STRATEGY RESEARCH PROJECT

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APPLYING KNOWLEDGE ENGINE TECHNOLOGY IN THE MILITARY, OR HOW HAL THE COMPUTER FROM THE MOVIE "2001: A SPACE ODYSSEY" MAY MANIFEST ITSELF IN THE MILITARY

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COLONEL CHRISTOPHER L. SARGENT
United States Army

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USAWC Strategy Research Project

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or how HAL the computer from the movie "2001: A Space Odyssey", may manifest itself in the military

by

Colonel Christopher L. Sargent

United States Army

Mr. Robert Minehart

Project Advisor

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U.S. Army War College

Carlisle Barracks, Pennsylvania 17013

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ABSTRACT

Author: Christopher L. Sargent

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Knowledge engines such as Arthur C. Clarke's "HAL," the human-like computer in the movie *2001*, are on the horizon. A knowledge engine's ability to aid commanders in producing well-informed decisions faster than an adversary can react, will accelerate the tempo of battle more than is envisioned in today's information age. The enabling technologies are rapidly maturing, allowing a coherent effort on the part of the military to reap significant rewards.

Information dominance can be measurably improved with the addition of decisionmaking tools that rapidly assimilate strategic, operational and tactical data to provide the commander and staff with reasoned options and advice for better and faster decisions. Today this is being done with high-tech systems in a collective effort, but without a vision of the true potential. To delay this effort, or to support disparate and uncoordinated technical endeavors, will mean a dissolution of effort. Because there are so many roads that can be traveled in a technical sense, a cost effective, and incremental approach is necessary. Time is important as this technology can be developed by an adversary fairly rapidly and quietly. Requirements and recommendations for the practical development of a military knowledge engine are included in this paper. The sobering fact is that a creative adversary could well develop a sophisticated knowledge engine before we do.

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HAL in the Military's Future

When Arthur C. Clarke and Stanley Kubrick created the movie 2001: A Space Odyssey, they envisioned a human-like computer called HAL that totally controlled an immense, complex spacecraft. The technology required to emulate HAL in the 60's when the movie was made was so elementary that imagining a real HAL was absurd. At the time there were euphoric scientific breakthroughs in artificial intelligence and the "reasoning" ability of computers. However, this soon gave way to mediocre, incremental achievements and disillusionment for many. Conventional wisdom today argues that the enabling technologies, especially computer intelligence, have not progressed nearly well enough to develop a credible HAL by 2001 as the movie suggests and may not be ready for up to 50 years.[1] With reasonable arguments against the achievability of this capability, the vision of futurist's such as Clarke seem to be just that, a vision, with little hope of realization.

Pursuing a HAL-like knowledge engine for the military is essential, yet there is no coordinated program to develop such a concept. What is sobering is that future adversaries may realize a knowledge engine's potential and develop these rapid decision making aids before we do. The irony is that as our military dominates the high tech battlefield, it is focusing on the enabling technologies for knowledge engines, but not the "big picture." The leverage in the information age is to develop the intelligent management of information. Unfortunately, we are limiting our vision to what is appealing and available for the short term solution.

Knowledge engines multiply the effectiveness of information superiority by using reasoning tools to process information and provide viable solutions to problems. The potential of this development is exciting as it can radically change our decision making process. The military commander and his staff have the potential to accelerate the gathering of information and make informed decisions before an adversary can react to counter them.

Defining a knowledge engine's capabilities can be almost boundless with so many creative possibilities. What must it have, what shouldn't it have, and what will make it a success with decision makers? This discussion will be limited to a system useful to military decision makers in their operational environment.

Background

PROMIS

An early experiment that received notoriety was the U.S. Justice Department's program called PROMIS, or Prosecutor's Management and Information System. PROMIS was developed in the late 70's and early 80's to manage legal cases by investigating federal and state databases located across the country.[2] Its potential was realized when prosecutors were able to tie various criminal's defense counselors to organizations and crimes unrelated to their original investigation. This was possible only after computer hardware and software was able to search unrelated databases and draw relationships that were otherwise elusive. It provided highly reliable evidence of wrongdoing which was useful in court. PROMIS technology was eventually exported

to Israel where it was a principal means of tracking the Palestinian populace and political dissidents.[3] This early use of machines to collect information was rudimentary. However, it showed the potential of searching dissimilar data sources, sifting through more information than was humanly possible, and providing information others could not produce.

