Lighting Analysts
illumination engineering software
10440 Bradford Road, Unit A Littleton, Colorado 80127 USA
info@agi32.com www.agi32.com t.303.972.8852 f.303.972.8851

Lighting Analysts software programs **AGi32** and **ElumTools** utilize the *Helios32* calculation technology developed by byHeart Consultants Limited. The described major upgrade to the Helios32 technology will be implemented in AGi32 version 2.3 (January 2012 release) and ElumTools 2012 Release 3 (to be announced Q1_2012).

byHeart Consultants Limited
620 Ballantree Road
West Vancouver, BC
Canada V7S 1W3
Tel. (604) 922-6148

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Helios32 and kăMR Technology™

The most significant feature of *Helios32* Version 6.10 is its redesigned radiosity calculation engine that takes full advantage of today's multi-core processors and multiprocessor computers. Based on byHeart's proprietary kăMR Technology[1], *Helios32* now offers faster performance in:

1. Geometry parsing;
2. Radiosity calculations; and
3. Photometric calculations.

These are not incremental improvements. On an Intel i7 quad-core CPU, for example, most environments will see speed improvements of three to four times for the geometry

[1] kăMR Technology owes its development to a flock of birds. The Northern Raven (*Corvus corax*) ranges throughout the temperate and arctic Northern Hemisphere, and renowned in the mythology of many native cultures for its intelligence and problem-solving capabilities. They are usually solitary birds, but occasionally flock together as an "unkindness of ravens" (similar to a "murder of crows").

Several ravens were observed solving a problem of how to gain access to food. Their communal solution was an example of Aristotle's classic "law of excluded middle," which states that of two contradictory propositions, one must be true and the other false. More practical and even more surprising was the observation that their solution could be applied to the formulation of radiative flux transfer equations.

kăMR Technology honors their contribution. The prefix kă is the phonetic spelling of the raven's signature call, while the suffix MR represents Multi-core Radiosity. Given their generosity in helping to solve a vexing problem, it seems somewhat unfair to call them an "unkindness."

parsing, radiosity calculations, and virtual photometer performance with multiple meter positions.

Parallel Processing

Modern desktop and laptop computers employ microprocessors with at least two “cores,” which are the units responsible for executing program instructions. If the program can be designed (“parallelized”) to execute on two or more cores at the same time, the performance will increase approximately according to the number of cores.

Unfortunately, the radiative flux transfer equations that form the basis of radiosity calculation engines cannot easily be parallelized. Consequently, previous versions of *Helios32* performed their radiosity and photometric calculations using a single core.

Helios32 with kăMR Technology uses a novel reformulation of the radiative flux transfer equations that enable the radiosity and photometric calculation engines to execute on as many cores as are available. This includes high-end desktop workstations that have multiple multiprocessors.

So, *Helios32* now offers parallel processing capabilities. This does not mean however the performance will increase according strictly to the number of cores. Several factors will determine the ultimate performance increase.

Hyper-Threading

Many Intel microprocessors offer Intel’s proprietary Hyper-Threading (HT) Technology. Hyper-threading works by duplicating certain components of each core such that the Windows operating system “sees” two virtual cores for each physical core. Here for example is what the Windows Task Manager displays for an Intel i7 quad-core CPU with hyper-threading enabled:

