delivered by a relay of equestrian couriers.[7] Message-laden pigeons in the 1200's played a pivotal role in the long-distance involvement of the Sultan of Turkey with his armies.[8] The idea proved so durable that the British Air Force employed an inventory of over 16,000 pigeons during World War II for similar "telecommuting" purposes.[9] Postal mail and subsequently, the telegraph, were principal means in the 1800's for news correspondents in the field to

communicate work to their home offices.[10] Telephones became a means of working from afar as early as 1877.[11]

A critical mass was sparked in the 1970's by Jack Nilles, a NASA scientist who, after becoming frustrated with the amount of productive time wasted by traffic jams of southern California, promoted the idea of working at home. Nilles coined the terms "telework" and "telecommute" to capture the essence of his philosophy:[12]

> *Teleworking* refers to ANY form of substitution of information technologies . for normal work-related travel. It's "moving the work to the workers," instead of moving the workers to the work.
>
> *Telecommuting* refers to that most common variant of telework, in which information technology substitutes for the daily commute. Telecommuters often work away from their principle office one or more days per week . either at home, at a client's site, or in a telework center. Most contemporary teleworkers are telecommuters.

The ubiquity of e-mail, telephones, and faxes has legitimized telework to the extent that monikers such as absentee worker, open collar worker, decruiter, virtual employee, tele-guerrilla, tele-cottager, and enterprise asset have emerged to describe those involved in distance work.

Enablers of distance work

Although history illustrates the feasibility of removing the worker from the workplace, it is almost rash to think of telework being used in a modern fast-paced world for anything more than bureaucratic tasks. We are accustomed to the notion that distance work is bought at the price of rapidity, nimbleness, intimacy, and immediacy. But, as we enter more and more into the "global embrace," we find the case for distance work becoming more substantial. The convergence of two key events have lead to this: 1) feasibility of "ephemeral" media, and 2) creation of a knowledge workforce. The former establishes the technological feasibility of distance work; the latter defines the skills that can be exploited by distance work.

Establishing communications infrastructure in Iraq. (U.S. Air Force photo)

Ephmeral media. McLuhan's aphorism "the medium is the message" emphasizes the effect communication technology has on the fabric of government, business, and culture. He points out that "[s]ocieties have always been shaped more by the nature of the media by which humans communicate than by the content of the communication."[13] It is thus a natural consequence that any communication technology that fails to provide adequate capacity for the exchange of ideas will not receive wide acceptance.

Early attempts at distance work illustrate this. Until the 1800's, information was transmitted over long distances principally by "durable media," meaning, content was encoded on material that had to be physically moved from sender to receiver.[14] Clay tablets, pottery, paper, and so forth served as such media.

While durable media have the major advantage of affording their correspondents physical control over the information, they present two major disadvantages. First, the requirement to transport information restricts the speed with which parties can exchange ideas. The time lag between sending and receiving information depends heavily on the distances and the means of transportation involved. Arthur C. Clarke brings this issue to life in context of the long-distance collaboration in the distant past: "When Queen Victoria came to the throne in 1837, she had no swifter means of sending messages to the far parts of her empire than had Julius Caesar, or for that matter, Moses."[15] Although it is not uncommon in modern times to employ "overnight" services to move durable media over long distances in less than 24 hours, the fact remains that such latency in time may still be ill-suited to real-time distance work.

Second, the ability of written symbols to express concepts constrains the content value of messages. Problems inherent to communication - such as incorrectly using symbols, using ambiguous symbols, or compressing information to fit the medium - are amplified because the

ability of all parties involved in the communication to interact swiftly is significantly diminished by long distances.

Innovations brought about since the1800's have opened new possibilities in distance collaborations. Telegraph, telephone, microwave, radio, and optical technologies provide the wherewithal for transmitting information at high speeds with a minimum of human involvement. Information encoded on these media still needs to be moved from location to location; but, the mechanics of how the information is transported differs from durable media. Whereas durable media requires humans, animals, or machines to transfer information; this "ephemeral media" relies on the physics of electromagnetic waves to pass along messages.

Substituting physics for mechanical methods to get information from one place to another allows us to approach the richness of real-time, face-to-face human contact that is so critical to distance work. Specifically, ephemeral media provide three distinct advantages over durable media: volume, speed, and turnaround. Given the proper data encoding, a suitable frequency spectrum, and proper equipment, ephemeral media have the capacity to move large volumes of information, including high-fidelity cinema and sound in real time. Information is being transmitted at the speed of light, thus the delay between the time information transmission starts and the time it reaches its destination is as small as it can possibly get. If all communicating parties take advantage of ephemeral media, they have the capability to converse and to interact.

