

TEN IMPERATIVES FOR INFRASTRUCTURE

Walter Stewart at CANHEIT 2010

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Good morning, I am very pleased to have this opportunity to speak to you, and I am always glad to be in Newfoundland, I thank Graham Mowbray for the invitation. In saying that I am pleased to have a chance to speak to you, I am expressing a lot more than the obligatory polite acknowledgement of my audience.

University CIOs represent many things to me; three are key:

1. You are a product of a revolution in university life unprecedented in the thousand year history of western universities.
2. You are also a sign of another revolution – a revolution in ways of knowing.
3. You are active agents of both revolutions.

Now you may be sitting there thinking, Good God what is he taking about? or looking at each other and saying, “Who knew?”

Who knew, indeed? It seems to me that there are remarkably few people – certainly, not just university CIOs, who do their work with a real sense of their context. Now I am not suggesting that you do not know that you work for University “X”, in 2010, or that your university is in the 2nd or 4th year of an IT plan, or that your university like all others is entering a renewed period of austerity. I am suggesting that you may not have a sense of a wider context that places your work in a decade’s long process that changes the role of the university and of a much longer process that is changing the very ways human beings know.

I think having an understanding of where one’s work fits in a much wider context is energizing, and an antidote to the debilitating sense of ennui that results when daily work can seem like a dispiriting process of two steps forward and one back. I think this is particularly true in your work because you live in an environment in which many are free to keep their heads in the clouds and choose to ignore your very existence – until something doesn’t work. No matter how focused on

an overall plan or the role of IT in the modern university you are, you are constantly dragged back to the quotidian – an email system crashed, a key storage device is malfunctioning, the commodity internet service is jammed by student video downloading. In a role where the challenges of the quotidian are omnipresent, I think it is critically important for one's morale and to keep a sense of moving forward to know one's place in a very wide context – a context that reaches back well beyond oneself and reaches even further into the future. Such a sense of context, is for me, crucial for sanity when all around seems mad. The oldest among you may remember having to memorize Kipling in school,

If you can keep your head when all about you
Are losing theirs and blaming it on you,
If you can trust yourself when all men doubt you,
But make allowance for their doubting too;

For me, a well-developed sense of context is the best prescription for keeping your head.

For my time with you this morning, I am going to reflect on my sense of your context – not in any complete or prescriptive way – simply a set of reflections that I hope will both encourage you to give thought to your wider context and assist you in so doing.

First of all, a disclaimer, many of you know that I am an independent consultant; indeed, I have done work for some of you. Others of you will be more used to me functioning for my regular clients, most notably CANARIE and the Toronto Region Research Alliance. If you like and find useful what I have to say this morning, then please congratulate my clients for having the good sense to engage such a useful fellow. If you think what I have to say is a great load of nonsense, then please also congratulate my clients for having the capacity to get useful work out of an obvious nutter. For I speak to you this morning simply in my own name.

A last word before I get to the meat of what I have to say, most of you who have heard me before will be accustomed to an informal style with a few key words on the back of an envelope; I rarely use a prepared text. This is one of those rare occasions. As I prepared for today, I became deeply aware that the heart of my message to you is complex. I am not about to introduce to you concepts about which you haven't heard. There is nothing original about the concepts I shall discuss. Rather, I hope that the value of my time with you this

morning is in the connections I make among those concepts. Connections that I hope may be original or provocative and carry some sense of the "new". The complexity of those connections seemed to me to be better served by a more structured formal address. I hope you will agree.

