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Volume One: KEEN Engineering

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Back to the Future

Becoming KEEN 3

The next business frontier is rethinking everything we consume: what it does, where it comes from, where it goes, and how we can keep on getting its service from a net flow of very nearly nothing at all – but ideas.

– Paul Hawken, Amory Lovins and L. Hunter Lovins,
Natural Capitalism

Great engineering can be *replication*, which is what Henry Ford did. Or it can be *invention*, as Thomas Edison showed us. So we'll need to continue to include innovation in every piece of engineering we do from now on, because that's what makes KEEN different.

Certainly, we've got to deliver good customer service. We've got to deliver quality. And we've got to be able to provide innovation. The real job of everyone in this room is deciding what that innovation looks like on behalf of the client: do they want invention or replication or some combination of both?

With that, Kevin Hydes kicked off KEEN Engineering's 2005 Spring Management Conference in Vancouver in late February – three days devoted to cross-company planning, updates, strategy and celebration. It was a time to reflect on KEEN's forty-five year tradition and a time to look introspectively at its strengths and weaknesses and at what the future could be.

Innovation: Replication and Invention

One glimpse of that future – perhaps the most visible and certainly the largest KEEN project ever – is already underway in Vancouver. Construction began in November 2004 on the \$565 million expansion of the Vancouver Convention and Exhibition Centre (VCEC). Extending out over the shoreline of Vancouver's Coal Harbour, the facility will accommodate the needs of larger national and international trade shows and conferences, also serving as the broadcast center for the upcoming 2010 Olympic and Paralympic Winter Games.

Today, postcards of downtown Vancouver often feature images of the immense white sails over the current convention center – a feature that will remain in place along the harbor, soon to be joined by a green, landscaped roof over top of the new space; in fact, it will be the largest living roof in North America. This element is one of many elements included to meet the city's sustainability mandate for the additional 359,000 square-foot facility.

For KEEN, retained as the project's mechanical, plumbing and fire protection engineer and much of the electrical design, the VCEC is a perfect opportunity for its engineers to replicate and enhance the innovative designs they have created for earlier projects. In collaboration with the project architect, Musson Cattell Mackey Partnership, KEEN's strategies include green roofs, natural ventilation, on-site wastewater treatment and radiant heating and cooling – this time on a much larger scale.

“In most cases, we're just applying the systems we know how to do – and do well,” said Hydes. “This building in itself will probably save more total greenhouse gas emissions through these sustainable strategies than maybe twenty or thirty past KEEN buildings that in many ways are more progressive.”

Other sustainable features for the Convention Centre will include an advanced blackwater treatment plant, using micro-fiber filtration that results in very high-quality water for irrigating the green roof and an adjacent park in summer and for flushing toilets and urinals. The majority of heating throughout the expanded space will come from chillers used as heat pumps; in turn, seawater

will serve as condenser water for the chillers, eliminating the need for cooling towers and dramatically increasing system operating efficiency. Inside, the new 250,000 square-foot Exhibition Hall will incorporate radiant cooling in the roof structure; in-slab floor radiant systems within meeting rooms; and ballrooms and pre-function areas will absorb the solar loads of large perimeter glass areas in summer and offset cooling effects in winter.

“Why work on these large-scale projects?” asked Hydes. “To me, it's

all about making them as green as they can be. It's about leverage. And it's about greenhouse gases.”

Today, more than a decade after KEEN Engineering's transition to green first began, and five years since it declared a company-wide commitment to sustainable design and consulting, the LEED® standard has unquestionably transformed the market while redefining the parameters of occupant comfort and energy efficiency across North America. Still, USGBC's goal to impact the top 25 percent of new and existing buildings raises some questions for Hydes and others at KEEN, a firm clearly dedicated to living and promoting LEED® – what about the rest of the market? KEEN, therefore, is determined to concentrate on three distinctly different strategies going forward; first, on architects, owners and others driven to go beyond LEED® standards in their buildings; next, on the primary LEED® audience itself – to learn, to motivate and accelerate the system that already exists; and, finally, on representatives of the business community, institutions and government who believe that LEED® certification represents only a specialty niche or is too expensive.