Pilot's Associate

The F-22 fighter has brought the humanization of computers into the 21st century with the Pilots Associate, a "virtual buddy" for the single pilot, that discerns the most lethal targets, tunes radios, and helps fly the aircraft. All this is focused on helping the pilot manage what could otherwise be an overwhelming situation. This is a limited application of a knowledge engine, as little communicating is done outside its world, that is, gathering new information to present unique options for the pilot. What is has done though, is refine the man-machine interface, or human engineering required for persons and computers in a threatening environment.[4]

Defining a Knowledge Engine

"Knowbots," a nickname for knowledge engines, defines an intelligent robot that can reason and respond to humans. They are most useful as a decision aid to provide solutions or options to complex and sometimes abstract problems. The challenge to date has been translating the complexity of human intelligence into a useful form in computers. Today, in 1997, HAL does not exist in any cost effective form. "The hardware technology is sufficient now to build an intelligent machine, if we just had

enough understanding of intelligence."[5] Although much work has been expended on modeling intelligence, it is the least developed of the technologies that are being developed for knowledge engines.

To define a hypothetical HAL of today, let's call it a Knowledge Engine With a Personality, or KEWP ("Q-P"), for the sake of brevity. KEWP would consist of a computer with an operating system, which would be the "brain;" one or more means of communicating with its owner, say by voice and keyboard; and a means of communicating externally to collect information physically distant from its location, for example by radio, wire or fiber optic cable.

The most significant enabling technology in developing knowbots is producing an operating system that can reason. A neural network computer which uses artificial intelligence, expert systems and fuzzy logic, may be a reasonable solution today, but ever improving solutions are evolving with time. A recent achievement in reasoning by computers indicates we can make great strides in technology, and not plod incrementally. A software program called EQP that was recently written, solved a mathematical problem considered unsolvable by computers up until now. "The achievement would have been called creative if a human had done it. ... It was designed to reason, rather than to solve any definite problem. The program is being hailed as a 'quantum leap forward' in the reasoning abilities of computers."[6]

KEWP would contain databases such as worldwide topographic data, capabilities and limitations of both threat systems and friendly systems, profiles of adversarial leaders, military doctrine, and cultural tendencies. To provide an expert

system capability, it could be programmed with the thought process of Sun Tzu, Adeed of Somalia, and MacArthur, or any others chosen, for strategic insights to a situation. The way they thought, which is what made them so effective, is what is captured, not so much what they thought. This is the essence of the expert system. Prior to a particular operation, specific expert system databases could be pulled off the shelf or rapidly tailored to a situation and passed to several leaders. LTG Patton was known to have read Rommel's book in WW II and used the information to defeat him in battle. A similar use of expert systems could provide leaders and managers with the cultural implications of certain decisions, or the impact of local weather on a variety of courses of action. Imagine deploying to combat in a particular area with a myriad of lessons learned available and expert systems that warn of previous pitfalls experienced on the very terrain over which you will have to fight. Lessons learned from the combat training centers could be integrated into modules tailorable to specific operations. This information would also be available for the commander's staff and tailored for their use in aiding the staff planning process.

The commander also needs to know how KEWP arrives at certain conclusions, implying those who program the information must provide a recallable audit trail. The limitations of equipment, training, and doctrine used in WW II and Desert Storm, for example, should not constrain the thought process of tomorrow.

KEWP could be programmed to aid a weak staff member with an expert systems capability, that is, distilling the techniques and logical thought processes of experts for that particular staff function. What we now do with staff manuals and professional

schools, the expert system takes to the next level by coaching, and intelligently searching, or "data mining", to significantly improve the staff member's effectiveness. Using the principles of war, a course of action could be examined by Clausewitz or Jomini for their expert system perspective. Then ask for Sun Tzu's or George Marshall's view for other possibilities.

