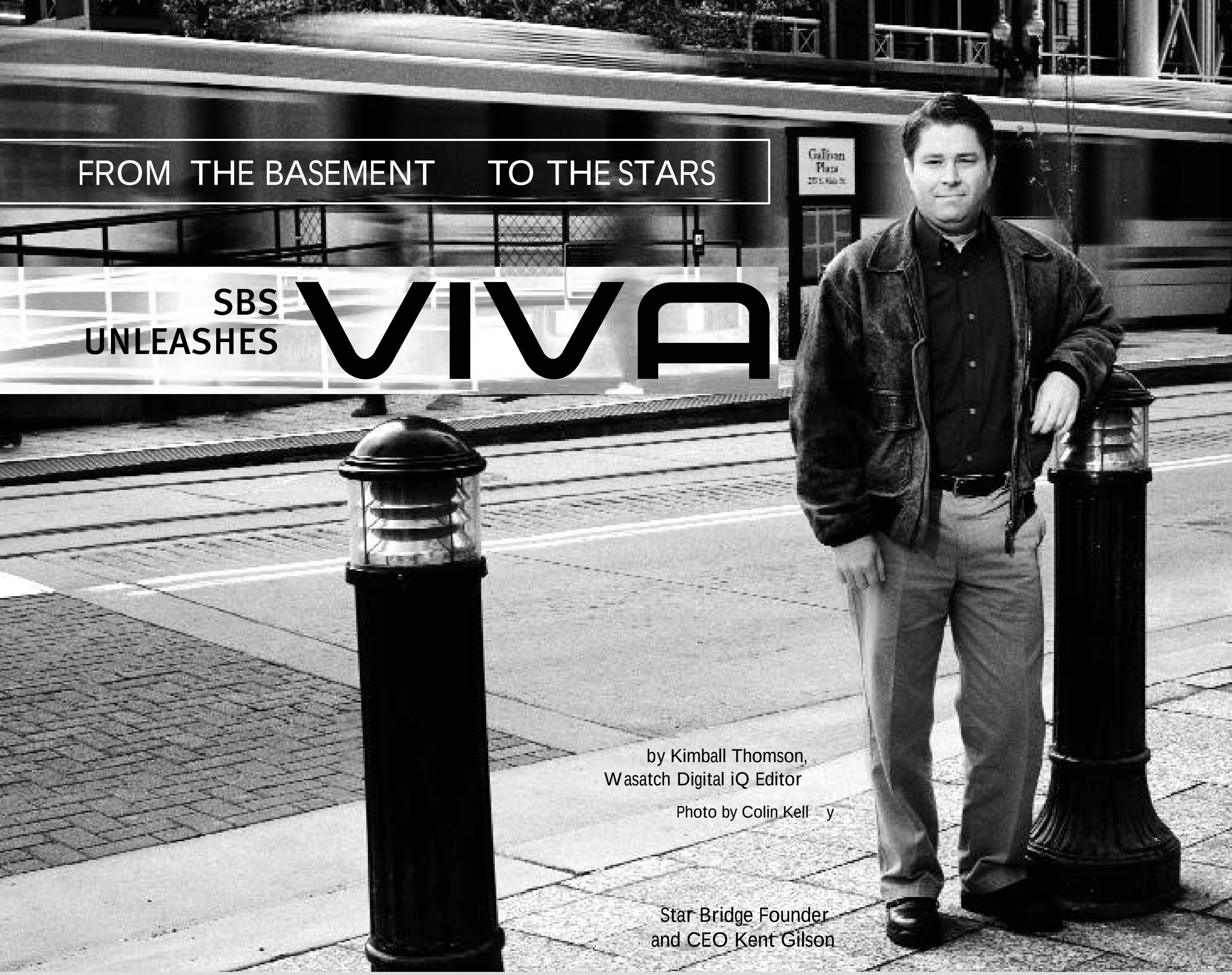
FROM THE BASEMENT TO THE STARS

SBS UNLEASHES VIVA



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Star Bridge Founder and CEO Kent Gilson

"I'm sorry, Dave; I can't do that." For many viewers, the most memorable – and chilling – moment in Stanley Kubrick's 2001: A Space Odyssey was the scene in which ship computer Hal uttered these words in defiance of an order to allow a crew member to reboard the ship, leaving him stranded in deep space. Suddenly, a tool created to serve its human user's interests and intentions had developed its own thoughts and volition – and was able to defy its human masters.