So what are these concepts or phenomena, the connections among which I believe are critical context to your work? I have chosen ten that I might entitle ten imperatives for infrastructure:

- The emergence of integrative discovery and a move beyond reductionism
- The emergence of "digital" discovery and the primacy of data
- The emergence of the social sciences and the humanities as "digital disciplines"
- Technical developments in computation, networking, data management that make the first three possible
- The transformation technical possibilities have wrought on the university's students
- The emergence of a knowledge economy
- Demands on the university from government and society for more immediate answers
- The move of the university from serving a niche elite market to serving a broader number of learners
- The role of the university as a corporate entity
- The role of the university in the preservation of democracy

As I was preparing to speak to you, the complexity of the interrelationship among these phenomena became all the more apparent to me. I could find no standard rhetorical model to use in introducing them to you. Which is cause? Which is effect? Which came first? Which followed? Which is primary? Which is secondary? Which is chicken? Which is egg? They all simply are. They are deeply interconnected. And they singularly and collectively have major impact on your work. One unifying feature among them is that they each demand an order of infrastructure far greater than has ever existed in the past. You are the folk charged with the provision of the lion's share of that infrastructure. That is why it is deeply important that you understand the breadth of the issues that will challenge that infrastructure's capacity and capability.

Each one of these concepts could form the basis of a talk, or, indeed a whole conference or set of conferences. Nonetheless, I want to spend

a minute or two on each in the entirely arbitrary order in which I have listed them.

- The emergence of integrative discovery and a move beyond reductionism

In the mediaeval world, knowledge was a unity headed up by theology as the Queen of the Sciences. But even as the notion of the unity of all knowledge was reaching its clearest expression, the seeds of a new way of coming to know, empiricism or knowledge through the experience of the senses, through experimentation and the scientific method were beginning. The beginning of this new way of knowing was co-incident with the establishment of the first universities. Notwithstanding their roots in monastic foundations, universities became centres for the triumph of knowledge through experimentation as opposed to knowledge through adherence to received doctrine. Experience through experimentation led to a reductionist approach which sought to develop understanding of the most minute building blocks of knowledge in any given area. Reductionism led to the development of great specialization.

Many would suggest that reductionism has run its course. Albert-László Barabási, Professor of Physics at Notre Dame says "*Now we are close to knowing just about everything there is to know about the pieces, But we are as far as we have ever been from understanding nature as a whole....Riding reductionism, we run into the hard wall of complexity.*" This is a quote that has always seemed to me very close to TS Eliot in Chorus From the Rock:

*The endless cycle of idea and action,
Endless invention, endless experiment,
Brings knowledge of motion, but not of stillness;
Knowledge of speech, but not of silence;
Knowledge of words, and ignorance of the Word.
All our knowledge brings us nearer to our ignorance,
All our ignorance brings us nearer to death,
But nearness to death no nearer to GOD.
Where is the Life we have lost in living?
Where is the wisdom we have lost in knowledge?
Where is the knowledge we have lost in information?
The cycles of Heaven in twenty centuries
Bring us farther from GOD and nearer to the Dust.*

Increasingly, the frontiers of knowledge are seen in the complex interrelationships among the components. One of the most iconic examples of this evolution is perhaps the ultimate reductionist triumph of our time, the mapping of the human genome and its 21,000 separate genes. Some of you may have seen this past Sunday's story in the New York Times on the 10th anniversary of the completion of the map. The article's title is *A Decade Later Gene Map Yields Few New Cures*. The article contrasts the promises made in 2000 that there would be legions of cures for all manner of disease with the few medical breakthroughs that have actually occurred. The incoming director of the US National Cancer Institute, Harold Varmus, is quoted: "Genomics is a way to do science not medicine." The article makes it clear that the breakthroughs in medicine may come from an understanding of the architecture of the whole built upon knowledge of the parts. In short, an understanding of the parts may be critical, but knowledge of how those parts are integrated into the whole is key.

Unlike the dismissive tone of Barabási and Eliot, the New York Times article makes it clear that the mapping of the genome is foundational; but it is not the transformative step. The transformation will come from an understanding of the whole system. I would suggest that across the world of discovery, we are at a similar stage. Our challenges are about understanding the architecture of how the components come together. We will build on our understanding of those components, to be sure, but it is in the study of the integration from which the next breakthroughs will come. Be very clear that this transformation bespeaks the emergence of a different way of human knowing.