A knowledge engine's programming is critical to the success of its effectiveness, which is another way of saying the output is only as good as the input. It's use of logic in forming questions and its search for the right locations are also critical. Anything that inhibits or pollutes KEWP's search for information, such as inadequate databases or poor communications to or from remote sources could lead to shortsighted or misleading results.

KEWP could be present in an operations center, to be used by one or all of a particular staff. If used by many, a hierarchy of authority within a staff section may be necessary to prioritize workload.

Robotics Laws

Isaac Asimov, a prolific writer of science fiction novels, defined three laws of robotics in December 1940 that attempted to constrain the behavior of robots. His first law; "A robot may not injure a human being, or, through inaction, allow a human being to come to harm," was conceived to protect humans and prevent the irrational use of robots. But this law would conflict with the military use of KEWP for combat, resulting in death or harming a foe. HAL's harming humans was also a theme in the movie 2001: A

Space Odyssey, and brings to light the need for some restrictions in the development of knowledge engines. You obviously can not have a knowledge engine control weapons systems, where it eventually "learns" that to reach an end, it kills its owner or "friends," as a means. How would KEWP deal with recommending a fairly lethal course of action for its owner? Those who program KEWP will have to deal with conflicts in rational thought.

The Knowledge Engine's Search for Information

Once a knowledge engine is given some initial programming to think intelligently or reason, it either uses preprogrammed databases in the computer, or gathers information externally to continue to grow. A term for this maturing process is "adaptive learning." As computers become faster, have more memory, and cognitive programming develops to become more "human-like", the personification of KEWP will become more realistic. First generation systems will probably seem awkward or out of touch with reality. These systems could generate a mistrust of the technology if not carefully developed. As initial software gets better, and communications and information collection improves, KEWP will prove more valuable.

The Internet

As the Internet is becoming an integral part of our daily lives, the military's dependency on the Internet for communications, such as for the Global Command and Control System, is growing as well. Commanders in distant lands will have satellite or radio communications with systems linked to the Internet. Or a staff intelligence officer

will tap into open source intelligence to get timely information about a remote country's military, culture and political activities. Information about some remote areas can be scarce in the military today, and with the resources freely available via the Internet, much more will be available in the future.

Data Warehousing and Data Mining

Effectively searching through vast amounts of data will be time consuming unless efficient tools are developed. Today, those tools are not commonly in place, making the search within some databases difficult or impossible. As standards are developed, the sophisticated storage of information, which is data warehousing, and its "smart" retrieval, that is data mining, will become practical. The Internet has a very limited form of a data mining capability in search engines. Search engine technology of word matching is fast but crude when compared to the potential offered by more advanced forms of data mining. "Mining your data means letting the software answer vague questions and discover unknowns - for example, finding patterns or correlations that haven't been noticed before."[7] With data mining, software is becoming a "smart detective" in the search for information. A real advantage in integrating data mining in a knowledge engine today is that most of its development is being fueled by commercial industry.

Communicating with your Knowbot

Voice recognition and Natural Language Processing (NLP) are improving, which will allow users to communicate effectively with KEWP. Whereas, in the past it was

difficult to always recognize both genders, or people under stress, NLP systems will eventually comprehend both male and female voices, while under stress, without the need for templating necessary today for accurate recognition while under duress.

Databases resident in memory, will include the user's personal background and preferences to improve communications, that is, a tactful demeanor to enhance the man-machine interface. KEWP's reminding of important meetings, giving the next day's weather, or providing a humorous quote of the day are examples of what is easily achievable to provide the "P," in personalization.

A means of accurately identifying authorized users of a particular knowledge engine will likely be necessary to prevent the wrong people from disrupting it's capabilities. Passwords, voice recognition, thermal pattern recognition, finger print verification, or any combination of these and other user authentication systems may prove useful, with a balance struck between the level of security required and the ease of use demanded. If passive recognition systems are possible and accurate, KEWP will "know" who is communicating with it, making it appear more humanlike.

Thermal imaging has been personalized recently, for example, "The heat patterns that arise from blood vessels in the face can now be used to accurately and quickly identify people in a new kind of security system. ... The system is accurate enough to distinguish between identical twins."[8] To complement a set of eyes, we can add a nose to KEWP developed by Tufts University. "The new system comes closer to the versatility of real noses. It has an array of fiber sensors that detect different chemicals. By analyzing the combined reaction of a bundle of 10 sensors, the neural

network could I.D. up to a million compounds."[9] These technologies, when combined or fused, will accelerate recognition times, and improve identification accuracy.