If Star Bridge Systems CEO Kent Gilson has his way, NASA spacecraft will soon be guided by a computer named HAL – and the way computers are presently conceptualized and utilized will rapidly become unrecognizable.

HAL is an acronym for the Hyper Algorithmic Logic computer created and refined by Gilson and his Star Bridge engineering team. During the past 15 years Gilson has been a leading pioneer of "reconfigurable computing" (RC) – a phrase he coined in 1988 to refer to the capacity of such machines to rapidly and optimally adapt their hardware configurations to the changing requirements of their human users. "In effect," said Gilson, "reconfigurable computing enables the frequent remanufacture or morphing of the entire physical hardware, according to the demands of the user's specific behavioral requirements."

Reconfigurable computing hardware components perform somewhat like software, in that they are programmable rather than hard-wired. This programmability results from the fact that reconfigurable computers utilize a specialized programmable chip called the Field-Programmable Gate Array (FPGA) rather than the hardwired chips used in conventional computers.

According to Gilson, this hardware programmability yields tremendous advantages in speed, price and flexibility for computers utilizing RC technology. Gilson refers to such machines as "hypercomputers." Gilson and the rest of the Star Bridge engineering team maintain that their HAL 300GrW1 is the world's fastest computer for many applications, and that its HAL series is the first line of general-purpose reconfigurable computers.

It is difficult to envision IBM's Deep Blue sitting in a corner of the living room or being wheeled into an operating room; HAL 300, conversely, does not occupy much more space than does a mini-computer.

Star Bridge has two comprehensive patents pending – one for the company's hardware, the other for its software inventions. Each patent covers numerous separate inventions, which Star Bridge's Morrison & Foerster patent attorneys eventually plan to break up into multiple patents.

Gilson's HAL is far more user-friendly than its namesake from the Arthur C. Clarke novel and Kubrick film.

"I conceive of computers as extensions to human intelligence and intentions," said Gilson. "For many centuries, humans have created innovative machines as extensions of their physical capabilities: from hammers to wheels to motors." During the past half-century, he said, humans have become increasingly focused on creating machines that extend our minds. "We are now probably at the point where we are inseparably connected to our information machines. HAL represents a major step forward in enabling artificial intelligence functions."

According to Gilson, HAL was designed from the ground up to mimic the hierarchical structure and function of the human mind – in particular, the visual cortex, which Gilson believes is the core seat of understanding in the brain.

VIVA Hypercomputing

To make reconfigurable computing approachable and accessible for programmers, Gilson created VIVA to serve as the operating environment for the HAL machines. VIVA consists of a high-level object oriented programming language, an operating system, and a compiler on a custom user interface.

"The combination of VIVA and Field Programmable Gate Arrays (FPGAs) is what we call hypercomputing," said Gilson. "What it represents is a new kind of computer and a new type of computing. VIVA is the first multi-purpose language that targets this new ultra fine-grained, ultra tightly-coupled, massively parallel compute substrate.

"We are interested in doing the things you can't do with ASICs (Application Specific Integrated Circuits)," said Gilson. "This is essentially a new class of computing that gives new meaning to the term/broadens the scope of 'general purpose computing.'" According to Gilson, VIVA hypercomputing opens up the possibility of doing things ASICs – or collections of ASICs, which he said constitute all non-FPGA-based computer systems – will never be able to do. "Serial processers are limited – imprisoned, if you will – by their serial architectures."