This last advantage was the deciding factor for distance work. Pundits originally claimed that broadcast technology, such as radio and television broadcasts, would lead to the electronic global village in which the world's population would be tightly integrated into an egalitarian system of knowledge. True, while information can be transmitted across the globe without regard to the physical transportation mechanisms that hindered durable media, the inability to interact and seek clarification of ambiguous or non-comprehensible information makes ephemeral media little more effective than durable media in this regard. Those receiving the information become consumers in the global village, not partners. Two-way communication technology - first experienced with telephones and radios, then later with computers - provides a conduit in which information can flow in two directions. It wasn't until this became feasible that ideas could be truly exchanged over long distances.

Knowledge workers. Suitable communication technology has proven to be a necessary condition to distance work, but not a sufficient one. The technology must be recognized as useful, and a workforce able to exploit its capabilities must be in place.

In the past century, material goods, such as steel, automobiles, clothing, aircraft, etc., were the primary determinants of value. The manufacturing skill and resources required to create these items made them scarce relative to their demand. Whoever produced them could influence their selling price and thus establish the basis of an economy.

Historically, the influence of an economy of a particular material good was bounded by a region defined by geographical and political circumstances. Each region had an interior within which transfer of ownership of material goods could be done with ease, and a boundary through which commerce could take place only with difficulty. The free exchange of knowledge about goods

was likewise principally retained with its region. Information regarding marketing, needs analyses, advertising, consumer awareness, etc. was thereby bounded by the reach of material goods within the region. The consequence of this was that the value placed on information was subjugated by the economic value of material goods.

Today's communication technology has flipped this relationship. Although commerce in material goods may still be difficult across regions, information can transcend regional boundaries. Manufacturers of material goods have open to them a wider audience than ever before, increasing the potential for greater demand for their goods. Technology gives them the ability to work with remote customers as if they were local ones, and thus be competitive by being able to tailor products to meet specific needs. From the consumers' perspective, the world becomes the ultimate customer-centric market; technology makes it possible to locate items and information to meet highly customized and individualized needs. The value of products in the global market, then, has become increasingly driven by information.

This economic power of information has led to recent years being dubbed the "digital economy"[16] in recognition of the pronounced role of information on the production, development, and management of material wealth.

Paradoxically - at least in terms of economic theory - the ever-increasing supply of information accessible through modern technology does not mean the value of information is decreasing. Instead, its value is increasing due to the scarcity of time and resources required to find useful information from the overall information supply.

Anyone who has tried to find information on the Internet has experienced this. Performing a search for something as seemingly innocuous as an estimate of the number of web pages in existence is daunting. Using the term, "number of web pages," one of the popular web search engines[17] yields over 14,000 results. "Internet demographics" results in 5000 results; "Web page statistics" in 4,000 results, and so forth. It took a person trained in search techniques approximately two hours to find a statistic from a reputable source that could be cross-correlated with at least two other sources.

Communication technology has produced a new sector in industry: knowledge workers.[18] Much as the manufacturing community refines unprocessed natural materials into usable goods, this sector mines vast amounts of data for usable information. Skilled workers find, collect, distill, interpret, disseminate, etc. information deemed useful. Because of the nature of the raw material with which they work, knowledge workers don't necessarily have to be physically located with the consumer of their product.

Providing finance and accounting services to the orient from a central location (U.S. Air Force photo)

Obstacles to distance work

Notwithstanding its potential, distance work has significant detractions. An Office of Personnel Management survey[19] identified a number of barriers to telework within the U.S. government. The primary issues centered around 1) vulnerabilities introduced by permitting access to network services and data from beyond the physical bounds of an organization; 2) reliability and usability of software and hardware supporting telework; 3) managers' ability to oversee work efforts, enforce performance standards, and evaluate workers; 4) workers' ability to be treated fairly, remain informed, improve skills, and participate meaningfully. The commercial sector reports similar concerns[20,21,22]

Clearly, telework is in its infancy. This becomes all the more obvious in examining organizations' telework work policies. AFI 36-8002, *Telecommuting Guidelines for Air Force Reservists and their Supervisors* is a typical example. It requires telecommuters to enter into a contract-like agreement with their supervisor. They must designate specific work deliverables, timelines, reporting mechanisms, equipment, funding sources, etc., and the agreement must be ratified by the supervisor as well as other designated authorities. The agreement has the effect of protecting the employer and keeping tight governance over the telecommuter. In doing so, it assumes that the work can be precisely scoped in advance and its results rigidly controlled, both of which are difficult to do if the nature of the work is abstract or unpredictable. It is suited for specifying well-defined tasks, but discourages quick-turnaround, on-demand, and unforeseen jobs.