Today we limit our concept of a tool such as KEWP to speaking English, but why should we? Progress is being made to reduce the restrictions in its application. "German software provides almost instantaneous translations; depends on sophisticated modules for speech recognition, analysis, translation, and voice synthesis."[10] This indicates software for integrating any foreign language is feasible today. This would give KEWP a role as translator, but more importantly, allow non-English speaking nations to develop and implement knowledge engines sooner than would otherwise be possible. This has the potential to significantly improve interoperability with any coalition partners.

KEWP and the outside world

The quest for tactical Intelligence in military operations provides an example of how a knowledge engine can be useful. Although this example is limited, this same idea could apply to logistics, future plans, or administrative concerns. Let's say some members of your staff, the S-2 section, for example, are pooled with other higher, lower, and peer intelligence sections in a distant headquarters. Your only connection is via communications systems and now you need intelligence that requires outside input. Your S-2, in conjunction with other S-2s, see a need for "leader and cultural information" for a hot spot that you, the commander, will maneuver to in a few hours. The intelligence staff collectively seeks, analyzes, and disseminates the appropriate

intelligence to your location where the knowledge engine helps organize the information for your use.

A balance will be required in how information is processed and distributed to prevent bottlenecks in communications. Will computer processing be done at higher headquarters and filtered down, typical of today's staffing? It will likely occur at all levels allowing the various battlefield sensors, as well as other commanders and staffs to pass only essential information in times of high demand. This is called parsing, which allows prioritized information to be passed first and more detailed information to follow later, when time permits. That same concept is applied to all users to keep the avalanche of information that would otherwise be distributed to a minimum. Parsing, if done well, provides an optimum flow of information to and from higher, lower, and lateral users. Another way to look at this concept is to realize that each user can tailor what information will be necessary for the mission, with KEWP as the filter for any additional data that might be useful. Should relevant data become available, but not distributed to the user by default, KEWP could question the user for their interest. If that kind of data is found useful, KEWP has "learned" to introduce similar data in the future. Such "adaptive learning" is one reason why the knowledge engine will become more useful with time.

The Effectiveness of KEWP in Peace, Crisis, or War

The Practical Application of Knowledge Engines

KEWP's initial "trial by fire" will likely be in training exercises that test a unit's ability in ways otherwise found only in armed conflict. Just as the Army is testing the fielding of many interrelated digital systems in Force XXI (1997), a system such as KEWP will be observed under similar circumstances.

The Armed Services will gain greater benefit of this technology if it is simultaneously applied in the Navy, Air Force and the Special Operations Command. Aiding a Navy ship's captain, or the operations chief of an Air Force tactical operations center, will bring synergistic benefits, multi-service cooperation, and greater standardization.

Because knowledge engines can be useful in almost any life threatening, time restricted environment, they are well suited to the military. Particularly useful functions and unique considerations that highlight their use are included below.

Planning and Rehearsals

Planning and rehearsals are a fundamental consideration in military operations and one well suited to a knowledge engines capabilities. With terrain databases and known enemy locations, for example, it can develop routes to a objective, analyzing the risk of using each route before a step has been taken. KEWP's ability to quickly run simulations will provide answers to tactical options so rapidly that many can be evaluated with probabilities for success attached to each. A commander's instinct will

challenge some of the outcomes, with KEWP providing reasons for higher or lower risk for each option. Eventually, a knowledge engine should gain credibility as it adapts to external stimulus, or data.

Because knowledge engines could be placed in several locations to serve staffs and commanders, they could accelerate planning with a better situational awareness of all involved. With a common operational picture and rapid access to information, the intelligence, logistics, and communications concepts can be more quickly coordinated, developed and disseminated. Staffs could be in various locations to best influence the situation. If operations are ongoing, and with the real-time reporting of maneuver elements and their logistical and operational condition, the staff can make quicker and better estimates for future operations.

