

Characteristics of Innovation

A Review of KEEL (Knowledge Enhanced Electronic Logic)

Objective:

This report identifies a series of “characteristics” that can be used to evaluate the potential impact of a new technology on society as a whole. These characteristics can be used to assist in establishing a potential value of that technology to acquisition candidates.

- **Anything that provides a service or solves a problem that was never before possible**

Computer-based systems handle fixed rules with some level of adaptability. KEEL extends the abilities of computer based systems to incorporate human-like judgment.

The ability to exercise judgment has been what separates computer-based systems from human systems in the past.

KEEL extends the market reach of mechanized systems.

Machines amplify human capabilities. Machines with KEEL allow more functions to be mechanized.

- **Anything that eliminates a major problem (or cost) for people or organizations**

Human error is a major cost issue for many domains. Errors in judgment can be minimized by utilizing KEEL based systems.

Humans make errors because of lack of attention, failure to perceive, limited memory, and poor judgment. Computers have already addressed the first 3 components of human error. KEEL enables a response to the poor judgment area.

Reducing the number of humans to perform tasks or to operate equipment can reduce costs.

The military has requirements to provide the same level of service at reduced costs in the future. This means that systems need to be automated. This means that there is a need to reduce costs. Right now humans apply judgment to perform many of their duties. If these jobs can be automated, costs can be reduced.

- **Anything that commoditizes a high cost function thus eliminating an existing business opportunity**

Some "experts" charge a high price for their services.

Decisions and actions performed by those experts that follow a simple set of rules can already be automated with conventional computer technologies. It is the interpretation of information by "experts" that has differentiated them and allowed them to charge high fees. Using KEEL, one can capture and deploy the reasoning models of these experts. This has the potential of commoditizing the services of some experts. For example, the medical industry is loaded with high priced "experts" that observe patients and analyze diagnostic tests.

Service technicians are often required to maintain complex equipment. There are high recurring costs to maintain a trained service staff. Each technician needs to be trained individually. Embedding diagnostic understanding into devices will allow devices to diagnose their own problems. Using KEEL, these diagnostic techniques will need to be developed one time and deployed with the devices.

- **Anything that creates the demand for another service or function**

KEEL can create product and service differentiation.

Organizations that provide more intelligent and capable solutions will create more demand for their solutions.

If opposition organizations are able to create more intelligent solutions using KEEL Technology, then new "technologies" will need to be created to respond to them.

KEEL has the potential of upsetting the economic / power base in almost any industry. The primary way that has been used to offset "intelligence" has been the use of "force".

- **Anything that provides a service or solves a problem in a significantly better way**

KEEL allows constant / continuous refinement in the development of any solution.

A great many technological solutions create such complex models that they need to be totally recreated from scratch when they need to be extended, or need to respond to new situations or new knowledge. This means that KEEL based solutions can provide a major life cycle cost reduction.

Complex models can be created with the KEEL "dynamic graphical language" without the need for support from mathematicians or software engineers.

This means that Domain Experts can create the models directly without transitioning ideas from the domain experts to the mathematician to the software engineer (back

and forth) until the design is created. The domain experts can focus on solving the problems, rather than on the development process.

Some complex problems cannot be solved in one pass. The domain expert may need to "learn" how to describe the problem (and the solution) through interactive test and review techniques.

Many experts have never had to fully "explain" exactly how to solve problems. The KEEL dynamic graphical language allows the expert to build models and test them during the development process by stimulating inputs and "seeing" how the model performs. Development of these complex systems is commonly an iterative process. The models will get better and better over time.

While humans learn through experience, the human (written / verbal) language is not effective in explicitly explaining how information is interpreted.

KEEL models are 100% explainable and auditable.

- **Anything that creates a new class distinction that makes one group more powerful or significant**

If KEEL is owned by a single organization, then that organization would be the only one able to exploit it in their domains.

KEEL is a fundamental technology. Anyone that has a significant competitive advantage has the potential for creating a class distinction. Knowledge is power. Understanding is power. The ability to mechanize (automate) devices with superior knowledge and goal seeking capabilities that can be constructed with KEEL can have a significant advantage.

- **Anything that removes or eliminates the need for another significant activity or function**

The US military has recognized the need to "do more with less" in their vision for the future. This means that autonomous weapons / vehicles / devices will be used to fight wars in the future.

KEEL-based autonomous devices can perform according to KEEL-defined policies. They can pursue goals on their own; independently or collectively. This keeps humans out of harm's-way. Warriors will transition from individual fighters to tacticians and strategists where one person's abilities can be amplified through many devices.

Embedded diagnostics and prognostics based on KEEL technology can reduce the need for trained support staff.

Policies described (and executed) with KEEL Technology are 100% explicit (explainable and auditable). There should be no need for large groups of people trying to understand why things happened like they happen.