Like most organizations that permit telecommuting, AFI 36-8002 addresses the rules under which telecommuters can work away from their duty location, but it does not promote any doctrinal policy on how telecommuting should be used to the benefit of the overall organization. In the absence of an overarching strategy, the work policy itself governs, by default, how telecommuting is perceived and used. In this case, the heavy emphasis on controlling worker actions means that telecommuters must perform tasks that can be defined in advance and have short-term measurable outcomes.

The barriers noted in the OPM study and elsewhere are very real; but, they are tactical. The more significant barrier is the absence of a coherent philosophy for how distance work fits into an organization's mission.

Birth of the virtual organization

Despite disadvantages, the relevance of distance work can be seen in industry. The business world has long realized that competitive edge - indeed, often the very essence of survival - depends on serving a customer base in as many venues as possible. It has been quick to pick up on the lessons that information is a viable economic commodity and that the emerging profession of knowledge workers are "information gatekeepers." By relying on interconnectivity for global competitiveness, it also recognizes that the consequence of global reach is the requirement to respond quickly to customer needs.

This need to be agile has caused much of the business sector to reformulate fundamental business models, that is, "the core architecture of a firm, specifically how it deploys all relevant resources (not just those within its corporate boundaries) to create differentiated value for it customers."[23] Business models in the last half of the previous century were predominantly vertical in scope. A company conducted as many functions as possible in-house - or among a permanent alliance of companies - rather than sustaining the costs and risks of working with outsiders for critical business functions. For instance, a personal computer manufacturer operating within a vertical market would consist of plants that manufactured various computer parts, as well as facilities for assembling the parts, loading the software, marketing the computers, providing help-desk service calls, formulating new models, etc.

In contrast, a movement among contemporary organizations is to divest of vertical models in favor of ones that take advantage of communication technology and knowledge skills. The new models, termed "virtual", advocate having only a minimal set of "core" businesses within corporate boundaries, and teaming with outside organizations as the need arises. This suggests that organizations are dynamic in nature: they become coalitions, building partnerships to fulfill specific business activities and replace those partnerships with others as business needs change. Organizations thus become capable of adapting themselves to meet customer needs. They also have the potential to be physically distributed, taking advantage of today's pervasive communication technologies.

The virtual organization has become all the more possible by the digital economy. By necessity, manufacturing economies had to organize around physical location so as to minimize the costs of handling material. The shift toward a more service- and knowledge-based economy removes this restriction. Communication technology allows firms to knit together pools of workers regardless of their location.

Few businesses operate in a pure virtual mode that connects workers together in a logical organization devoid of physical infrastructure. The failures of the dot com industry showed, in part, the immaturity of virtual-only organizations. Instead, industry has sought to straddle the conventional world of physical assets and the cyber world of electronic commerce. Such "Bricks and Clicks" businesses represent a unique blending of conventional business practices and

technology not possible as little as a decade ago. Businesses which sell products under a "bricks and clicks" model rely on both conventional and on-line services to reach customers. "Bricks" refers to the traditional, physical buildings where goods are warehoused and where people shop; "clicks" is symbolic of the sound a computer's mouse makes when conducing transactions over the Internet. The end result is the same: a customer purchases an item. What differs is how, where, and when the customer goes about making the purchase.

Bricks-and-clicks businesses in the service and manufacturing industry adopt an analogous model. Their "bricks" are the infrastructure of buildings, offices, stores, etc. in which they do face-to-face business. Their "clicks" are off-site employees, contractors, and business partners with whom they collaborate to achieve business goals by means of electronic networking.

Regardless of the business context, the "bricks" component provides an avenue of working in the person-to-person context necessary to resolve complex issues, and the "clicks" component seeks to build a sustaining business community. Organizations using a "bricks and click" approach typically house the decision-making authority of the company in the "bricks" part and establish associations dynamically with knowledge workers, customers, and suppliers as the "clicks" part.