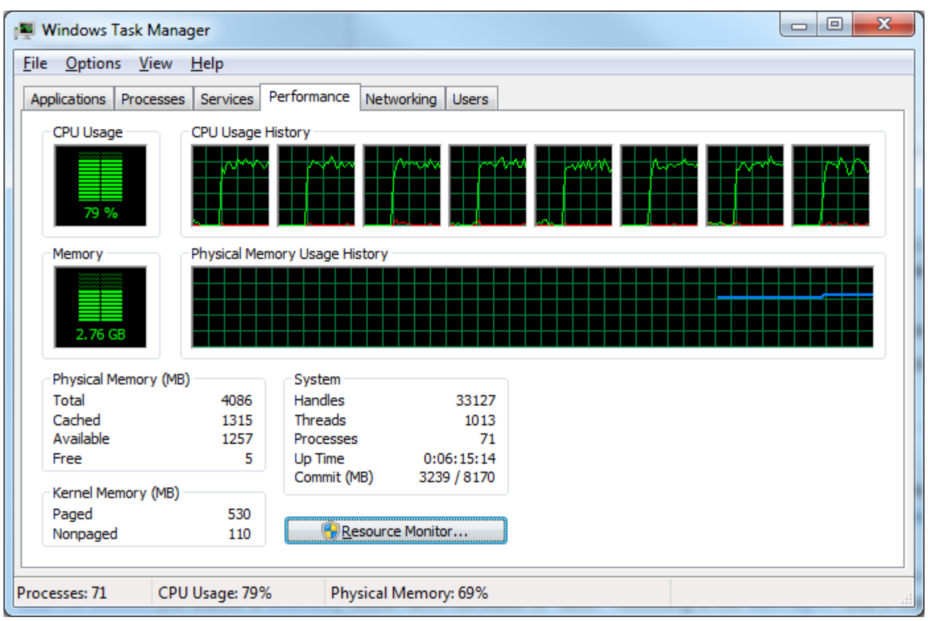

FIG. 1 – Windows Task Manager showing eight hyper-threaded virtual cores with an Intel i7 quad-core processor.

Looks however can be deceiving. Intel itself states[2] that hyper-threading offers at best 15 to 30 percent performance improvement when it is enabled, and for some programs performance actually decreases.

For *Helios32*, it is unclear whether hyper-threading offers any clear advantage. Some environments show a small improvement when hyper-threading is enabled, while others do not. It does not appear however that hyper-threading degrades performance, and so it should remain enabled. (Hyper-threading is enabled by default with Windows 7.)

Given this, it is evident that it is the number of available physical cores that determine the performance increase of *Helios32* with kǎMR Technology.

Memory

The ability of the microprocessor cores to run at full speed depends on their ability to access memory without delay. Modern microprocessors typically have anywhere from 2 to 12 megabytes of fast "cache" memory on-board. If the data for the *Helios32* environment being processed can be stored in this cache memory, then it is likely that the CPU usage for each core will approach 100% most of the time for the radiosity calculations.

For larger environments whose geometric and materials data must be stored in main memory and swapped with cache memory on an as-required basis, the CPU usage may drop as the cores are forced to wait for the data to be transferred from the much slower main memory.

FIG. 2 illustrates a typical *Helios32* environment with 19 luminaires, 7,935 surface elements, 15,172 vertices, and 24 textures. This environment requires approximately 50 MB of memory. When the radiosity calculations are performed on an Intel i7 quad-core CPU with 8 MB of cache memory, the average CPU usage (as shown in FIG. 1) is 80 percent. In other words, the cores are spending approximately 20 percent of their time waiting for data to be transferred from main to cache memory.

FIG. 2 – Typical *Helios32* environment

[2]See http://www.intel.com/technology/itj/2002/volume06issue01/vol6iss1_hyper_threading_technology.pdf.

This issue applies however regardless of the number of cores being used. Even in the worst case scenarios then, multi-core CPU usage will exceed that of a single core, and so there will always be a performance advantage over previous versions of *Helios32*.

Many Cores

Intel has recently demonstrated an experimental 80-core microprocessor and, along with its competitor AMD, is promising a continual increase in the number of physical cores available on a single microprocessor. In addition, high-end desktop workstations will continue to offer multiprocessor solutions. The challenge then for software developers – and it is a challenge – will be to design programs that can take full advantage of massive numbers of cores.

There is however a hardware limit to the number of cores that Windows can support. The industry-standard x86 (32-bit) architecture has a limit of 32 cores (physical or virtual), while the x86-64 (64 bit) architecture has a limit of 64 cores.

As designed, *Helios32* with kăMR Technology can support an unlimited number of cores, so it is future-proof against further hardware advances. Whatever the future of desktop computers, *Helios32* is ready.

Faster and Faster

Preliminary results indicate that byHeart's kăMR Technology offers speed improvements on the order of 1.5 to 1.8 times for each additional physical CPU core with both small and large environments. *Helios32* Version 6.10 however implements only the first iteration of this technology. Development is ongoing to further improve the overall performance of *Helios32* with kăMR Technology.