Example: The war in Iraq was based on the interpretation of information by humans and documented (or not documented) with the English language. The background for decisions and actions have been discussed and debated over and over again, costing a significant amount of resources and money. If the decisions and actions had been documented in KEEL, it would be easy to trace "exactly" why decisions and actions were taken. If there was any error in judgment, the exact reasons would be visible (and correctable).

Legal and Insurance costs associated with medical errors could be reduced or eliminated if the reasoning process was explicitly documented and correct.

KEEL judgmental models for diagnosing and treating patients could explicitly define how patients should be diagnosed. Risks would be known up front.

- **Anything that redirects spending from one direction to another**

Rather than paying individual experts for their services, fees might be paid to organizations that possessed the "best" KEEL models that have been refined over time.

If KEEL (a basic fundamental technology) was sold to a foreign organization, then products and services based on KEEL may have to be acquired from that foreign organization.

KEEL is a fundamental technology. The organization that can exploit it in various industries has the potential of creating a paradigm shift causing funds to go to the organization that "owned", and could deploy, KEEL-based solutions.

- **Anything that gives one person or group a distinct advantage over another group**

Should only one group have sole-ownership of KEEL Technology then they should be able to exploit it in their domain(s).

They would then be the sole supplier to any that could benefit from it.

The group that owns KEEL Technology for a domain could refine their own understanding of how information should be interpreted to create superior solutions.

The military (the Navy with Sea Power 21, the Air Force with Vision 2020, and the Army with FCS ("Future Combat Systems")) all recognize the need for autonomous behavior.

With KEEL one can build and extend adaptive behavior that will allow autonomous devices to pursue goals on their own.

- **Anything that can act as a catalyst that stimulates broad change**

Conventional computer based systems provide "left-brain" functionality. KEEL is the first technology focusing on "right-brain" information interpretation.

KEEL provides a new way to process information. This has the potential for developing a whole new industry for incorporating human-like reasoning into products and services.

The world is rapidly moving to an information based economy. Countries and organizations that know more and can react faster will be dominant.

Conventional computer technology (IF THEN ELSE) logic is available to anyone. KEEL has the potential to give communities that own / use it a significant advantage. Because it is "NOT" open source, it can be controlled.

- **Anything that changes how society works or plays**

Knowledge workers (in the US) have replaced the manufacturing jobs of the past.

KEEL has the potential for automating more of the knowledge workers' tasks. It has the potential to transform the workforce.

The aging population will demand more and more caregivers. This cannot be supported with humans alone.

Cost effective robotic caregivers may provide an effective solution.

- **Anything that creates a new problem (or cost) that everyone must address**

If one organization "owns" KEEL capabilities, that organization has the potential to charge for services. If it is significantly better than existing solutions, people will redirect who they pay.

For example, if medical diagnostics and prognostics could be delivered "better" with a KEEL based system, then the owners of that knowledge (and understanding) would be able to extract money for better services.

- **Anything that can transform an existing significant problem into something with major benefits**

The military has demands to do more with less. Manpower costs are a significant issue.

Presently human experts (operations, technical specialists) are needed to operate and maintain equipment. The costs to train, maintain, house, feed, etc. these human

experts are significant. These humans also make errors in judgment as they perform their duties.

Automating the human reasoning capabilities of these resources with KEEL Technology has the potential to greatly reduce costs while at the same time allowing systems to avoid human errors in judgment. It should be possible to create cognitive KEEL engines that create 100% explainable / auditable decisions and actions. As the situations change, the models can change easily. The KEEL cognitive engines will effectively take no space, thus reducing the costs associated with housing them on ships. Maintenance can be handled with much fewer resources than humans require.

- **Anything that stabilizes a major unstable system: (economic, political, social)**

Asymmetric warfare has somewhat decreased the importance of tactical nuclear weapons as wars are fought at lower man-to-man levels.

Autonomous tactical weapons (UAVs, UUVs, AGVs) that are mass produced can give the owners of those weapons a tactical advantage. When one group has a significant advantage, it has the potential for stabilizing the situation.

- **Anything that invalidates a broadly held belief, or law of nature**

Presently there is a widely held belief that humans provide the only way to "interpret information" and respond to complex problems.

KEEL was designed to address this issue. KEEL has the potential for changing the knowledge worker paradigm, allowing many of these services to be automated. This is no longer the domain of science fiction.

- **Any new knowledge about the universe or life that allows mankind to enter new domains**

While not directly a KEEL target solution, it might be of value to incorporate KEEL reasoning engines in long space flight missions.

This could lead, indirectly, to new knowledge that could open totally new doors for research.

The potential to deploy KEEL reasoning models in "agents" that participate with humans in virtual worlds has the potential for opening new doors. (Social networking is one example: Facebook, MySpace, Second Life).