

Tomorrow's Universities and the Seven Pillars of the Knowledge Revolution¹

By Ismail Serageldin

Outline:

Introduction

The Seven Pillars of the Knowledge Revolution

- Parsing, Life & Organization
- Image & Text
- Humans & Machines
- Complexity & Chaos
- Computation & Research
- Convergence & Transformation
- Pluri-Disciplinarity & Policy

Reinventing education

- On Content
- On method
- On the participants
- On the organizational setting

The University Yesterday and Tomorrow

- The Mediator of Transition
- The University and the Economy
- Values
- The University as a physical presence
- University Governance

Ten Aspects of the Higher education System in the 21st Century:

- Part of a changed concept of education (reinventing education)
- A changed higher education landscape
- The University and Society
- The University and the Economy
- The Core functions of the University
- Curricula for tomorrow
- University Governance in the 21st century
- What business model for the future?
- Values and modernization
- Building in change

A Global University?

Conclusions

Introduction:

We all agree that we are moving rapidly towards the knowledge based society and the technologically based economy, with the well-known and well-documented aspects of

globalization overlaid on this transformation. Here I am speaking of the structure and presentation of knowledge and how we humans will most likely be interacting with knowledge, whether we are academics or researchers or simply the descendants of those who used to go to public libraries and ask the librarian for assistance with a good book to read or a reference source for the paper they are preparing for college. This knowledge revolution shall have profound implications for the institutions of education from kindergarten through post-doctoral levels, research, whether public or private, and the cultural institutions that support our knowledge structure such as libraries, archives and museums.

It is this that I refer to as the “New Knowledge Revolution”, a subject I have treated elsewhere at length and in more technical detail². This knowledge revolution can be diagnosed by seven key characteristics, which I like to call “pillars”, and which I shall briefly describe here. These are:

- Parsing, Life & Organization
- Image & Text
- Humans & Machines
- Complexity & Chaos
- Computation & Research
- Convergence & Transformation
- Pluri-Disciplinarity & Policy

Before proceeding to discuss the manner in which I think this revolution will impact specifically the universities of tomorrow, and making some recommendations as to how that inevitable transformation could be handled to smooth out the change and embrace the future, a brief word about each of these seven pillars is pertinent here.

The Seven Pillars Of The New Knowledge Revolution

First: Parsing, Life & Organization

Since the beginning of time, whether we were writing on scrolls or on codexes, whether the codexes were printed or in the form of manuscripts, the accumulation of knowledge was based on parsed structures, with units put next to each other like bricks in a wall of an emerging structure.

It was the juxtaposition of these individual parsed works that created the accumulation of knowledge... the rising edifice built piece by piece, brick by brick or stone by stone...

In addition each piece was “dead”. By that I mean that once published it stayed as it was until a second edition would appear. If we both had copies of the same book, we could both open to, say, page 157 and find exactly the same thing in our respective copies. It did not change whether we did it immediately after the book appeared or decades later.

The Internet changed all that...

The web page became the unit of parsing. Instead of the classical sequence of presentation, we now think in terms of a home page and then hypertext links into other related documents.

We can expect more fluidity into the merging of image, both still and video, and the transitions from one reference link into another.

Search engines complement the World Wide Web as the on-line material—unlike the traditionally published material – becomes alive. Today if I look up a web page, and you look it up, at the same location a few hours later, it will probably have changed, since the material is constantly being updated.

Furthermore, as we move beyond the current structures of the web, towards the semantic web, where we can search for relationships and concepts and not just objects, the structure of organization and presentation of knowledge will become one large interconnected vibrant living tissue of concepts, ideas and facts that is growing exponentially and which will require new modes of thinking to interact with it. It will automatically spawn these new modes of thinking and scholarship will no longer be parsed like bricks in a wall, it will be more like a smooth fluid flowing river.

If one were to try to take into account as well the emergence of the social linkages phenomena that the internet and the web have now made possible, we can now visualize what some specialists have called the "Meta-Web", with high knowledge connectivity and high social connectivity. Does the Meta-web prefigure the connectivity of intelligence?

Second: Image & Text

Throughout history, the primary means for the transmission of information has been text. Images were difficult to produce and to reproduce. This has changed. With the digital revolution, everybody can record images, both still and video, and computer generated graphics are becoming affordable by everybody.

The human brain can process visual information with incredible rapidity. Enormous detail can be captured and processed in a fraction of a second. So some new features of the current knowledge revolution appear imminent. One is the far larger reliance on image – in addition to text – in the communication of information and knowledge and the changing forms of the storage and retrieval devices that this will require as we move from text dependent book and journal to digital still and video image presentations as well as three dimensional virtual reality and holographic presentations. Interactivity will also become a feature of this new image-based virtual-reality world. Again what does that mean in terms of the presentation, the search and retrieval functions and the interaction between the researcher and the material in the future?