Mission rehearsals may be as simple as having KEWP run through an operation to arrive at an outcome, or they could be as complex as providing 3D visualization of a maneuver from any perspective, to include the enemy's. Simulation and modeling has matured to where running such rehearsals simultaneously in various locations throughout the world is becoming practical. Weaknesses can be quickly identified and addressed. All members of a joint team can converse as the plan unfolds to make future corrections. Variations such as bad weather, or logistical shortfalls, can be evaluated to determine risk.

Ethics

Ethics and the use of knowledge engines for meeting an endstate should be interesting. Take the case of a military force in an unfriendly land. If viable alternatives for a mission include disrupting a country's banking system, and the commander has the infowar tools to do this, how should this be approached? Causing the collapse of a dictator through the banking system may support your objective, but not ethically at the expense of the greater populace. Situations may arise that affect the ethics of host or coalition partners, but that have little relevance to our own ethics. KEWP can raise the warning flag. Conditions such as these are sure to arise with strategic consequences. Improved communications may reduce some of the risk by improving coordination, but there are likely to be opportunities when KEWP's options, if followed, will have far-reaching implications.

Psychological Operations

KEWP could provide advice on the means and ways to psychologically influence an opponent. The cultural, ethnic, religious, and political background of an area of interest can be evaluated by the knowledge engine. A prioritized list could be provided of the most useful techniques to influence enemy leaders, soldiers, or the population. This may enhance short fused operations where psychological operations, when used early, can be particularly effective. Information or techniques gained could also be stored and disseminated for use by lateral units, or for the future. Because many cultures have rich and varied traditions, values, and fears realized over centuries, the

advice available through expert systems could provide an abundance of information, and possibly unique solutions, more rapidly than would otherwise be possible.

Just as psychological operations can influence an enemy, tactful interaction with the media can prove beneficial in gaining support "back home." KEWP could provide the coaching valuable to properly communicate the military situation. It could also maintain the latest "news clips," via the Internet, to keep leaders abreast of the world's perspective of their situation.

Fight as You Train

"You fight as you train" is a common phrase in the military, underscoring the importance of ensuring the training is as realistic as possible. This philosophy encourages the use of knowledge engines for training as well as for operational deployments. If used while in peacetime or training, the system has a chance to grow and the give the operator time to learn how to use it, while the operator can become familiar with its limitations.

The Battle Command Training Program, or BCTP as it is commonly referred to, will provide fertile ground for the growth of KEWP at higher levels in the Army. Similar testing environments in the other services, federal agencies and with coalition partners will benefit everyone.

Peacetime

Knowledge engines may actually prove more useful for peace operations than for other types of military operations. The military's role in operations other than war is

growing and may be a good classroom for us to "teach" our knowledge engines and develop the technology. As we search for various means to avoid a crisis or conflict while still in a pre-crisis situation, the knowledge engine has the potential to work "non-stop" entertaining options for avoiding a more serious conflict. If adequately programmed, it would not only look for military solutions, but economic, political, and cultural solutions, as well.

Covert operations have always been, and will continue to be a tool for U.S. policymakers. Information operations will become an increasingly viable alternative for covert operations as the ability to employ a wide variety of "infotools" becomes available. The knowledge engine, in this sense, is a perfect toolbox within which to keep these and other tools of our trade. The very situation where a knowledge engine would shine is in analyzing all options and prioritizing solutions, when little time is available. There may be a shift in emphasis from using direct action to using information technology as a means to address immediate concerns. For this reason, Special Operations Forces, especially, have a viable interest in the development of knowledge engines.

Crisis

As a situation transitions from peace to one of potential conflict, the amount of time available to make decisions shortens. Now the decision maker is willing to take more risk, all in the effort to meet an endstate. This, in turn, may mean new ways to solve the problem become viable. KEWP becomes a more useful tool as less time is at

hand and new options become available. As the crisis approaches, the ability to plan and react faster than your adversary may prove the key to success.

War

When the most is at stake and a nation is at war, the value of knowledge engines will prove most useful. The pace of warfare is increasing dramatically, with the phrase "revolution in military affairs" recently introduced to dramatize this change. Whether or not we are in a revolution, there is no doubt that a force with the ability to see the battlefield better, and to move more quickly and with greater lethality, will have a significant advantage. KEWP can facilitate information superiority as the decision maker's right arm. In addition to quickening the pace of battle, other tools for information operations are evolving.