And the World is Watching

The City of Vancouver was selected as the host city of the XXI Olympic Winter Games to be held in February 2010. Among its premier venues will be the Richmond Olympic Oval, home to a state-of-the-art, long-track speed skating venue with seating for eight thousand spectators. Located along the banks of the Fraser River and the centerpiece of a \$155 million complex, the Oval will be a showcase multi-purpose sports, recreation and community facility both before and after the Games. The Richmond Olympic Oval is scheduled to open in late 2007 just in time for the national speed skating competitions in 2008, then the world championships in 2009, and finally the 2010 Olympic Winter Games.

In late 2004, KEEN was retained by the Vancouver Olympic Games Organizing Committee to handle the mechanical and electrical

Look at the world around you. It may seem like an immovable, implacable place. It is not. With the slightest push – in just the right place – it can be tipped.

– Malcolm Gladwell
The Tipping Point: How Little Things Can Make a Big Difference

design, joining Cannon Design, a U.S.-based architect and leader in recreational/leisure/sport facilities internationally. The Vancouver Games also represents a conscious effort to broaden and strengthen the focus of sustainability for the Olympic Games, building on a decision made by the International Olympic Committee (IOC) more than a decade ago to environment as a third pillar of the Olympic Movement.

“The Oval is undoubtedly the gem of the new facilities being built for the Olympics,” noted Hydes. “It’s also one of the most significant projects in our firm’s history and will be seen by a global audience, by more people than any other building we’ve ever worked on. It’s going to be a dramatic structure – and elegant in terms of engineering – that will house the venue that’s always one of the most intense and exciting competitions of the Games.” “For us to be working on it and publicly displaying it as a sustainable project,” he added, “offers so many opportunities to get the word out about green buildings.”

KEEN is considering a wide range of renewable energy, wastewater treatment, air quality and other strategies for the Oval. As lead designer on the project, Blair McCarry and his team are also actively investigating the use of several new technologies, some piloted on the many smaller community and recreational facilities KEEN completes each year. These technologies include daylighting in large volume spaces without affecting the ice and using new heat recovery techniques to create new ice for the skating surface.

For Canada and within the global context, the sustainable goals of the Vancouver Olympics – in terms of reducing greenhouse gas (GHG) emissions – line up perfectly with the country’s broader commitment to the Kyoto Accord, which concludes in 2012.

February 16, 2005 was an important date for Canada and KEEN Engineering – the day the Kyoto Protocol commenced. To mark the occasion, KEEN held its “Kyoto Gala” at the Vancouver Pan Pacific

Vancouver Convention and Exhibition Centre

Location:	Vancouver, British Columbia
Type:	Convention/Meeting Facility Expansion
Size:	359,000 sq.ft.
Completion:	Under construction, completion expected in summer 2008
Rating:	LEED® Registered
Architect:	Musson Cattell Mackey Partnership and LMN Architects

Sustainable Features:

- Largest green roof in North America
- Micro-fiber filtration blackwater treatment system for irrigation, toilet flushing and urinals
- Seawater as condenser water for chillers
- In-slab ceiling and floor radiant heating and cooling
- Fire protection systems feature seawater source back-up



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Hotel to acknowledge Canada's commitment to the Kyoto Protocol and to celebrate KEEN's 45th anniversary as a firm. Canada's goal under the Kyoto Protocol is to reduce its GHG emissions to 6 percent below 1990 levels by the year 2012.

During the Gala, KEEN staff mingled with invited guests – city officials, local architects and planners, university representatives and the press – surrounded by banners and detailed informational posters about Kyoto, climate change and GHG statistics. KEEN staff members were able to discuss the Protocol and answer questions about its implications for Vancouver and Canada. "I encouraged people to talk with clients and explain that all their buildings could be 'twice as good' buildings through sustainable design and improved efficiencies," said Rosie Hyde, KEEN's Director of Research who was charged with briefing all staff prior to the event.