The Virtual Air Force

From "Bricks and Clicks" to "Jets and Nets"

The very same forces - global reach, information economy, knowledge workers - which lead the business world to adopt virtual components is also at work in the military.

The close of the cold war signaled a major shift in the application of military force, particularly in the way in which the resources of the Air Force were managed. Previously, the prevailing force management philosophy was that of placing segments of the globe under the protection of regional commands. Each command was manned and equipped to handle a set of specific, identified threats within its general geographical span.

Public interest mirrored this principle of discrete, global threats. The potential danger posed by the Soviet Union overshadowed the numerous smaller menaces around the world. The collapse of the Soviet Union removed the predominant "enemy," and popular interest in a large-scale military waned; however, the military found itself still engaged with less conspicuous antagonists. The Air Force, in particular, became consistently forward deployed in multiple conflicts, but with fewer dollars, personnel, and bases than ever before.

The Expeditionary Aerospace Force concept realigned force structure to accommodate this new reality. Accepting the premise that the Air Force can no longer afford to be the permanent pervasive presence of the cold war era, it espoused an expeditionary posture of being able to tailor force structure to meet a particular need and to dispatch that force quickly for relatively short periods of intense activity.

In the most abstract sense, the EAF characterizes the Air Force as having force elements and infrastructural elements. The force elements consist of the personnel, equipment, and aircraft that

respond quickly to crisis situations and meet day-to-day military commitments; the infrastructural elements provide the command and control functions needed to plan, coordinate, evaluate, and direct the operations of the combatant components.

At the heart of the EAF philosophy is the concept that force and infrastructure elements are marshaled according to the peculiarities of a specific mission and then dispatched to carry out that mission. Moreover, it provides for expeditions so created to change during their operation to meet the needs of the circumstances at hand, thus providing the dynamics to address small-scale contingencies to large-scale war.

This requirement for dynamism imposes on the Air Force a fluid deployment of resources, one that is dependent on assets that aren't necessarily physically collocated. The EAF, in essence, has created a military that operates using a virtual model: its structure and placement of resources change to meet the needs of the circumstances at hand. When air power is employed, it is done so in a highly interconnected environment regardless of physical location. In employing physical assets coordinated with communication networks, the EAF has taken the concept to "bricks and clicks" one step further . to "jets and nets."

Remote monitoring of an aircraft. (U.S. Air Force photo)

Reachback through virtuality

The EAF is not without logistical costs. Expeditions so created are, by definition, a physically detached subset of the entire force. They put forth a sufficient forward presence to address foreseen needs, but have to have the ability to draw on rear organizational elements for support.

The doctrine of *reachback* is defined as[24]

> The process of obtaining products, services, and applications or forces, equipment, or materiel from Air Force organizations that are not forward deployed (AFDD 2, AFDD 1-2). This capability allows commanders to obtain or coordinate support from units not physically located with the forward force. By leveraging advances in communications technology, reachback capabilities make it

> possible to utilize CONUS and/or rear-based assets and organizations to perform various functions in support of AEF operations. Effective use of reachback will reduce the number of personnel and amount of equipment which deploys to the AOR, reduce airlift and support requirements, and will positively impact a commander's ability to protect the deployed force. Reachback is predicated on global communications, rapid global mobility, and time-definite resupply capabilities.

Reachback hinges on two elements. Rear forces must have the capability to assist forward forces; and forward and rear forces must be able to communicate with each other. Reachback is not possible if either component is missing, and its effectiveness is constrained by the weaker of the two. Indeed, how the two elements are poised to complement each other determines the "bandwidth" of the reachback: rear echelon forces which are able to provide support and which are equipped to make maximum advantage of lines of communication have a higher probability of success than forces which consider support and communication to be independent, separate activities.

Foundations of Virtual Work

Traditionally, reachback has been associated with situations in which forces are deployed in action; however, modern technology turns reachback into a tool that can also be used during peacetime. Viewed as a philosophy for putting skill where it is needed, reachback is the business model for configuring and managing the virtual components of the military. It becomes, in effect, the guiding method for marshalling resources and connecting those resources to operational needs.