A further major feature of this integrative approach to knowledge is that it will frequently become expressed in other media than text. Shared interactive experience, multiple media, immersive visualization will share text as the medium for academic and other discourse. This truly will be a different way of knowing – a way that your infrastructure must support.

To do integrative discovery requires very different infrastructure than that for drilling down and isolating the component bits. Breaking the questions into a million smaller questions is fine and has produced a great deal of foundational knowledge, but we are challenged by putting it all back together. We need the infrastructure for monster volumes of data; memory systems that can hold it all in order than complex multi-varied simulations can be run; data environments that can receive and integrate data from multiple devices; networks that

can enable those multiple devices to exist in multiple locations while serving users also in multiple locations; and preservation and curating capacity for that data. This is your work.

Let's look at a second phenomenon:

- The emergence of "digital" discovery and the primacy of data

I don't need to spend any amount of time convincing you that discovery has become digital. You witness on a daily basis the proliferation of sensors, spectrometers, scanners of multiple modalities, on your campuses, and you enable the connection of your researchers to remote instrumentation like the LHC, CLS, Triumf, multiple telescopes, and an international network of compute and data resources. You, together with regional compute consortia, the country's network organizations, and the operators of "big science" installations, are in the vanguard of building the infrastructure that makes the transformation to digital discovery possible. You have made extraordinary progress in a very short time, but you have only begun. The surface has scarcely been scratched. Large projects in the works like the Square Kilometre Array, the instrumentation of wide swatches of the natural world including oceans, watersheds, forest systems, etc. and continual improvements on existing technologies that provide every greater resolution and thus ever greater amounts of data will make the current data flows seem as trickles. Note that I will say more in a moment about the social sciences and humanities joining this data deluge.

Progress has indeed been made in building some elements of the infrastructure, but no where has progress been slower than in building the infrastructure to house and curate the data. Yes, you have been part of the creation of greater capacities to process the data and many in this room have participated in building more robust networks to move the data, but little progress has been made on how to store, manage, curate, and guarantee ongoing widespread access to that data. This is especially true when you consider that most data currently under care was generated within the lifetime of the technology on which it sits. What provisions are in place to move that data as technologies become obsolete and are replaced with new technologies potentially with little similarity to existing methods. Just try and find a device upon which to play your 8-track tape collection.

You know painfully well that perhaps the biggest fraud ever perpetuated on an unsuspecting world by the technophiles is that to be

digitized or born digital is to be preserved. No stone tablet, no vellum scroll, no scientific notebook has ever been as vulnerable as the research data stored all over your campuses on rogue servers in closets about which you may or may not know.

Can we build the data infrastructure to profit from the digitizing of discovery? Absolutely! But it will require extraordinary collaborative focus and effort. And let it be said, it will be hugely challenging because much more than computational infrastructure or network infrastructure, the infrastructure to manage data will be hugely people intensive, so its costs will be regular and ongoing and unable to be met by once only capital transfusions every three to five years.

- The emergence of the social sciences and the humanities as “digital disciplines”

Some have suggested that those of you in charge of the provision of infrastructure for discovery are fortunate that scientific disciplines were the first off the mark. As challenging as their needs are, the challenges will be dwarfed by the challenges when the social sciences and the humanities fully engage in digital discovery. The data volumes in longitudinal studies, the length of time the data will need to be kept and accessible, the models of computation that will be required to compute likely human behaviour; the models of computation that will be required to do multi-variable simulations over decades and centuries, the data volumes from the cataloguing of all forms of human knowledge, the search capacities required to analyze human ways of knowing, the bandwidth requirements to make all aspects of interactive human experience accessible virtually all have the capacity to grind current levels of infrastructure into paralysis.

Furthermore, although science has led the way, let us be clear that across your campuses they are still scientists at work making little use of the tools of digital discovery. The computer savvy have been in the vanguard. There are many behind them, less savvy, that might well have made greater progress had your campuses had the human support resources available to assist them in the transition. The need for human support in the transition as part of campus infrastructure will be for the foreseeable future all the more critical in the social sciences and the humanities.