Just a year earlier, the Canadian government officially launched its "One-Tonne Challenge" campaign, calling on all individual Canadians and businesses to reduce their emissions by one tonne – about 20 percent – through lower energy usage and other lifestyle changes. KEEN took that challenge a step further, issuing a challenge to everyone on its own staff – as well as engineers across the industry – to reduce their greenhouse gas emissions by 1,000 tonnes on an annual basis through better design. Featured in *Canadian Consulting Engineer* recently, Hydes and Hyde observed that:

One engineer designing exclusively "twice-as-good" buildings would be able, every year, to reduce Canada's total annual greenhouse gas emissions by more than 1,000 tonnes CO₂, for a 26,000 tonne reduction of annual emissions by 2030. Multiplying annual savings by a fifty year service life for buildings, that engineer's work saves the planet more than 1.3 million tonnes....The ongoing greenhouse gas emissions associated with the operation of these buildings, year after year for the next half-century, will be part of the legacy we leave to our children.¹

The North American Green Leader

KEEN believes it has earned the right to be called the "North American Leader in Sustainable Engineering" – an achievement that KEEN employees take seriously and one that consistently informs their actions as a firm. Creating change and assuming a leadership role in North America's building industry is tightly woven into KEEN's mission as a firm.

The future is not some place we are going to but one we are creating. The paths to it are not found but made, and the activity of making them changes both the maker and the destination.

– John Schaar, futurist

In spring 2005, Hydes, KEEN's President and CEO, became the new chair for the U.S. Green Building Council (USGBC) and its more than 5,500 member firms. An early participant in the Council and co-founder in 2003 of the Canadian Green Building Council, Hydes saw his new role as an opportunity to help broaden the reach and impact of sustainable design across the continent. To that discussion, he posed the questions: what about the mass market, and what about the "beyond LEED®" thinkers who are advancing the art and science of green buildings to new potentials?

Hydes says that the USGBC must continue to target the leading 25 percent of the building projects; but some estimates are now showing LEED®'s impact as just 1 percent to 5 percent of the market after the first five years:

The challenge for me currently, as USGBC Chair, is to make sure we get the other voices at the table as well – that we hear from the business community and the mainstream developers who continue to build hundreds of millions of square feet of new buildings every year. Why isn't every project that they do LEED® certified or a green building? Imagine the impact of 2,000 architects designing LEED® buildings...

I think there's an implied requirement right now in the marketplace to do more than just a code-minimum building. The market is advanced enough and our experience is sufficient at this time to know that we can just do smarter things that do have environmental benefits without creating any economic downside.

KEEN's evolution, growth and ability to remake itself as a business has followed its own distinctive "bell curve". It is a symbol Hydes uses to describe the firm's past and present – "KEEN 1", "KEEN 2" – and its ongoing transition to becoming "KEEN 3". KEEN 1 represented the mass market, delivering innovation on conventional projects but primarily as a traditional engineering firm. Becoming KEEN 2 represented a new way of thinking, through projects like the C.K. Choi Building and Library Square and the creation of KEEN Concepts and other new services. Now, KEEN 3 means continually expanding the firm's focus: back to the mass market, applying the green principles it has already learned, and ahead to "beyond LEED®" projects, sharing those new ideas and techniques with the rest of the market.

To Hydes, green should be standard on every project:

When asked what percentage of our work involves sustainable design, I've often waffled on the answer as being around 50 percent. The more I think about it, that's complete nonsense: it's got to be 100 percent. Why would we choose not to do something green on every job? It's almost unethical. If we know we can do something and we know there's no risk to it and no cost to it, then we should just do it.

Further reinforcing KEEN's drive to change the market – and its own ongoing internal transformation – is the recent commitment to ISO 14000 standards on environmental management. ISO 14000 is a structured approach to addressing an organization's environmental bottom line, with specific guidance on how to evaluate and improve environmental performance. These standards are also designed to be compatible with quality management standards.

Richmond Olympic Oval

Location:	Richmond, British Columbia (Greater Vancouver)
Type:	Recreational Facility; Speed-Skating Venue for 2010 Olympic Winter Games
Size:	350,000 sq.ft.
Completion:	Under construction, completion date of Spring 2008
Rating:	LEED® Registered
Architect:	Cannon Design



In 2005, KEEN Vancouver began applying ISO 14000 to all MEP and business processes used among the office's ninety engineers, adopting the best of its green practices for all new jobs. Further, KEEN is auditing every one of its approximately one thousand projects annually to assess the actual impact of those design decisions: on water and energy efficiency, occupant comfort, operating cost savings and other improvements that collectively exceed the performance of building codes year after year.