A topic receiving much attention is the computer network attack, or CNA. Computer networks can be attacked during any phase of operations, but will certainly be critical assets for both sides immediately before and during armed conflict. KEWP would provide the expert system capability to plan, coordinate and aid the execution of a CNA.

Transitioning between Peace, Crisis, War and Post-Hostilities

A knowledge engine for military operations must provide a commander and his staff a capability to transition between phases of a conflict. Such transitions are typically not easily handled and require a quick change of mindset. KEWP would have no biases in such situations and could readily adapt to changing environments. Having

the experience of MacArthur's effort in Japan, or the Marshall Plan's concept for Europe, in an expert system, are examples of how KEWP could provide the decision maker a different perspective in addressing the changing environment seen after hostilities.

The Reality of Developing KEWP

Who's Side is Time On?

Time is an interesting variable in the development of a knowledge engine. Developing the enabling technologies takes critical skills to accomplish, but can be done leisurely, with relatively little financial backing and few means of being detected. Creative minds, not money, are the key.

Hackers give indications of this creativity. As their skills are developing from juvenile interest to a professional preoccupation, the seriousness of their work is printed in newspapers. With a world of talent that is growing, and funding that is sure to lure candidates, it is only time before the use of information warfare, in general, and knowledge engines in particular, will manifest itself.

What seems unfeasible to many is simple to others, meaning our conventional wisdom may dictate applying a significant portion of our defense spending to reach knowledge engine goals, while a subtle, creatively intelligent "information warrior" may produce astonishing results with few funds. The "leap ahead technology," in this sense is the creative development of information management tools to achieve ends.

DOD and DARPA Initiatives

Initiatives by both DOD and DARPA pursue the realization of knowledge engine technology, but not as an end-item. The focus is instead, on the enabling technologies that are critical to fielding a KEWP-like system. These are "...automated planning and reasoning tools; fast-running modeling and simulation; improved intelligence processing and fusion; improved human-computer interface and cognitive support; information warfare event detection; ...computer software-intelligent agents for operations; networking technology;..."[11]

DARPA is developing the bandwidth for radio systems to appease the military's voracious appetite for data. A study by DARPA indicates bit rate increases of 100 to 1,000 times that available in 1997 will have been tested in Task Force XXI Advanced Warfighting Experiment, and generally available by the year 2000.[12] Such increases will facilitate the high data rate required by KEWP and other military information systems.

The Development of Computer Intelligence

DARPA is developing an aid for combat commanders in the form of the Warfighter's Associate, or WFA. Much like the Pilot's Associate, the WFA will focus on providing critical information and options when "the going gets tough," typically during the fog and friction of war. It will analyze those things the commander looks at now, such as the enemy and friendly forces situation, operational and logistical data, and the terrain and weather. Traditionally known as METT-T, or mission, enemy, troops,

terrain, and time, these are the elements, which if given balanced consideration, will improve the likelihood of success. When poor conditions exist in which to make decisions, such as in poor weather, with little time, and where, for example, you haven't slept in two days, etc., the benefit of a "smart" associate gains credibility. The WFA will be a staff aid as well as a commander's aid, capable of searching remote databases with a formal query generated by the user, such as for local weather patterns for the S-2, or food available in the region for the S-4.

The initial effort with the War Fighter's Associate is as an information integration tool and not as an intelligent system, where it would adaptively learn with time. The future potential of aids such as WFA is limited without the adaptive learning function. The evolutionary development of knowledge engines will progress from limited systems that provide simple solutions, to highly complex systems that may eventually aid interagencies in forming heterogeneous solutions to national problems. The application of knowledge engine technology is well suited to this complex environment, but not before it is developed for well-constrained environments, such as for the small unit or ship level. The question is, at what level should it be targeted for its early development? It must be as limited, or narrow, an application as is reasonable, but one that proves its worth. With tenative success "under its belt," it will gain credibility.