The cost and energy savings hypercomputing represents over conventional serial processing systems, according to Gilson, are enormous. "I think the Department of Energy is paying about $100M for a trillion-instructions-per-second computer," he said. "We will be able to deliver a machine that fast to the workstation consumer – the pro-sumer – for $100,000: 1000 times cheaper. And probably that much more efficient in power consumption. We're talking about literally a revolution in computing; VIVA is the tool that makes that accessible."

"I think you can call this a real leap in programming," said Dr. Olaf Storaasli, a senior research scientist at NASA Langley, "a graphical environment in which you can be very innovative in how you put things together and form functions, without all the drudge Fortran and C++ programming. I believe it can be worked into a host of general and specific applications; if you're creative enough, you can create an infinite instruction set."

Storaasli and another NASA chief scientist, Dr. Robert Singleterry, have followed Star Bridge's progress almost since its inception. Both were participants in the inaugural VIVA training class, taught by Gilson and Cheif Scientist Dr. Lloyd Allred at the company's Midvale headquarters in February 2001. Others participants included two high-level munitions experts from the Air Force; a leading computer science professor from a university in Switzerland; two scientists from a New Zealand wireless technology client, and an engineer from the San Diego Supercomputer Center.

"This is a completely new way of looking at looking at and performing things with computers," said Singleterry, "which is the only way we are going to be able to compute – to translate our ideas into solutions – as fast as we can think." Singleterry had been exposed to FPGAs for well over a decade, but it was not until he began to follow Star Bridge that he saw FPGA-based systems conceived of as general-purpose machines.

"I was accustomed to the idea of FPGAs used for prototyping, especially in integrated circuit designs, and other specialized functions," he said. "But when I was exposed in-depth by what Star Bridge was doing – to the idea of taking an FPGA and reprogramming it many times per second according to the function you wanted it to perform, a light went on for me. That was a compelling proposition for me, something I could have use for."

One of VIVA's central contributions to FPGA-based programming, according to Dr. Giri Chukkapalli a scientist at the San Diego Supercomputer Center, is the creation of an accessible, intuitive programming language. "Programming FPGAs was such a tiny niche activity," he said. "VIVA opens it up to any intelligent programmer willing to learn a new system."

The Making of an Entrepreneurial Inventor

Gilson has a prolific background in entrepreneurship and product creation and development. "From the time I first started fantasizing about my future," said Gilson, "I wanted to be an inventor." Gilson received his first computer in 1974, at the age of nine. Working on the machine immediately became his chief passion, and he taught himself all the machine language and hardware systems data available at the time. "I would go through Radio Electronics (now Popular Electronics), almost lusting at anything resembling a computer."

One revealing anecdote from Gilson's life happened when he was twelve. He was one of a group of boys being presented with their Star Scout badges who were asked to name the person they most admired. Most of the other boys identified either their fathers or a prominent sports or religious figure. Gilson's immediate and unequivocal answer: Thomas Alva Edison. "Even then," he said, "on some level computers represented for me an affordable creative medium – without recurring engineering costs – that a child of modest means could use to create and invent."

Gilson progressed from that time to engage increasingly complex computer hardware and software problems. He created a Space Invaders game at age 12 because he couldn't afford a quarter a game to play it at the arcade. He created a digital music synthesizer when he was 16, and in the same year designed and built his first computer from the chip level up, a Z80-based system he programmed with toggle switches.

At 18, Gilson designed his first parallel processor, which had a similar structure to today's Field Programmable Gate Arrays (FPGAs). In the same year, he left high school to run his first IPO, for a company called "Forward Electronics Corporation," which created and distributed a memory image drive (akin to today's auto-save feature on most application programs). "I went door to door peddling the shares," he recalled. "It didn't turn out half bad; I raised approximately $150,000 for the company." He eventually sold Forward Electronics to a Colorado Company.

At age 22, Gilson created a three-axis robot that served as a plotter and a rapid prototype machine for printed circuit boards. In the next few years, he created a laser printer for Digital Image Systems of Florida, the first application of reconfigurable computing built using FPGAs. The machine could rasterize (prepare the graphic and font data for printing) 400 pages per minute, and cost under $300 in hardware parts, consisting essentially of four FPGAs, a 68000 processor and memory. The product was bundled with software and sold for approximately $25,000 into the online negotiable document printing industry, and was used by such clients as ADP and Exxon.