"So if we can save fifty tons of greenhouse gases on a building because of the improvements we've made, then we need to start totaling the impact of that on an annual basis," noted Hydes. "I'm predicting that five years from now, it will be a requirement to declare these types of numbers. So it's important for us to start to get this new thinking within our firm. We want to be able to say to owners and architects: 'This is the impact that we think we're seeing with these sustainable approaches.'"

A Prototype for Green Living

Separated from Vancouver by the Strait of Georgia and from Washington State by the Strait of Juan de Fuca is Victoria, the capital city of British Columbia. World-renowned for its picturesque Inner Harbour, heritage buildings and colorful gardens, Victoria is considered one of the most livable cities in North America. The old industrial Dockside Lands located downtown, however, have long posed a challenge for city leaders: the brownfields site along the waterfront is made up mostly of contaminated landfill containing garbage and petrochemicals.

That blighted, forgotten fifteen-acre landscape is about to change, the result of a new \$300 million, mixed-used development that may become a prototype for sustainable communities in the future. Known as Dockside Green, the site will be the biggest development of city land in Victoria's history, planned as 1.3 million square feet of residential, office, retail and light-industrial space. The city, in partnership with the

Windmill Development Group and VanCity Enterprises, has mandated that all buildings on site be certified LEED® Platinum.

For KEEN, too, Dockside Green represents an exciting new piece of the future: not simply the idea of brownfields redevelopment, but an opportunity to participate in an advanced green project that represents a complete, developed package. Two years ago, the firm was invited to join the development team that included Joe Van Belleghem of Windmill, a Victoria-based pioneer in LEED® buildings, and Peter Busby of Busby Perkins + Will, along with VanCity as the financial partner. In December 2004, the City of Victoria selected Windmill's proposal – largely on the merits of its innovative environmental features.

"There's going to be a lot of magic happening with Dockside Green," said Blair McCarry, the lead designer for KEEN. "Its real significance is that the entire concept is based on an assessment of the 'triple bottom line.' This development is taking that idea to a new level: creating new jobs on site, revitalizing the local economy with viable businesses, and aiming for a greenhouse gas-neutral community that's also a net producer of clean energy."

Dockside Green's master plan calls for 860 units of housing, a small hotel, a commercial village and 75,000 square feet of offices and lofts. The Wise Energy Co-op is also planning to locate a bio-diesel factory on site to produce significant amounts of fuel per year. Various demonstration uses for the bio-diesel by-product – made from kitchen wastes and restaurant grease – include fuel for the harbor ferry, mini-transit vehicles and Dockside's car-share smart cars.

In addition to serving as a sustainability adviser for the development, KEEN will be responsible for all mechanical and electrical design. The development's main goal is to generate sufficient renewable energy on site to meet its entire heating, cooling and electrical needs. Central to this scheme is a wood waste-to-energy utility plant – biomass energy co-generation – that will produce approximately 2 MW of electricity and 3 MW of

heat output. Wood waste is typically available from nearby mills, woodworking shops, and the tree trimming and deadfall in the CRD. Also included will be geothermal heat pumps for commercial buildings where cooling is required.

The plans for water and wastewater are no less innovative. All sewage will be treated on site, utilizing a sophisticated bioreactor tank/ultra-filter membrane system to process all blackwater to near drinking water quality for irrigation on Dockside's green roofs, for landscaped water features and ponds, and for toilet flushing. Extensive water conservation measures will be employed throughout the development, dramatically reducing potable water use in buildings. In addition, stormwater collection and storage systems will supplement the treated blackwater for irrigation and to feed creeks and ponds along a greenway running the length of the property.

"Dockside Green has the potential to create a unique international dialogue about what sustainable communities can and should be", said Hydes. "When we consider what the future is all about in terms of this triple bottom line – socially, economically, environmentally – how do we describe the buildings we're building, how do we describe their efficiencies, and how do we program in long-term efficiencies over time? That's really where we need to reach with a very visible project like this."

Embracing Change, Sustaining Change

Influencing an issue, influencing codes, influencing the MEP industry – even the design practices of direct competitors – and the architectural profession, remains a core tenet for KEEN Engineering in greening North America's buildings. Whether active involvement in USGBC or speaking at conferences and to the consulting engineering community, the firm maintains a deep, overriding belief in change.