Eventually, we may all have a "HAL" as a personal associate. Isaac Asimov envisioned such a situation many years ago in a short story where young school children were given their "slate" at a young age. It talked to them, reminded them of important events, and coached them through their early years. This was science fiction,

but today similar concepts are opening our eyes to the possibility of seeing what Asimov foresaw. DARPA has initiated a program called the tactical information assistant, or TIA, to embrace these emerging technologies, a sophisticated equivalent of today's personal information managers. In another initiative, a body vest has been developed for soldiers where, "the vest will initially support a computer data storage device, a wireless modem, a GPS device, a plug-in diagnostic interface module, a wireless radio, and a head-up display."[13] These may eventually be refined to a pocket device accomplishing the integration of many functions coming to fruition today.

The limiting factor in the quest for KEWP is our ability to imitate human capabilities. "According to Alan Turing (a computer intelligence specialist), language skills and common sense are the essence of intelligence. There's just on problem: language understanding and common sense are the two things we don't know how to do. ... Bottom line: Understanding is the key to AI. More than anything else, it's the one technology that eludes science."[14]

Research and Development Realities

Below are factors that bear on the cost effective and practical development of a knowledge engine.

1. Require the first fielding to be a simple system with limited capabilities, first and foremost. Early promises of artificial intelligence and expert systems in the 60's caused great expectations, but later quick rejection. No product then produced met the expectations of most observers.

An initiative at the Combined Arms Center, Fort Leavenworth, Kansas, is focusing on a knowledge engine capable of aiding the planning and rehearsal of missions. This program, if combined with the Warfighter's Associate, would be a great start for the integration of other enabling technologies. A champion for an effort like KEWP is needed such as support through the Army After Next program or similar programs of future vision within the armed services.

2. The technology of cognitive thought should be developed in conjunction with, and not in isolation from, the other enabling technologies. Because the development of "intelligence" will likely be a combination of hardware and software, and because it will take a fair amount of lead time to develop, its maturation in parallel with KEWP's, would shorten the time to fielding.

3. Think "joint" and bring all services into the development effort. The benefit of using KEWP in all services, to include Special Operations, spurs standardization and will have a synergistic effect which will compound the advantage already seen in joint operations. The tougher challenge will be gaining acceptance of the concept from coalition partners. Involving coalition partners may prove especially helpful if their perspective provides unusual solutions to some of the development challenges. Corporate interest may grow, as well, providing funds and ideas.

4. Keep the size practical for the application. What may start as a system in a Bradley fighting vehicle will eventually shrink to a man portable unit, absurd as that may sound today. Imagining a breast pocket "buddy" is not too unrealistic within the next 15 years (2012).

5. Integrate expert systems early. The services have a wealth of historical information that can be applied to develop expert systems. An example is the involvement of retired officers know to be "experts" in their fields. General Shelton's Haiti experience, for example, if developed via an expert system, would benefit many tactical to strategic thinkers in the military. The traditional school teachings and use of manuals are, by their nature, limiting in their usability. Included, should be economical and especially political perspectives, not just military in KEWP's development. Bosnia taught us that soldiers at all levels are exposed to situations that can have international implications, and therefore high level interest.

6. Develop an expert system optical disk (CD or DVD) that can be used by primary staff officers today. The intent is to provide expert advice to staffs and aid staff functions for the battalion, naval ship, or air operations center, as examples.

7. Keep the user intimately involved in the development effort. The iterative feedback from users will keep the effort tuned to current requirements and aid acceptance.

An Idea Whose Time Has Come

This portrayal of a knowledge engine for the military is meant to convey a sense of what is possible as well as what is probable. The promise of computerized associates in an operations center or in the cockpit of a single pilot aircraft are significant. Because we can develop and field a KEWP with limited but useful capabilities soon, we should use the rapid advances in science to begin assembling the

pieces. This is a concept that once started, will take on a life of its own, much like the computer and Internet have done. Its simply a rebirth of the computer as a likeness of ourselves with a worldly perspective. The marriage of intelligent software, computers, communications, and reasoning software with adaptive learning, is difficult to fathom, but recognizably certain to provide a tangible benefit once pursued. We should not miss the opportunity to apply a KEWP to military operations.

END NOTES

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