Kent Gilson and a HAL circuit boar d

Gilson left Digital Image Systems in 1990 to found National Technologies, Inc., which changed its name in 1992 to Metalithic Systems, Inc. (MSI). At MSI, Gilson produced the first commercial FPGA array processing board. From 1992-95 he created a 128-track complete signal processor and digital recording studio, Digital Wings, which won the first annual Xilinx Best Consumer Reconfigurable Computing Product award. Digital Wings also won the Best of Show award from EQ Magazine in 1997 at the 80,000-participant National Association of Music Merchants conference (the Comdex of the music industry). During his seven years at MSI, Gilson raised just under $10M for the company.

Star Bridge Systems

In 1997, Gilson left MSI to return to Utah in order to pursue other reconfigurable computing opportunities. He founded Star Bridge in December 1997.

For its first year, Gilson operated Star Bridge out of his Draper basement. The first Star Bridge employee he hired was former U. S. Attorney Brent Ward, who left Salt Lake law firm Parry Lawrence & Ward in October 1998 to act as President and COO for Star Bridge. Ward currently serves as CFO for the company. Other prominent additions over the next year included director of science and technology Dr. Lloyd Allred, a former Los Alamos scientist and engineer, and senior programmer and analyst Keith Tanner, who came to the company from Moog Aircraft Group.

Star Bridge's principals believe hypercomputing will greatly extend the reach of computers – to such areas as complete immersion virtual reality systems, real-time video processing, gene mapping, and protein sequencing. For example, said Gilson, any degree of complexity in video-signal processing algorithms can be executed on the machine; it is just a matter of adding more processes. "This is the compute substrate that can make the Holodeck a reality," he said of the total immersion room in the modern iterations of Star Trek.

While Gilson contends that RC technology is universally applicable in computer components, Star Bridge will focus its initial efforts on traditional super-computing domains, such as the aerospace, military, bioscience, and telecommunications industries. "These are areas in which we believe the advantages of our hypercomputers are most apparent," said Gilson – and demand for those advantages is most immediate.

One high-level project in the final planning stages is a joint effort with the Harvard Observatory. Star Bridge recently received a proposal from the Observatory to perform the largest virtual supernova experiment to date. "They said basically that they want to virtually blow up a star in-vitro," said Gilson.

Star Bridge has also entered research partnerships with – among others – the San Diego Supercomputing Center, biomedical faculty at UCLA, the National Aeronautics and Space Agency (NASA), and the U.S. Air Force (USAF). On an East Coast trip that began March 26, 2001, the company delivered a HAL 15 computer to NASA. NASA made the delivery an official press event: the agency's CTO officially accepted the machine, and the Director and Deputy Directors of NASA Langley were in attendance.

Star Bridge also received a recent formal invitation from the laboratory of James Watson (co-recipient with Francis Crick of the Nobel Prize for the discovery of the structure of DNA), Cold Spring Harbor Laboratory, to discuss potential collaborations. Star Bridge is also in discussions with the NSA to collaborate on the creation of a large-scale hypercomputer.

Reconceptualizing Computing

According to Gilson, one of the key obstacles SBS will need to overcome in establishing its technologies as a fixture in industry and the marketplace is the conceptual barrier people form from the limitations of current computer systems. "People will have to get used to rethinking what you can do with a computer," he said.

Storaasli agreed with Gilson's assessment. "Since this is really a paradigm shift from what engineers and programmers are used to," he said, "it will be a challenge to sell it to colleagues we need to get on board with this. Most are not used to the idea of reconfigurable programming, coming from a different way of thinking about how to work with computers. We need to communicate the monstrous potential of this thing, to compare it with other things out there and relate it what engineers and programmers already know."

A Control Center Named HAL?

NASA research scientists Dr. Olaf Storaasli and Dr. Robert Singleterry envision many uses for Star Bridge hypercomputers at their agency. Perhaps one of the most intriguing possibilities is service as a control center in spacecraft and satellites.