"Certainly, we got out early on this issue in some markets," said

Dockside Green

Location:	Victoria, British Columbia
Type:	Mixed-use Residential/Commercial/Industrial Development
Size:	1.3 million sq.ft.
Completion:	Under construction, first buildings scheduled for completion in January 2007
Rating:	LEED® Platinum Expected
Architect:	Busby Perkins + Will

Sustainable Features:

- Greenhouse gas-free energy for electricity and heating
- Biomass energy co-generation (through gasification of wood waste) to generate district heat and electricity
- On-site sewage treatment facility utilizing bioreactor tanks and ultra-filter membranes to treat all blackwater to near drinking water quality
- Bio-diesel factory, producing fuel for harbor ferry, mini-transit and car-share smart cars
- Geothermal heat pumps for commercial buildings where cooling is required
- Reduced potable water use
- Stormwater and treated blackwater for irrigation on green roofs, water features and ponds



Hydes. “What I’m trying to do in the professional arena really is talk about KEEN’s business and engineering success relative to taking a very strong position on sustainability – you know, literally describe what we’ve done in detail, give engineers the ‘how to’ in tapping this market to further transform the market.”

One recent KEEN-authored article offered insights on setting fees to ensure profitable green design projects that can generate additional revenue and income. In the April 2005 issue of the *ASHRAE Journal*, Tim McGinn of KEEN’s Calgary office contributed his experience with a high-end corporate classroom/conference center on a community college campus with a budget of \$14.5 million:

Fee arrangements for green building projects recognize the shift of the mechanical engineer’s role as part of an integrated design team. This higher degree of integration during the conceptual design stage demands active involvement from all participants. The challenge for mechanical design firms is to maintain full participation from the architect, owner, and others and still remain profitable.

As the green building industry rapidly moves towards the mainstream of design, the challenge for firms not currently involved in designing green buildings is to adapt to maintain market share. Firms need to gain the experience and expertise to efficiently design green buildings. A consultant with a demonstrated expertise in green design often will receive the commission based on the value brought to the team.²

“I think what we’ve been able to demonstrate to the industry is that green design isn’t a passing fancy, it’s a mainstream issue,” said Hydes. Ultimately, KEEN realizes that this approach gives new meaning to the design process, particularly for the next generation of engineers, and represents an emerging new frontier in mechanical and electrical systems thinking. That is also part of the KEEN story going forward: the drive to attract and retain top talent from across the U.S. and Canada – those who are interested in non-traditional design

assignments and in learning the leading-edge core competencies required of green engineering. “Today, our sustainable position creates a lot more clarity around what KEEN is all about,” added

One metric tonne equals 1,000 kilograms. The volume of one tonne of greenhouse gas emissions (GHGs) would fill an average two-story, three-bedroom house.

Hydes. “So there’s a lot more alignment and self-selection among our candidates even before they come to the interview table. As a result, we’re more likely to be successful in hiring, and we stand a far better chance of making the type of impact we’re trying to make.”

In addition, KEEN takes a proactive stance on teaching, bringing its message of sustainable design and technical proficiency to university graduate and undergraduate students. No fewer than five KEEN principals now volunteer as university-level guest lecturers or adjunct professors in Seattle, Vancouver, Calgary, Toronto and Montreal. Others serve on curriculum committees for engineering and architecture schools.

“Again, there’s a self-interest in helping these programs so that every engineering graduate coming out of every school has a basic palette of understanding of environmental issues,” said Hydes. “Traditionally, there’s been very little training on this knowledge among our rank-and-file engineering graduates, so we’re trying to go right upstream of the problem and influence the curricula.”

Tomorrow... Just Arrived

It is quite possible – even likely – that some of those engineering graduates will work on what could be the most innovative, high-performance building in North America: CIRS, the Centre for Interactive Research on Sustainability. To be located near downtown Vancouver, the CIRS concept was created by the University of British Columbia to accelerate the adoption of sustainable building

and urban development practices in response to the immense challenges facing cities as a result of population growth and environmental degradation worldwide. The \$15 million center will foster sustainable research and design and demonstrate advanced information technology, computer modeling and advanced visualization capabilities.

