KEEL Technology Technical Whitepaper Covering A Training Tool for Field Commanders

KEEL® Technology – Executive Summary

Compsim's KEEL® Technology (Knowledge Enhanced Electronic Logic) is technology that can be used to put human-like decision-making in products or software applications. Using KEEL for military and commercial applications will enable people and devices to operate more efficiently. This whitepaper will focus on the use of KEEL in infantry training exercises.

KEEL Technology – Introduction

Many of today's training solutions to field commanders in the military involve what is called "recognitional decision-making". Some of the aspects of recognitional decisions involve those where 1) experienced Commanders are leading the troops, 2) there are time pressures to act, and 3) battle spaces are changing rapidly (and mission goals become ambiguous or inconsistent).

One training solution used widely in the military involves providing the field commanders in a situation where combat-related decision-making is needed in order to plan an attack. After each scenario is presented to the student, the class discusses their ideas and possible means of planning attacks, takeovers, or rescues. Using this type of training, there is no right or wrong answers; only a discussion of different options designed by the students.

Using a KEEL based training scenario, the field commanders would have the opportunity to use "best practices" in their training sessions. The experiences of past commanders could be presented to the students as solutions to the problem or scenario. This would allow them to have at least one recognized solution to the military exercise to either use or consider when making the final decision for the troops in their command. A KEEL based training tool installed on a PDA or laptop computer could be carried to the field for training sessions without the need for a human instructor.

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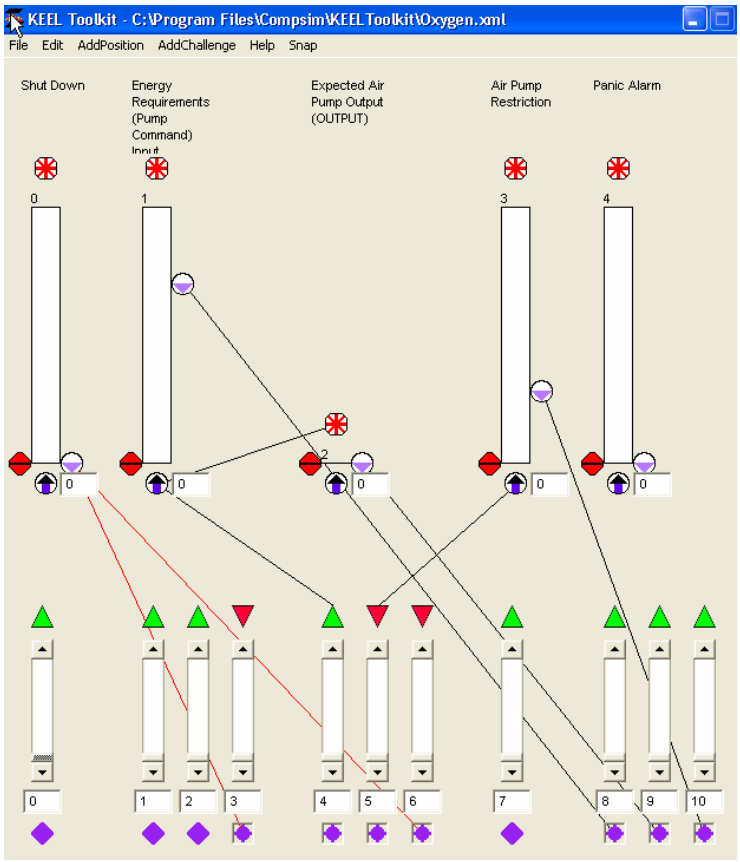
KEEL Technology – Basics

Technology Overview

KEEL Technology can be considered an "expert" system that uses the decision-making skills of a human as the basis of judgmental decisions. The KEEL Toolkit provides the mechanism to collect and test those reasoning skills before deployment in the final product. KEEL targets human reasoning applications; or so-called *wicked* problems where one is looking the 'best' answer rather than a 'correct' answer. KEEL does not target *tame* problems which can be addressed with formulas.

KEEL Technology is implemented as a Rule-based System. The KEEL Toolkit allows knowledge to be graphically represented in the form of production rules. Rules are developed graphically as ideas that are supported or blocked by reasons or inputs. Individual ideas are wired to other ideas, which specify decisions or actions. The rules can change dynamically as the environment changes…

The image below shows the development environment provided with the KEEL Toolkit.



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The KEEL Toolkit is interactive. The designer (i.e., the human "expert") sees the decision-making actively being performed as soon as linkages are made. This makes designing the application easier and faster. In addition, the toolkit supports the creation of decision 'models' in a library. These individual models can be merged into production solutions to accelerate development of KEEL Engines.

When the "expert" has completed the design of the application, he/she uses a menu item to translate the application into computer source code (C, C++, Microsoft C#, JAVA, Microsoft Visual Basic Version 5/6, Microsoft Visual Basic .NET, Macromedia's FLASH, and PLC Structured Text for implementation in Programmable Logic Controllers). This allows KEEL to be Architecture independent, as the code can be run on any platform.