The vision of a pool of "virtual airmen" that can be tapped at a moment's notice regardless of location has doctrinal significance to force planners, and is increasingly possible with today's technology. While the ideal virtual airman as a holographic helper familiar to science fiction television shows is beyond our reach, we can picture virtual duty as falling along a spectrum of capabilities. At the low end, the virtual airman works in a remote location and communicates via postal mail. This is reminiscent of days in the early part of the last century in which business was conducted almost exclusively by correspondence. The virtual airman in the middle technology range works offline, but communicates by e-mail and telephone. "Telecommuting" normally connotes this form of technology. Virtual airmen working at the upper end of technology use the tools of the high-speed Internet and videoconferencing to accomplish their jobs. Work at this end of the spectrum distinguishes itself by being accomplished on-line and in near real time. It is here that the virtual airman is perceived as being almost physically present. In such an environment, the virtual airman can conduct, from a remote location, face-to-face meetings, manipulate equipment, etc.

While distance work is intuitively simple to understand, its realization is quite complex. It requires careful consideration of four elements: location, time, capacity, and participation. *Location* refers to the physical placement of the producer of the work relative to the consumer; *time* refers to the synchronization between work consumer and producer; *capacity* refers to the

degree to which the virtual work must approximate on-location work; and *participation* refers the number of parties that are involved in the work product. The maximum possible benefit derived from virtual work depends on how well technology and culture within an organization align these elements. A mismatch among any of the four means that more energy must be expended to produce work equal in value to that produced in an optimal match. Put another way, the cost, time, frustration, and bureaucratic overhead associated with virtual work overshadows the value of the work product itself in an environment that uses a poorly suited virtual model.

Foundational Virtual Model

Ellis *et al*[25] point out that the organization infrastructure we put into place to support a virtual work model hinges on the relationship between time and location. In particular, they suggest that the mechanisms by which we communication in a work environment are based on *where* the work is being performed versus where it is used, and *when* the work is performed versus when it is used (see Figure 1). Although their work addressed software support for collaborative work groups, their ideas can be abstracted to the more general concept of virtual work.

The *Same Place-Same Time* quadrant of Figure 1 characterizes the communication demands of the traditional work place. People are at work at the same time and are physically collocated; consequently, they swap information in a face-to-face fashion. They operate synchronously, meaning, interaction takes place contemporaneously, and that information is exchanged in an agreed-upon sequence. Bandwidth in such an environment is rich because parties can state concepts using a mix of verbal comments, visual signals, drawn symbols, non-verbal cues, etc. The immediacy of the interchange makes it possible to quickly adapt the transmission of information to the situation. Because this quadrant represents the most complete set of conditions for communication, it is used as the standard against which virtual work is compared. The ultimate goal of a virtual workplace is to mirror this quadrant.

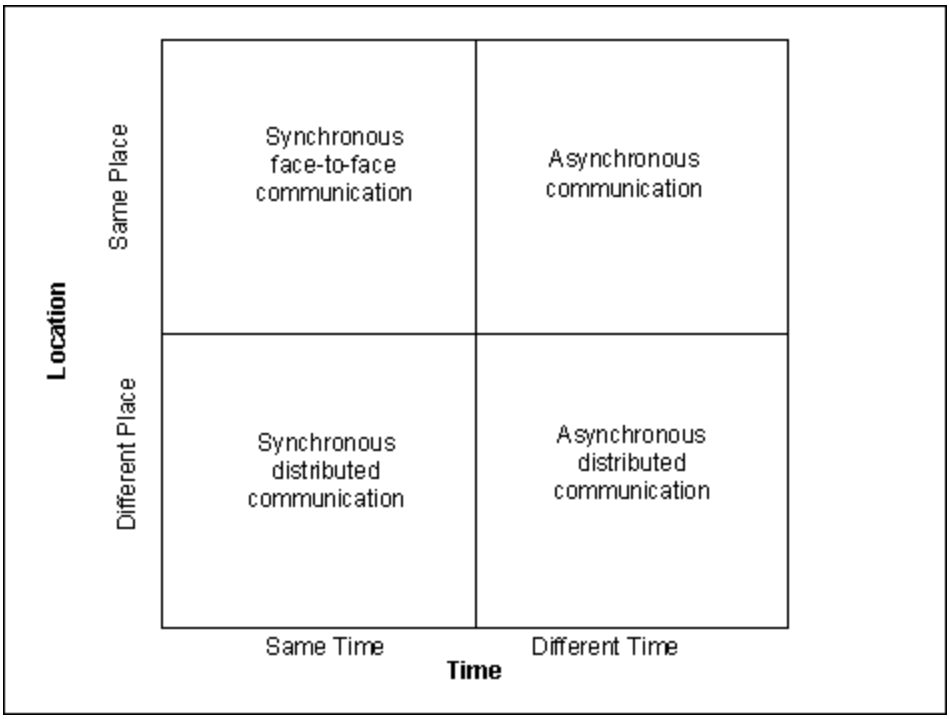

Figure 1. Time-space taxonomy of virtual work.