"One of the strongest potential advantages of Star Bridge's reconfigurable computer," said Singleterry, "is that while it runs its 'lower brain' functions – pumping fuel and information around the ship and turning switches off and on – there's an upper brain there, considering its operations. 'Oh, the user just told me I will be performing such and such a function. The last time I did it this way; maybe it would work better to do it another way this time…' We are approaching artificial intelligence functions here. This system has the potential to be orders of magnitude more responsive and adaptable than what we have now. But we might have to do something about the name Hal…"

Storaasli added that hypercomputing's reprogrammability could be a tremendous boon to NASA's satellite operations. "Imagine the power of being able to reprogram our satellites remotely," he said. "It would basically obviate the problem of obsolescence." Storaasli indicated that the oldest satellite with which NASA is in contact has been in orbit for about 35 years. "If that satellite were reprogrammable, it could perform many more functions than simply saying, 'I'm here; now I'm here.'"

Dr. Olaf Storaasli (right) and Dr . Robert Singleter ry of NASA

One of the key conceptual shifts involves hypercomputing's parallel processing. Parallel computing is the ability to do many different processes simultaneously. "Conventional computers can only do one thing at a time," said Gilson. "Clever programming can make a computer appear to do many things simultaneously, but it is actually only switching rapidly between tasks and sharing capabilities. Parallel processing is literally hundreds, sometimes thousands – and in our case, even millions – of processes running simultaneously, each process with the capability of responding to and interacting with input stimuli in a few billionths of a second."

Programmers will now be enabled to represent algorithms and problems in parallel form, rather than being forced to translate them into one-dimensional serial form. Gilson contends this is a more natural way of programming: both because it better reflects how things happen in the real world – many things invariably happen at once – and because our brains have evolved to think in parallel rather than serial fashion.

"Much of what we are trying to do in our projects at NASA rely on massively parallel processing," said Singleterry. "We've done studies running millions to hundreds of millions of processors in serial computers. Many of our algorithms don't parallelize very well. With this system, that constraint is gone."

According to Singleterry, in addition to parallel processing, hypercomputing offers the benefit of hardware that quickly adapts itself to optimally perform specialized tasks. "This reconfigurable hardware allows us to do what we want to do – and only what we want to do – which is the fastest way you're going to compute with silicon. You don't waste a lot of time moving in and out of memory; it's all done on the hardware, incredibly quickly."

He added that reconfigurable computers are uniquely fault-tolerant. If part of the hardware goes down, the remaining circuitry functions without it – a point Star Bridge has illustrated by shooting a hole in a circuit board and demonstrating that the computer continues to function without a glitch.

Another reconceptualization hypercomputing will drive, according to Gilson, is the idea of real-time computing. "People talk about real-time computing, but the actual modus operandi is 'command and wait.' Many who claim to approach real-time computing are actually only shortening the wait time."

SBS hypercomputers, according to Gilson, are truly parallel: a million processors running simultaneously at 100 megahertz (100 millions processes per second). "In traditional computers, the more complex the algorithm, the slower the system operates, because it takes more and more instructions. With hypercomputing, as the complexity increases, instead of using more instructions, which are time-consuming, you use more and more processes running at the same 100 MHz speed."

Building Libraries

Another challenge Star Bridge faces is more practical in nature: the necessity of building VIVA-based libraries. "VIVA still needs to evolve up," said Gilson. "It works, it's functional for a lot of different things, but we're not really calling it truly general purpose until the libraries get fleshed out. We've picked just the top echelon of researchers and early adopters in order to help us in that process: NASA, the Air Force munitions research, the San Diego Supercomputing Center, and a couple of very strategically picked commercial partners that are going after specific applications."

"Hypercomputing is going to need to enlist a lot of proactive individuals and groups to get involved building up libraries," said Storaasli. He predicted that a global collaborative effort would gradually grow up and expand. "It will probably take a few years to make it all happen. But I believe with our help and that of other people out there, it will quickly accelerate as information and excitement about hypercomputing ripples out."