And what does all this mean for the effective description in meta-data, the storage, searchability and retrievability of this enormous and growing world of still and moving images, both fixed and interactive? We will no longer be looking up images through key words entered into text data bases such as meta-data catalogues: Computers will do this for us.

Third: Humans & Machines

With the exception of pure mathematics and some aspects of philosophy, it will no longer be possible for any human to search for, find and retrieve, and then manipulate knowledge in any field, much less add to it and communicate their own contribution, without the

intermediation of machines. Even in literary criticism and the social sciences, the stock of material to search through can no longer be done manually.

This is not good or bad. It just is.

Now, after a special chess playing program called Big Blue of IBM defeated world champion Gary Kasparov in Chess in 1997, can we indeed ask, as some visionaries are doing, whether “consciousness” and “intelligence” are emanating qualities from very complex systems? According to some, we are going to witness that happening with machines when they will pass certain thresholds of complexity and power, such as when the level of the processing power reaches certain sizes, and software advances within a decade or so after that to certain levels, all of which is likely to happen within the first half of the 21st century.

But whatever the merits of that particular debate and its ramifications, it is clear that changes are already noticeable in the domain of libraries and the internet. One example of that is the new World Digital Library: The system allows one to link video, image text and commentary and maps into one seamless whole and to be able to search by many different approaches (time, geography, theme, cluster, or even by a single word) and browse the material as well as find what one wants from the digitized material on offer from all the countries of the world.

Fourth: Complexity And Chaos:

The world we live in is remarkably complex. The socio-economic transactions of a globalizing world are exceedingly intricate as, with the click of a mouse and the flight of an electron, billions of dollars move around the planet at the speed of light. The web of interconnected transactions is enormous, and the ripple effects of any single set of actions and its interaction with other effects is difficult to predict.

Our cities have become not only much larger but also much more complex, and ecosystems are not only delicate, they are intrinsically very intricate. So are biological systems.

The reality is complex and chaotic, meaning that complex systems have non-linear feedback loops that result in systems and subsystems that are extremely difficult to predict. Many of our models, based on the simple mathematics and analogies drawn from physics, are proving inadequate.

Fifth: Computation & Research

Till now, Computing has been largely seen as the extension of a large calculating machine that can do dumb calculations at incredible speeds. Computer scientists and engineers were implementers who made the life of the creative people and the researchers less tedious. Wonderful tools, no doubt, but just tools all the same. Today, the concepts and the techniques of computing will become a central part of the new research paradigm. Computational Science Concepts, tools and theorems will weave into the very fabric of science and scientific practice.

Consider data management. Data when organized becomes information. Information when explained becomes knowledge. That in turn, when coupled with reflection, insight, and experience may lead to wisdom, but that is another story.

But beyond the scale and magnitude of the collections of data, we are looking for connections between collections of data. These pose particular problems that involve qualitatively different issues. Computer science is where the most work on such classes of problems has been done.

Sixth: Convergence & Transformation

Domains are gradually converging. In simplest terms, once upon a time we had chemistry and biology as distinct and separate enterprises, now we have biochemistry. Such moments of convergence, generating new sciences and insights, turn out to be some of the most fecund moments in the evolution of our knowledge and the development of our technologies. Today we are witnessing the convergence of three hitherto-separate fields with the birth of BINT: Bio / Info / Nano Technology.

At the same time, we need to develop what the NSF calls “Transformative Research”. That is research capable of changing the paradigm in some fields and domains, such as synthetic biology and femto-chemistry. Such research is extremely valuable. Thus we witnessed the discovery of the structure and mechanism of DNA engender entire fields like genomics, proteomics and metabolomics.

A question before us, is whether such developments will remain serendipitous or will our research paradigm systematically force the development of such converging domains and transformative insights? I believe we are poised to do the latter.

Seventh: Pluri-Disciplinarity & Policy

There is real value in crossing disciplines. Increasingly, both in academic organization and in tackling real-life problems, we note that the old “silos” of disciplines when functioning alone are counterproductive. Much of the most interesting work is being done in between the disciplines, where they intersect or where the gaps are.

Increasingly we recognize that our real life problems, such as poverty, gender or the environment, are all multi-dimensional and complex and require a special way of organizing all the various disciplinary inputs. Just as we say that diversity is enriching, so is the sharing of knowledge across disciplines.