Leaving the scientific “slow to adopt” and the social sciences and humanities out is not an option for two reasons:

1. The development of skills for integrated discovery and thinking will demand huge contributions from all elements within the academic community. Infrastructure must facilitate the reception and integration of those contributions. Not least among the contributions that humanists will bring to the mix are the models for ethical reflection that will allow for the healthful development of such infrastructure. Discovery detached from ethical reflection can be, in no measure, integrative. As we move forward in integrative discovery, human factor elements will become critical. Those elements will more often than not be contributions from the social sciences and the humanities.
2. The primary purpose of university based research is the formation of next generation highly qualified people. No university that does not afford the experience to its students of integrative study based on a hugely integrated infrastructure across the disciplines can be said to be doing its job in the second decade of the 21st century.

I will have more to say about the humanities and the social sciences when I turn to the university's role in the preservation of democracy.

- Technical developments in computation, networking, data management that make the first three possible

Of the ten imperatives for infrastructure, I propose to say least about technical development. Most of you are far more familiar with ground breaking technical developments than am I. I will confine myself to two points:

1. I think it helpful to think of the technology of computation, networking, and data management as extending to the power of the human mind what other types of infrastructure have done to the physical power of humans. Up until the latter half of the 20th century, great leaps forward in human productivity and thus of prosperity were a result of a new found ability to harness to human will some order of magnitude increase in force. The lever, the catapult, the domestication of large powerful animals, wind, steam, internal combustion, jet engines, and nuclear power all allowed the puny human to exert a force well beyond a singular or even collective capacity. With the advent of computation some 70 or so years ago, we began a similar augmenting process to the human mind. Jaguar at Oak Ridges National Laboratory, the most powerful computer in the world according to the recent release from the Top 500 list, does nothing that you are not perfectly capable of doing with a slide rule and

several millennia in which to do it as well as several forests worth of notepaper along the way. Jaguar and its junior sisters do the “grunt” work of processing the vast volumes of data in order to answer the human developed question and return results that enable the human insight. It is an alliance with the human mind significantly analogous to the alliance between the jet engine and my body that allowed me to be here in the flesh in three hours rather than the multiple months it would have taken under my own power or even the couple of weeks it would have taken when my best options would have been train and steamer.

2. It is possible to realize full benefit from developments in computation, networking, and data management tools only when they are integrated into real infrastructure.

- The transformation technical possibilities have wrought on the university’s students

This is another imperative about which I need say little other than to highlight it. The net savvy, video game playing, social networking mavens that populate your campuses are different than you or me. I am reminded of a quote from the Declaration of the Independence of Cyberspace that was delivered by John Perry Barlow at Davos in 1996. It was addressed to, “Governments of the Industrial World, you weary giants of flesh and steel...” Among its points was the following: “You are terrified of your own children since, they are natives in a world which you will always be immigrants.” Well I don’t think we are terrified, at least anymore, but slow to assimilate immigrants we are.

Learners on your campuses are already part of a much more integrative approach to life. Their world is one of experiences, actual and virtual, that are different because it is they who are having those experiences. They use infrastructure natively that allows them to integrate their actual and virtual lives. As they engage in scholarship they will bring those expectations of infrastructure with them and will not understand infrastructures that are not truly integrated. They are peered with the world and are not about to stop regardless of whether their discourse is about the next party or the next breakthrough discovery.

- The emergence of a knowledge economy

Again, I am only going to make brief comments. I think that we have entered into a knowledge-based economy has become a cliché. The

problem with clichés is that as true as they are, they become shop worn and no longer subject to thought or analysis. Clearly we live in a world where exploiting knowledge brings higher value than the making of things. Economies that marshal knowledge most effectively will be the successful economies. We have made some progress towards fully implementing a knowledge based economy in Canada, but we have approached the transformation with some leisure believing that as a first-world economy we had an advantage over other less developed regions. It is past time we woke up.