The *Same Place-Different Time* quadrant of Figure 1 illustrates the next level of complexity beyond face-to-face communication. Here, the work environment provides a common physical location where the workers are distanced by time. For example, organizations that rely on shift work fall into this category. Workers share a common place of employment but perform work during different times of the day. In extreme cases, particularly in large projects that are broken into distinct phases, workers may be distanced by weeks or months. Synchronous interaction is not possible between shifts since the shifts are not operating simultaneously; instead, work progresses asynchronously, with work products being produced at a different time and, potentially, a different rate at which they are consumed. Because the *Same Place-Different Time* model operates within a common physical location, its supporting communication infrastructure does not have to be concerned as much with transporting work products as it does with coordinating work.

Conventional notions of distance work begin to enter the picture when considering the bottom half of Figure 1. The lower left-hand quadrant, the *Different Place-Same Time* model, describes the situation in which work is being performed concurrently in different physical locations. Communication mechanisms must be in place to both synchronize exchange of information to move information from one place to another.

The communication infrastructure required to support this approach depends on its required *capacity*, meaning, the degree to which it is similar to the *Same Place-Same Time* model. Relatively rudimentary technology can provide a rough approximation of a *Same Place-Same Time* model; whereas highly sophisticated technology is required to match closely the fidelity of a *Same Place-Same Time* situation.

For example, telephones and radios implement a crude form of a *Different Place-Same Time* virtual model. Work products are transported by voice, and synchronization takes place through the interchange of spoken words. Although interaction occurs in real-time using common equipment, communication is limited to what information can be conveyed by voice alone. In contrast, two-way video conferencing allows for a fairly elaborate virtual model. It offers the communication capabilities commensurate with face-to-face interaction. Given sufficient bandwidth and the appropriate tools, a person in one location can manipulate equipment in another location, such as a virtual pilot flying an actual aircraft or a virtual mechanic operating a remote robot that repairs a piece of machinery. Such a virtual model offers the advantage of being "almost" present, but is bought at the price of specialized and expensive technology.

The remaining virtual model, *Different Time-Different Place*, represents what is perhaps the most common approach to virtual work. The virtual worker - particularly a knowledge worker - may at times be placed in a *Same Time-Different Place* environment in order to exchange information in real time, but such events serve more as points at which work is synchronized than as long term situations. Instead, the worker spends more time performing duties in a "detached" mode, communicating asynchronously with the consumer of the work. As with the previous model, *capacity* determines the level of technology required to carry out work. Typical functions associated with distance work - e.g., identifying work needs, clarifying requirements, providing status updates, delivering information, etc. - can be accomplished with low-intensity tools such as e-mail, electronic bulletin boards, and file transfer applications. An "almost present" presence can be supported by on-demand video streaming and collaborative workgroup software.

Extended Virtual Model

Although the Ellis *et al* model of Figure 1 describes the relationship between time and location, it gives little insight into the complexities that come about when multiple people are involved. Figure 2 extends the taxonomy to include a *participation* dimension describing the effect the number of participants has on virtual work. This additional element depicts the command and control functions that must be in place in order to carry out useful virtual work. It illustrates that a more complex corporate decision making mechanism must be used when dealing with multiple virtual workers producing work for multiple consumers than when dealing with a single worker servicing a single consumer.

Work environments involving a single work producer and a corresponding single work consumer require the least amount of command and control. There exists a 1-to-1 relationship in which decisions and commitments are made between producer and consumer. Although the producer or consumer may each represent a larger group that requires that their activities be coordinated, the definition of the 1-to-1 relationship is such that the producer and consumer are answerable to each other and not to members of the other's group. Having the capability to interact - meaning, to exchange information, to seek clarification where necessary, to make decisions, to make commitments, etc. - is thus the necessary condition to conduct a meaningful work relationship, regardless of what quadrant the participants are in.