Professor Ray Cole of UBC's School of Architecture recently described the scope and vision of CIRS in *Canadian Architect*:

Green building practices continue to mature and find widespread adoption through incremental improvements in performance efficiencies. While an important first step, simply producing buildings that are progressively better than typical practice will prove insufficient to meet the requirements of a built environment that can support sustainable patterns of living within a context of rapid urban development. Greater performance leaps will be necessary and at a faster rate. This will challenge many existing norms and expectations and, in particular, redefine how we conceive the design, construction and operation of buildings.³

As part of the new Great Northern Way campus – essentially a “sustainability precinct” in Vancouver – CIRS will accommodate four academic institutions, including UBC, with space for researchers to collaborate on interdisciplinary and inter-institutional projects. Partners from the private, public and NGO sectors, such as the David Suzuki Foundation, will also share the research facility.

Following the project's initial feasibility study in late 2001, Busby Perkins + Will Architects developed the initial concept for the nearly 130,000-square-foot research facility, which has three main components: two institutional wings and a tenant wing separated by two central atriums. As the mechanical and electrical consultant, KEEN began schematic design in June 2005. Construction will commence in summer 2006, with project completion in late 2007 or early 2008.

Among the chief design goals for this off-the-grid green building is being greenhouse gas neutral and being a net annual green power producer. In addition to incorporating energy-efficient building products, CIRS' passive design, including 100 percent daylighting and ground-source heat pumps, will result in very low energy requirements. Rainwater will meet potable water requirements, all wastewater will be purified using a bio-filter system, and remaining stormwater will be controlled, re-used and discharged on site. A living roof, photovoltaics and micro-hydropower are a few of the other green features under consideration.

Equally significant, the CIRS structure itself will be used as an ongoing, state-of-the-art “living laboratory”. Over the lifetime of the building, CIRS researchers and building industry partners will monitor, analyze and document hundreds of data points to assess the effectiveness of new and existing sustainable building technologies, as well as the interaction of building occupants with these systems.

KEEN Vision

Where CIRS, Dockside Green, and other recent projects signify the firm's clear intent to explore new sustainable concepts and technologies, KEEN senior management – Mitchell, McCarry, Hydes and Anseeuw – also recognize the importance of leaping even further ahead to the next generation of ideas. Beyond LEED® . KEEN 3.

That leap, said Hydes, is “KEEN Vision”, which would build on the foundation of KEEN's long tradition of excellence as a firm and, more recently, the creation of KEEN Concepts group as its green R&D team:

I think what I'm talking about is a re-invention, a re-launch, but an intentional one, that may ask some very fundamental questions about the nature of design today or the direction we're headed in as a firm.

Centre for Interactive Research on Sustainability (CIRS)

Location:	Vancouver, British Columbia
Type:	Sustainability Precinct with Educational/Office/Retail Space
Size:	60,000 sq.ft. (Phase 1)
Completion:	Late 2007/early 2008
Rating:	LEED® Platinum Expected
Architect:	Busby Perkins + Will

Sustainable Features:

- Greenhouse gas neutral facility – net annual power producer using sustainable and renewable energy sources, including photovoltaics and micro-hydro
- 82 percent of Model Energy Code
- 100 percent daylighting as primary daytime light source
- Full blackwater treatment
- Living roof
- Ground-source heat pump system for cooling and heating
- High-performance exterior glazing
- On-site rainwater collection and re-use



Becoming KEEN 2, for example, gave us something else we could talk about that had meaning in terms of the social, economic and environmental benefits of green design. Yet there's always a danger that once you start to institutionalize certain beliefs and practices, like anything else, you may start to limit your work within known boundaries. So we need to continually challenge what we've learned, to self-examine, and to measure everything against the idea of First Principles. I definitely feel at this point that we've got to make the next leap to this KEEN Vision world.

I see a world where LEED® is not an option – it's required, it's the minimum level of performance in constructing, renovating or upgrading any building. After all, if we can incorporate green elements into every job we do, save energy, with no risk and without spending a dollar more of the client's money, why wouldn't we do it? It's simply a matter of being a good engineer, a good citizen. And it's the right thing to do.