The nature of the challenge, its scale and complexity, requires that many people have interactional expertise to improve their efficiency working across multiple disciplines as well as within the new interdisciplinary area.

Reinventing Education

The structure of the institutions of education and learning, those that channel the preparation of future generations of humans and the trans-generational passing-on of knowledge, will change. They will not only continue to evolve, they will morph into something unrecognizable to those who think of yesterday’s schools as a model, or those who yearn for their collegiate university experience. The public and private laboratories and research institutes, those institutions that help in the production, assimilation and codification of current knowledge and the creation of new knowledge, will also change. However, here, I

will just say a few words on the more obvious likely impacts of the seven pillars of the new knowledge revolution on schools and universities, barely touching on research facilities.

I think that we need to think even more boldly and dream of reinventing education completely...

The old model of rigid linear advance through 12 years of schooling, followed by four years of university after which one receives a degree that certifies entry into the labor force to practice some profession for forty years and then retire, will become totally obsolete. Continuous learning will be more than a slogan; it will be an economic necessity. The market will demand new skills, and an increasingly competitive world will force enterprises to continuously upgrade the skills of their labor force.

Education is likely to change profoundly in the coming decades, in terms of content, participants, methods, and organizational setting. Let us consider each of these in turn.

On Content:

Curricula and syllabi need to be revised to emphasize basic skills, problem solving and learning to learn. Teachers must be much better trained to become enablers who will encourage children to realize the joy of discovery, and be able to utilize teaching methods that allow each individual to change at their own pace.

The educational system of the future will witness an explosion in Content, beyond our capacity to imagine today. People will emerge from their basic education – increasingly including university level education – having learned to learn, and having acquired a basic infrastructure of fundamental skills, including interpersonal skills and the ability to function in a society. These fundamental skills will be complemented by a vast array of offerings in every conceivable combination of units and modules covering everything from artistic expression to advanced genomics, from music appreciation to mathematics. The flexibility of these combinations will allow people to learn continuously throughout their lives.

New fields of learning will come about. The most important discoveries will be at the intersection of the existing disciplines. Totally new fields have come about, such as genomics and proteomics. And beyond the natural sciences we are discovering how important trans-disciplinary work is. We need the wisdom of the humanities in addition to the knowledge of the natural sciences. We need the insights of the social sciences to bear upon the technical options of engineering.

On the Participants:

Participants in our educational enterprise will still involve parents at home and teachers at school. But students will play a bigger role in their own development. And virtual communities on the Internet will create a new form of peer group affecting the mental and emotional growth of the children and young adolescents of the future. I say this, fully cognizant of both its upside and its downside. Perhaps we should be more open to what our children will have to tell us... Take the words of America's Poet Laureate, Robert Frost:

Now I am old my teachers are the young.
What can't be molded must be cracked and sprung.

I strain at lessons fit to start a suture.
I go to school to youth to learn the future.

-- Robert Frost

On Methods:

Methods of teaching in the last fifty years have been almost totally confined to formal instruction in classrooms. Lectures, tutorials and supervised work have been the staples of education from time immemorial. We have barely started to explore guided learning through such instruments as distance learning, the Open University and modular adult education classes. I say that noting that the open university has been around for more than four decades, and that Massive Open Online Courses (MOOCs) are now a reality through the experience of the Khan Academy (which has more than 3.9 registered students, and the presence of UDACITY, COURSERA, edX and other offerings. We are just beginning to see the benefits of flipped classroom instruction where the lectures are on video and done on the students' own time (which also allows students to replay certain parts as many times as they want) and the contact hours will be spent with the teacher working with the students, at problem solving and clarifications (the functions that were traditionally left to homework to be done by the student on their own time).

We have barely scratched the surface of the potential that exists in self-learning. New “games” or game-like approaches that allow youngsters to gradually master skills by solving ever harder problems will use the same self-encouragement mechanisms and inherent reward mechanisms that moving from level to level by shooting ever faster and killing more adversaries in current and conventional games do. The software advances and the private sector interest to develop such new educational software along with the possibilities of having tablet computers available in India under \$40 opens up enormous possibilities that will allow us to do much more in guided learning, and to help a thorough-going revolution in self-learning.

Although I believe that formal instruction will continue to be important, it will increasingly be supplemented by flipped classroom instruction, MOOCs, games and both guided learning and self-learning will be enhanced through myriad offerings. And it will not only benefit the youth in their school and college years. Driven by curiosity and self-interest, the lifelong learners of the future will alternate between broadening themselves or pursuing hobbies on the one hand, and acquiring marketable skills on the other. The offerings for both will be there.