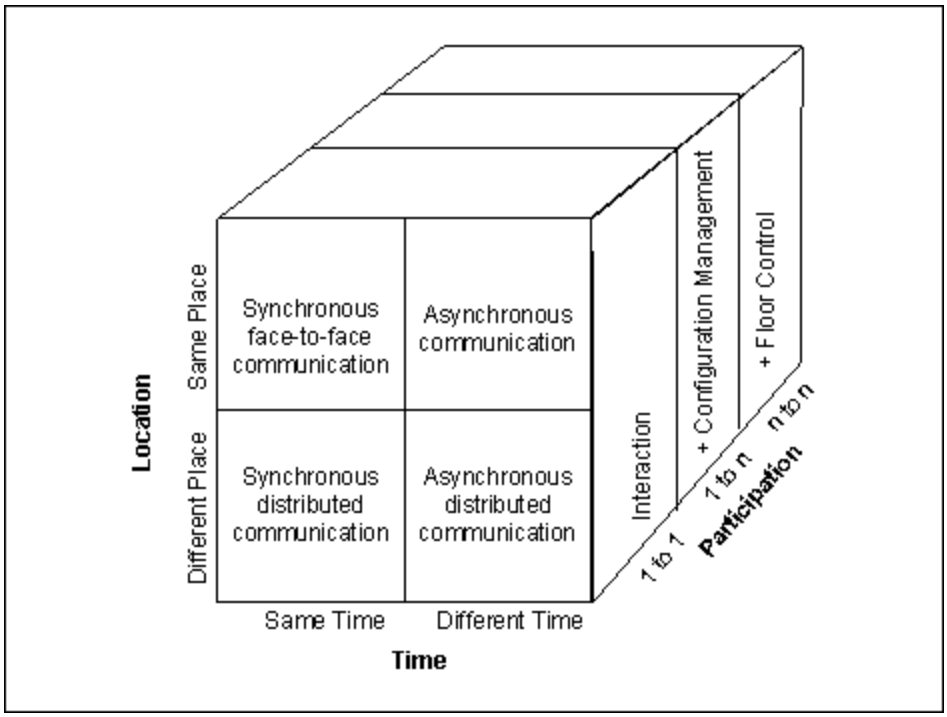

Figure 2. Conditions necessary for virtual work in context of location, time, and participation.

The previously mentioned AFI 36-8002 implements a 1-to-1 *Different Time-Different Place* virtual work model. Its rules establish a bipartite relationship between reservist and supervisor. Implicit in the publication is the designation of the reservist as the work producer and the supervisor as the work consumer. Both reservist and supervisor agree to what work is to be produced, as well how they will interact.

The concept of 1-to-1 *participation* need not be limited to people. A pilot controlling a single aircraft by remote control is an example of a 1-to-1 *Different Place-Same Time* virtual model. The pilot determines what a single vehicle does; the vehicle responds to the commands of a single pilot.

MK III RONS Robotics all-terrain, tracked vehicle with manipulator arm and TV cameras. (U.S. Air Force photo)

Command and control requirements become increasingly delicate as more participants are added to the virtual picture. Under 1-to-n conditions, a single worker is producing work destined for more than one consumer. This opens the door to the possibility of multiple, perhaps conflicting, work requirements that must be satisfied, as well as post-deployment issues that must be dealt with. This requires not only that the producer is able to interact with the consumers, but also that the producer is able to manage work requirements and work products. The work infrastructure must include support for configuration management whereby consumers agree upon work requirements, validate changes to work, and inventory work products.

1-to-n participation is a common scenario in software development. Engineers typically write software in a different location than, as well as asynchronously apart from, their clients. Development projects may have a number of clients, all of whom want to have the resulting software meet their unique needs. Changes to functional requirements compound the engineers' task, as does the process of seeking customer consensus in prioritizing the repair of software defects. These projects typically implement a *Same Place-Same Time* or *Different Place-Same Time* model when working with the customers on critical issues, then relying on *Different Place-Different Time* model for day-to-day operations. Regardless, the 1-to-n participation mandates the capability to interact with the customers and the capability to control configurations.

Establishing communications infrastructure in Iraq. (U.S. Air Force photo)

The n-to-n environment demands a level of sophistication beyond 1-to-n participation. The virtual equivalent of a collaborative group, this model involves multiple workers creating products that will be used by multiple customers. As with the previous participation models, the capability for the producer and consumer to interact is necessary to ensure the proper product is built, and support for configuration management is necessary to coordinate multiple sources of work requirements. Because multiple producers and consumers are involved concurrently, this model also requires floor control, the parliamentary mechanism which designates who can provide information at any point in time. The challenge is in coordinating the efforts of producers and consumers who may be operating under a variety of work models, and who may have different levels of precedence in receiving control of the floor.