I commend to you a recent special report in the Economist: *The World Turned Upside Down – A Special Report on Innovation in Emerging Markets*. Companies in the Fortune 500 list have 98 R & D Facilities in China and 63 in India some with more than one. GE Health Care has spent more than \$50 million on an R & D Centre in Bangalore. CISCO is spending more than \$1 billion on a second global headquarters also in Bangalore. Microsoft's R & D Centre in Beijing is the largest outside Redmond. These are not sweat-shop centres doing assembly line manufacturing. These are the knowledge economy jobs on which we thought we had a corner.

Throughout history, the economies that have triumphed at any stage are those that have put the infrastructure in place to most efficiently move raw materials through processing and production to value added finished products to market. In a knowledge-based economy, data are the raw materials. We require the world's most efficient infrastructure to move that data through processing to use and reuse by insightful minds that can produce value for world markets. We thought we were ahead; we aren't. We need to reclaim advantage – not through catch up – through leap-frogging and identifying our niche. Our niche that will save a place for us in the knowledge-based economy may well be our ability to integrate well beyond science and engineering to the social sciences and the humanities. A full technical understanding together with a highly refined knowledge of human factors may well be our cutting edge – if we develop the will and build the infrastructure.

- Demands on the university from government and society for more immediate answers

John Wood, Chair European Research Area Board and the Chair of the International Steering Committee for the European XRAY Laser from Imperial College, London gave a very interesting talk at Enabling Grids for e-Science in Barcelona last September. One of his key points was that the focus was now on the university because:

- *Politicians and society want answers to global challenges. Science is seen as a major part of the solution*
- *Whole body approaches[to solving global challenges] require several different disciplines to work together*
- *Ensuring a better understanding by funders and policy makers of implications [is critical]*

Climate change, Pandemic Prediction and Modelling, World Economic Systems, Energy Supplies and Alternatives, Cross Religious/Cultural Barrier Relations are just 5 sets of problems besetting 21st century governments. Save for the demagogues who would rely on prejudice and hate to cement their positions, the simplest of politicians can see that these issues cannot be addressed leave alone solved without knowledge across an incredibly broad range of fields. Stymied by the complexity and multiversity of the issues they face, and deeply aware of the budgets they provide the world's universities, governments are turning to the academy for help – often very naively looking for quick fixes, but nonetheless turning with an attitude that it is payback time. The investments have been made and are being made; society is looking for some answers.

In previous economic eras right through the industrial, universities were important to society and the economy, but at a distance. One only need look at the location of most universities – on a hill or in some remote bucolic setting. I always like Vancouver as an example. Need a university? Put it out on a point. Fifty years later, need another, put it on top of a mountain.

In the knowledge-based economy, universities move from the comfortable margins of the economy to its very centre. Universities have often lamented their marginal status in Canada. Well under the general heading of “be careful what you wish for” universities are finding that marginality had its advantages in terms of a quieter life.

Clearly the university needs to find ways to disseminate knowledge widely across society – to government, business, and the general public while at the same time safeguarding its capacity for deep analysis and empirically based discovery and developing its capacity to bring those qualities to highly integrative interdisciplinary work. No mean challenge and clearly a challenge requiring a very different type of infrastructure. I believe it is important to recognize that disseminate, although in standard use, is rather a dangerous word. It implies a one-way direction. The demands government, business, and the wider society are making on the university today are dependent

upon a highly interactive and iterative conversation that will run in multiple directions. The infrastructure you build and connect to must serve that model of interaction.

- The move of the university from serving a niche elite market to serving a broader number of learners

When I went to university in 1971, I was one of 1% of Canadians enrolled full time in a Canadian university or one of 300,000 in a population of 22 million. In 2009, 3% of Canadians were enrolled full time in a university according to Statistics Canada figures or 1.066 million in a population of 34 million. Please note that this number does not factor in part-time students. I would venture to guess that the numbers of part-time enrolments have grown at an even greater rate. I believe we would all consider it desirable if that engagement rate were to grow significantly higher.