On the Organizational Setting:

The schools and universities will not be replaced by individuals working on computer terminals or on their mobile phones or other technologies, from home or from elsewhere. This is because they serve three functions: a skill and knowledge imparting function; a certification function; and a socialization function. The first and second will change along the lines I have just described. But the socialization function will remain.

Children need to be with other children of their age, and so do youth who are just reaching their maturity. They need to learn to interact and socialize with peers. Only schools and

universities provide the requisite setting for such socialization, an essential feature of emotional development and the formation of effective citizens.

The University Yesterday and Tomorrow:

The University is an essential institution in any society, for many reasons.

The Mediator of Transition:

It is the locus of the transition of adolescents into adults, and the incubator of effective citizens. It is the custodian of the great generational transition. The World Bank has identified five essential transitions that occur between the ages of 12-24 in most societies³ and they make these years particularly important, and since the University helps mediate all these transitions, it is essential that it adapts the fashion in which it plays that role in the lives of our youth. These five transitions are:

Continuing to Learn: Whether to drop out of further structured instruction and university participation or not is the single most important decision in the teenager's life. Its repercussions and the future path of their career will be inevitably affected by it.

Starting to Work: The transition from a dependent student to an independent participant in the labor force occurs in these years, and traditionally with a pre-college or college education. The manner in which the university, and by extension the other institutions in the higher education system address that transition and facilitate it will have major impact on the economy and on society, not to mention the lives of the young people themselves.

Developing a Healthful Lifestyle: Key decisions on smoking, experimenting with drugs, attitudes towards sex and other choices that confront youth at that age can make all the difference in terms of their adoption of a healthy lifestyle or not.

Beginning a Family: Family formation starts at the older end of that age group. Thus the attitudes that they gain at university and the higher education system can make all the difference between a society with solid family units and one with broken homes. Household formation is about more than demographic change.

Exercising citizenship: The political awareness of the new generation is formed in those years, usually it is at university that they join political parties, start to vote and get exposed to a wide spectrum of ideas and debates. Their future attitudes as responsible participating citizens or detached apathetic individuals will make a major difference in effective democratic evolution of society⁴. The attitudes they develop towards politics and society will also make the difference between the rise of extremism and the success of pluralistic politics.

The World Bank was concerned with government policies that will increase investments directly and cultivate an environment for young people and their families to invest in themselves in what they called "decisions concerning the five phases with the biggest long-term impact on how human capital is kept safe, developed, and deployed". The World Bank then suggests that such policies should have three broad thrusts: expanding opportunities, enhancing capabilities, and providing second chances. Each pathway (opportunities, capabilities, and second chances) is applied to each of the five transitions, generating reform suggestions⁵.

The University and the Economy:

Two of the traditional functions of the University have a major impact on the economy: Research and certification.

The search for truth in the context of research, and that increasingly involves partnerships with for-profit private sector entities in addition to the government financing of public goods research, with all the advantages and pitfalls that such an expanded partnership offers. The US Academies recently produced a report recommending ten specific actions that should be taken to maintain the pre-eminence of American research universities in the years to come⁶.

The other was the certification function. A university degree was assumed to certify that a graduate has acquired certain skills that an employer will want. Today, the lasting validity of that certification function is being challenged by the revolution in the knowledge society in ways that make it clear that the old model of 12 years of schooling, followed by four years of university and a degree that allows someone to practice a profession for 40 years and then retire is no longer valid. So what changes will be necessary?

First, the silos of disciplinarily in the traditional structure of instruction will have to change. Convergence and transformation are making it clear that although we all need a foundation in one discipline to build on, we also need to learn to interact with others in others disciplines. Universities must adapt to that horizontal broadening.

Second, constant updating of knowledge and skills will be necessary, and a vast program of adult education will become an integral part of the University of the Future. It will allow for flexible career transitions and the modular upgrading of skills in different disciplines. Thus continuous education will become a necessity if labor productivity is to continue to increase.

Values:

Another traditional and essential function is the university's unique role as the custodian of the past and the inventor of the new, not just in terms of the socialization function and the societally approved behavior of citizenship, but in terms of values and culture. Cultural identity and the meaning and role of our heritage are part of it. History, archeology, cultural studies are all part of learning about our past and maintaining our heritage. But universities are very much the palaces where the young learn to challenge the existing and the inherited, to seek novel answers and to invent the new. Thus it becomes the locus of challenging the status quo, and sows the seeds of innovation, whose products and constructs will become the heritage of the future. That double process of preservation and renewal, of authentication and opening up to the foreign and the new, is one of the unique functions of the university, which will remain and will be expanded in the future.