N-way conferencing is an example of a typical n-to-n model in use today. Carried out in a *Different Place-Same Time* setting, such conferences involve two or more physically-distant parties communicating over video, sound, or data links. The chair of the conference gives the "floor" to other participants according to specified rules of order. Having obtained the floor, a participant may share information. Discussion and decisions ensue, but do so under the direction of the chair and following defined procedures. The chair can be an actual person, or a piece of software that brokers participants' involvement.[26]

A genre of software tools, known as "groupware", has arisen over the past decade to support *Different Place-Different Time* n-to-n work models. The tools customarily implement the electronic equivalent of a bulletin board. Group members interact by tacking information to "discussion" bulletin boards. Posted information is tagged with identifiers indicating the source, time, and precedence of the information, thus providing rudimentary floor control. Configuration management is achieved by providing support for proposing and voting on decisions; configuration control by placing information and work products onto a "baselined" bulletin board once they have been agreed upon.

Scenario: The Virtual Reservist

The trend over the years has been to trim the size of the active duty force as much as possible, using reserve personnel (including National Guard and Air Force Reserve) and contractors as a pool of additional resources from which to draw when military needs exceed that which the

active duty can provide. Procedurally, these resources are viewed as being in one of two states: they are either working engaged in their day jobs, or they are deployed on behalf of the military. The virtual reservist concept opens the possibility of using reservists' talents without having to deploy them. They would be attached to an active duty unit to provide a specific service, but would be doing so possibly from a separate location.

Obviously, some duties require reservists to be on-location; however, not all do. Moreover, situations arise when it is advantageous to "borrow" a reservist, especially if that reservist has skills that are rare or are needed for a short period of time. In addition to unit reservists and Individual Mobilization Augmentees, there could arise a third type of reservists, the virtual reservist, who has specialized skills that can be used in times of need but who has no desire to participate in regular reserve training activities.

What type of duty could virtual reservists perform? Tapscott gives some insight into the long-distance activities that can be supported with current or on-the-horizon technology:[27]

o providing health care

o manipulating machinery

o developing ideas

o executing processes

o designing items

o manufacturing and marketing goods

We might also add legal services, technical consulting services, "skunk works" problem solving sessions, etc. to the list.

Given the variety of activities, virtual reservists could be assigned to specific active duty units or could be "roving" resources that are tapped when needed. The former would provide stable and reliable backup to units; the latter could be used to address ad hoc problems.

CONCLUSION

The virtual airman at this point in time is an oddity, an intriguing idea. Few would seriously consider going into battle or undertaking a fast-paced peacetime project if success depended on having to rely entirely on virtual workers. The prevailing communication infrastructure in place today is ill-suited to support *Same Time-Same Place* quality work beyond low-intensity technology such as e-mail and file transfers;[28] and, the work culture within traditional organizations looks upon virtual work with distrust.[29] Hopefully, too, few would push the

concept of the virtual airman to the point of "tele-war" where fighting becomes a vicarious exercise conducted from a sterile and safe environment. Doing so would remove the gritty reality necessary to keep our sense of humanity in check. In short, the virtual air force is still in its infancy . and should remain so to some extent.

In a fashion, though, the virtual airman will become a by the momentum of the Air Force's move to a so-called net-centric fighting force. In contrast to the Air Force of the past where organizational elements were stand-alone, discrete components, the vision of the "new" Air Force is a force package whose organizational elements can be nimbly assembled to meet operational needs. Moreover, the vision calls for all the organizational components to act as an organic whole, able to respond as a single unit based on the capabilities of the individual parts.[30]

The recent events in Iraq demonstrate that the AEF concept makes the Air Force a virtual military, but only in the sense that it could piece together a fighting force from relatively large organizational building blocks. The next logical step is to have the capability to mold a fighting force by connecting together small - perhaps, even single-person - organizational units.

DarkStar unmanned air vehicle. (Department of Defense photo)

Notes

1. International Telecommunication Union. 2003. "Internet indicators: Hosts, Users and Number of PCs". *World Telecommunication Indicators Database*. Cited 23 May 2003. Available from http://www.itu.int/ITU-D/ict/statistics.

2. Central Intelligence Agency. 2002. "Field Listing - Internet Users." *The World Factbook 2002*. Cited 23 May 2003. Available from http://www.cia.gov/cia/publications/factbook/.

3. Neilsen/Netratings. 2001. "Global Internet Trends." Cited 6 Aug 2002. http://www.nielsen-netratings.com/.1