But how is the university different? Having tripled the percentage of the population enrolled, how has the university changed? Without wanting to go into a detailed discussion, I would say not much. The increase in engagement has, with exceptions, been accommodated through cramming more into the same model and deferred maintenance. Alternate delivery and the use of ICT has as yet had limited impact in the universities reach. I have to believe that the ability to cram more in is just about maxed out. I think of a young recent graduate friend of mine who did first year psychology in a lecture hall for more than 1300, and she didn't get a seat if she didn't get there early. Her first year was early in this decade; how much longer do we think learners of the type of which I have already spoken will stand for this, and how much longer can we cram more in anyway.

The deferred maintenance issue is terrifying; the crash cannot be long away. As buildings built on the cheap in the seventies, poorly maintained through the eighties, nineties, and the last decade, reach their past designed for period of thirty to forty years, there is a perfect storm in the making. Alternate delivery, making the full use of ICT productivity tools will become essential, but the infrastructure will need to be there not only to meet current needs but to extend the universities' reach much more widely in society.

- The transformation of the university as a corporate entity

Throughout most of the 1000 year existence of the university, it has been a loose community of independent scholars. The university as an

institution while perhaps not lean has been flat. Scholars have assembled themselves into departments and faculties and schools; but those structures have intruded little on the freedom of the scholar to determine his or her pursuits and the responsibility of the scholar to raise the resources necessary to pursue them.

The corporate entity known as the university has taken responsibility for some buildings, a library, a financial system, some level of community and government relations, a student registration system and not much else.

Some of you will remember that in 1997 when CFI was first constituted, a requirement of receiving funds was the filing of a university research plan. Those first research plans were masterpieces of fiction. I don't think there was a university in this country that had a research plan before one was required by CFI. This was the beginning of an expanded role for the corporation that is the university. In a world where discovery is increasingly dependent on elaborate, large, and expensive infrastructure the community of independent scholars simply cannot meet the needs. Increasingly the corporate entity has to expand its role in the life of the university in order to ensure that the scholars have access to the support and the infrastructure they need to do their work, compete for resources, and reach the widest possible audiences.

I would venture to guess that if we were to go back to 1995, a university CIO would have been as rare a commodity as a research plan. True there might have been a head of computing services, but often with no scope beyond that of registration and finance. The nineties were, indeed, the period when in the face of the desk-top revolution, central computational functions were disbanded in many institutions. Even by the end of the decade, some of the country's most prominent research universities had internal networks little better than wax string and two tin cans.

At the beginning of the second decade of the 21st century there are CIOs right across the country. That a gathering of those CIOs and their staff could attract more than 300 people is a clear sign of the change in the role of the corporation in university life. The infrastructure that you are building cannot be done by individuals or groups of scholars; it can only be done by the university and, indeed, increasingly only by consortia of universities, for it is infrastructure which by its very nature must have substantial central planning and execution precisely so that the free flow of data and the shared use of

specialized resources by multiple players across multiple discipline communities and multiple institutions is enabled.

Your role and your function as imperfectly supported as they may be is a major sign of the expansion of the corporate role of the university in enabling the work of the scholarly community. The infrastructure you are building is the outward sign of that change. For many, things are not moving quickly enough and that is probably true. For optimal results, we should be proceeding much more quickly, but the slower than ideal pace should not obscure the distance that has been travelled over really only a decade i.e. one one hundredth of the life of the university as an institution. It should be recognized that the pace is a consequence of how dramatic the change and how difficult it is for entities that have customarily reserved little in the way of resources at the centre to launch central activities. You are part of a culture shift, elements of which will be welcomed by the scholarly community and other elements of which will occasion caution if not hostility. Those of you who are most successful will be those who are able to quickly establish that your role is to enable not to constrain.