Singleterry added that one appeal for pioneering technologists – people who want to get in on the ground floor of a potentially extraordinary development – is the ability to help shape a major movement. "The users get to define the system," he said, "rather than having someone like a Bill Gates dictate what it is and what it can be used for. That is a winning prospect."

Gilson believes believes Star Bridge is in the midst of a historical cycle of public opinion – that one day most will see the incorporation of hypercomputing technologies into the mainstream fabric of computing as an inexorable and inevitable process. "For the last ten or fifteen years, peopple have been saying, 'No way, that's impossible, you can't do it, it's too niche market, it's too difficult, it's just not going to happen.' Federico Faggin was the first high profile person who came out and said, 'Hey, the future is FPGAs, and FPICs (Field Programmable Interconnect Devices).'Then people started taking it seriously, and it was officially a niche market.

"We're saying, 'It's already here; it's just a matter of shifting mindset.' There's something magical about achieving the critical mass of humans saying, 'Okay, that could be possible,' for it to become possible. It's kind of like, if you don't believe in miracles, they don't happen."

There are those who already believe in the inevitability of hypercomputing dominance. "This is eventually going to change the way everything happens in the computing world," said Ed Bradley, a senior engineer in the munitions branch for the Air Force Research Laboratory at Florida's Eglin Air Force Base. "In the not too distant future, people will be tearing down Bill Gates statues and replacing them with statues of Kent Gilson."

Creative License

Star Bridge is not immune to concerns about operating on the bleeding edge – too far in front of industry and market demand to gain traction – nor to the potential of being a disruptive economic force. "You can't just go out and create discontinuous innovations, and be disruptive in the market space," said Gilson. "It's not productive – especially something of this magnitude. You pull the plug out from the technology economy, the computer economy, and boom – you have a depression, and no one will buy your stuff. It's not good for you or anybody else."

Star Bridge's business model, accordingly, is based on tapping into existing and evolving marketplace dynamics, by licensing the technologies and processes it creates to market leaders and innovators. "There's an infrastructure already out there in place, and we've got to go out and fit within that infrastructure," said Gilson. "That's why we're a licensing company."

In addition, the company hopes to avoid entry barriers based on economies of scale, and shield itself from potentially debilitating risk exposure. "There's a lot of infrastructure elements out there that take risk in capital to put into place distribution, customer support and all that," said Gilson. "That's not something that we want to do; because it's already out there, and we don't want to recreate it. The barriers to entry are essentially capital, and risk, and things we don't want to expose ourselves to. We just want to leverage the value of what we've created, and let the other companies take and run with it so we can go on creating."

Innovation Culture

Star Bridge maintains a surprisingly low burn rate for an R&D focused company: $1.25M in 2000, offset by $1.0 M in license and equipment revenues. It currently employs only 10. In 2001, Gilson anticipates the company will be "handsomely profitable" – though earnings projections are proprietary.

One main reason Gilson does not wish to scale Star Bridge up into a large bureaucratic corporation is his wish to maintain a culture of creativity and innovation.

"Big companies are not innovators," he said. "I mean, they can't be innovative, it's impossible because they become risk managers." AT&T is not likely to replace all their long distance with packet based data and voice-over IP, because their profit margins would fall out from under them, and they would go from a $60B per year company to a $10B per year company."

"Really, it is startups that have the latitude to do things that are, well, crazy, and just – not wise," Gilson added. "You know, the old school refers to it as wisdom, proper management, stability. The culture that people grew up in at these big companies is so conservative. You just don't get the latitude to do a 15-year project, if the culmination of that project is going to destroy your market."

An environment of controlled growth and profitability, in Gilson's perspective, does not lend itself to creative innovation. "In that environment of quarter by quarter profitability and earnings and expectations management, with analysts courting and managing, you lose track of the big picture." The focus goes to this years profitability, this year's market segment, this quarter's earnings. "There's some logic to that, and it works and continually grows – but it's not a way to do innovation."

Gilson and Singleter ry