KEEL Engines are extremely small (approximately 1-3K of code with associated tables). The size of the tables depends on the complexity of the solution. KEEL Engines can run in 8 bit micros and above. There are no 'Libraries' of object code to integrate into the final solution.

Application Scenario – Field Commander Training using KEEL

As mentioned, a commonly used classroom training session for field commanders in the Army entails providing the commanders a situation where combat-related strategy is needed. The commanders are then asked to think about possible alternatives to solve the scenario they were given. The class then discusses the alternatives as a group.

A KEEL based solution might embed the expertise of seasoned commanders in the field. This KEEL training aid could potentially be packaged in a PDA or in a portable computer. Then the class would have this training available to them in the field, when they are asked to solve a similar problem. Unlike scripted games, KEEL based training scenarios could be executed over and over again, exposing the dynamics or real encounters. Since each of the elements of the scenario would have built in personalities, they would each adapt to change in a realistic manner. Once the personalities and skill sets are incorporated into a KEEL based training solution, these personalities and skill sets could be modularized and reused.

For example, if the students were studying and evaluating enemies located at different positions, each of the enemy positions could be driven by KEEL engines. Using this approach, the students could study the enemy in each of their locations to see how they might respond to friendly force's actions. As the commanders know, sometimes the enemy is passive, and at other times they might be more aggressive. Some enemies might be willing to fight to the death while others may be more likely to surrender, given the right conditions. These responses could be either random or controlled. The system

designer might also configure failures of the friendly forces. Once designed, all of these types of scenarios could now be individual KEEL engines.

Another training scenario might include an "analytical solution". This solution would include the logic that the army experts use to define how they think the troops should be deployed. This solution could be tested against multiple dynamic situations. An additional benefit would be in the development and testing of the "best" solution. If another degree of complexity is desired, the course could be designed by incorporating *scoring* into the KEEL battle scenarios.

Since KEEL solutions are not "scripted"; the students should be able to learn from the actual development process.

Here's how this might work in a training environment: The commanders would be told to position their forces. The training instructor would then start the session. Now that the battle has begun, both the friendly forces and the enemies are making KEEL based decisions. Therefore all of the decisions that are made are explainable. Using this training method, it would be possible to "see" the results of the planning and to do a postmortem of the actual battle from both sides. In other words, the students could be trained both as attackers and as the attacked (in case they happened to be attacked).

Components of KEEL

KEEL Toolkit

The KEEL Toolkit creates KEEL Engines that allow the software applications and devices to take on some of the reasoning functions commonly performed by skilled personnel today. The toolkit is the Domain Expert's method of accessing and using the KEEL technology described in the Technology Overview section above.

KEEL Function Block Diagram (KEEL-FBD)

The KEEL-FBD can be used to assist in the development of complex KEEL systems where multiple KEEL engines will be integrated into a single application. This application creates a "wrapper" that binds together multiple KEEL engines. Its primary purpose is to load the system and to move outputs from one block to the inputs to another. It also allows the user to determine the processing order of the blocks. This allows the external "glue logic" to remain the same, while the internal structure of the blocks may change.

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Compsim's Management Tool (CMT)

CMT provides services for knowledge capture, information weighting and knowledge reporting. This tool allows the knowledge base and decision making reports to be saved as XML files. The data can be then be imported into most state-of-the-art corporate databases. The XML format can also be used as the initial step in creating a KEEL based solution.

Comparison with Alternative Technologies

Technology Comparison Table

	Neural Nets	Fuzzy Logic	Bayesian Belief Nets	AI – Forward / Reverse Chaining	KEEL
General Concept	Pattern matching	Geometric Fuzzification / Defuzzification	Probabilities of Probability	Trial and Error	Dynamic adjustment to Importance of data (genetic)
Source of Understanding	Patterns	Human Designer	Human Designer / Statistics	Human Designer	Human Designer
Pattern Training Required	Major Problem	No	No	No	No
Explainable Decisions	No	Difficult	Difficult	Somewhat	Fully Explainable
Small Memory Footprint	No	No	No	No	Best
Performance	Determined by application	Determined by application	Determined by application	Worst	Determined by application
Suitable for Control	Yes	Yes	Probability not	Probably not	Yes
Interactive Development	No	Maybe	Somewhat	Maybe	Yes
Portable design (device, software, web)	Probably Not	Probably Not	Probably Not	Probably Not	Yes (one design, many output formats)
Weaknesses	Pattern training required; Decisions not "explainable"; Does not handle "surprise" conditions	Difficult to explain reasoning; Somewhat arbitrary design concepts	Statistics may not be available for non-linear systems; Difficult to explain	Fragile / brittle- hard to maintain; Does not handle "surprise"	

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For More Information

More information about KEEL is available on Compsim's Web site at http://www.compsim.com.

If you have additional questions concerning this technology, please contact us at hgkeeley@compsim.com.