While it may well be difficult when you are up to your ass in alligators to remember that you came to drain the swamp, I hope you know how transformative your work is.

- The role of the university in the preservation of democracy

I commend to you a book published earlier this year, *Not for Profit – Why Democracy Needs the Humanities* by Martha Nussbaum of the University of Chicago. I'd like to give you a couple of quotes:

When practiced at their best, moreover, these other disciplines [the sciences] are infused by what we might call the spirit of the humanities: by searching critical thought, daring imagination, empathetic understanding of human experiences of many different kinds, and understanding of the complexity of the world we live in.

And another,

...young people all over the world in any nation lucky enough to be democratic, need to grow up to be participants in a form of government in which the people inform themselves about crucial issues they will address as voters and, sometimes as elected or appointed officials. Every modern democracy is also a society in which people differ greatly along many parameters, including religion,

ethnicity, wealth and class, physical impairment, gender, and sexuality, and in which all voters are making choices that have a major impact on the lives of people who differ from themselves. One way of assessing any educational scheme is to ask how well it prepares young people for life in a form of social and political organization that has these features. Without support from suitably educated citizens, no democracy can remain stable.

I trust that we would agree that regardless of our own political stripe, the tenor of current political discourse in Canada does not meet these standards. Why is that an issue for the university and why do I raise it in the context of a discussion on infrastructure?

It is an issue for the university for two reasons:

1. The university is the home of reasoned discourse; it is the strongest bastion of the values of the humanities across all disciplines not just those in the faculties of arts. While only 3% of Canadians may be currently enrolled in university, public and private decision makers are almost without exception products of universities, and universities train the teachers who guide almost all Canadian young people through their early learning. If Canada's universities cannot be relied upon to drive the practice of reasoned discourse through the wider society, who else will? Too often one gets a sense in the academy of revulsion and distaste for the barbarians at the gate, rather than a spirited offense for rational discourse.
2. This is not a one-way issue of the university serving the society. It is the university serving itself. The values of the modern university are allowed to flourish only in democratic societies. Academic freedom exists only in societies where citizens are free and active in civic affairs. Reasoned discourse does not have much play in Pyongyang, Caracas, or Rangoon. I am not suggesting that Canada is close to slipping to those ranks, but I, for one, think we Canadians as citizens are as frogs in a slowly heating pan of water. When demagoguery, manipulation, disrespect for the conventions of parliamentary government, secrecy, and out-shouting the other sides triumph over reasoned discourse, democracy is not healthy, civic life is declining, and universities will be threatened.

I raise this issue with you today, because the infrastructure you are building is among the university's greatest assets in meeting the democratic challenge. It is that infrastructure that will extend the

university's reach much further in society; it is that infrastructure that will ensure that the university returns maximum benefit to the society that supports it both in knowledge and in formation; it is that infrastructure that will enable the university to bring cross disciplinary insight to society's most intractable problems; it is that infrastructure that will contribute to the university's optimal use of the resources given it by the rest of society; it is that infrastructure that will enable the integration and application of the knowledge and values of the sciences, the social sciences, and the humanities; it is that infrastructure that will ensure that the millennium old model of the university will preserve its timeless values while transforming itself to serve a 21st century society.

So these are my ten imperatives for infrastructure. I do not claim that the list is exhaustive, nor do I claim that what I have said about each of them in any way covers the whole picture. I trust that you recognize that each one demands the same infrastructure – an infrastructure that enables the free movement of knowledge, information and data among devices and among users and makes all accessible now and for generations to come.

I hope that what I have said is helpful in placing your work in a wider context. I recognize the exigencies of running complex infrastructure with scarce resources threaten on a daily basis any sense of the wider context. I once heard a former Metropolitan of the Anglican Church in British Columbia say in a sermon, "The trouble with life is that it is too damn daily." I hope that something I have said may help you keep the quotidian at bay as you go about planning to build the infrastructure for 21st century discovery.

I have deep respect for the work you do and a deep sense of how essential it is. I thank you for listening.