The University also supports the formation and transmission of the values of science. These values include commitment to truth, to honoring each contributor, to promoting imagination and questioning, to challenging the existing paradigms, to valuing imagination, to remaining open to the contrarian view and to arbitrating disputes by evidence and rational thinking. These are profound societal values, not just necessary behaviors to have effective scientific research. These values are forged by teacher example and student practice.

But perhaps the most important value that a university can promote in its relationship to society is the value of freedom of expression. For that is the fundamental first freedom necessary for the practice of other rights. By its practice other socio-political features will evolve. Accountability and pluralism require the contrarian view to be heard and the minority position to be respected. That is what freedom of expression is all about, and universities have been, and will remain, the defenders of these values against the tyranny of the majority and the tide of the conventional taste and opinion.

The University as a Physical Presence:

Despite the enormous impact of the ICT revolution on many aspects of the learning experience, I do not believe that the university as a physical location will simply disappear. I believe that the university is not only going to remain the central part of a changing higher education system, but also it is going to remain a physical presence in our communities and our cities, and that the campus will remain a locus of interaction , not just within the university community, but also between the university and society.

Evidence for that abounds. MIT put all its courses on line, but that did not result in the disappearance of applicants to obtain the MIT learning experience. MIT remains a major center of research and learning not just in the USA but in the world. The BA and the University of Pittsburgh present the SuperCourse, with over 170,000 PowerPoint lectures, but that does not replace the need for a proper institutional set-up for learning and socialization. The role of the University as a physical presence should not be underestimated.

University Governance:

The juridical status of the university is not the decisive issue in ensuring its excellence. Examples are many: e.g. UC Berkeley and Harvard show how a public and a private establishment can both be outstanding institutions. But in all cases a certain set of features mark their governance, including the degree of autonomy they enjoy in their decisions, the clarity of their sense of mission, and the standards they aspire to achieve.

Today, along with the general ideological drift in many parts of the world, there is a conception of idolizing the private sector, which suggests to some that higher education needs to develop a “business model” to curtail the increase in costs and promote efficiencies. Some even go as far as suggesting copying the manufacturing Business Model with: Future employers as customers; Students skills as products; Teachers as workers; and the Administration as managers. Nothing could be more destructive of the educational enterprise as to think along those lines.

While the educational enterprise can certainly benefit from a radical overhaul in how it undertakes its duties, it is in the context of greater sharing with the students, greater involvement with parents and society, greater common exploration of the boundaries of the new, greater involvement of the social actors in this central societal enterprise that we must seek the business model for the 21st century. A decision-making structure in the university should include all the social actors as partners in this enterprise: Students, Faculty, Administration, Community, Parents, Government, Financiers, and Industry.

This would not only ensure a greater transparency, responsibility and accountability, it would also help resolve the old town/gown debate, as well as structure the involvement of the social

actors in such a way that the essential autonomy of the institution is protected by embedding it in the context of this broadened partnership.

So, let me now try to summarize and bring together these various threads into ten recommendations that I would make for the University of Tomorrow.

Ten Aspects of Higher Education in the 21st Century

1. Part of a Renewed Education System: Reinventing Education

The ICT revolution and the transformation of knowledge manifested in the seven pillars are changing the concept and practice of education at this very moment, whether the authorities recognize it or not. Instruction is increasingly supplemented by guided learning and self-learning. The internet is opening undreamed of vistas of possibilities. On-Line education is a reality, and is growing fast.

On-line education can also leverage the "flipped classroom" technique used by a few innovative educators. The idea is to record the lectures separately, allow the students to see them on their own time, and maintain the classroom "face time" for the teachers and the students to work together on problem solving and other tasks. This "flips" the conventional approach where the classroom face time is used for lectures and the students do the exercises and problem solving on their own.

These and other innovations are still in the experimental stage, in the sense that we do not know if they will bring improvements in learning and retention or acquisition of problem solving skills and imagination by the students better than other more conventional teaching techniques. In the 1960s in the US there seemed to be a concept that different meant innovation which was by definition better than the existing. Experience has shown that not all innovations are improvements and not all old-fashioned techniques need to be discarded. This will be equally true of the new and dramatic change that the ICT revolution is bringing to education.

2. A Changed Higher Education Landscape

The ICT revolution is already offering many more options than anyone would have thought possible. Thus Khan Academy (<http://www.khanacademy.org/>) offers all sorts of courses in all subjects with on-line tutorials and other toolkits and support systems for both teachers and learners. The University of the People (<http://www.uopeople.org/>), is a tuition free on-line university intended to democratize Higher education. The Library of Alexandria in collaboration with the University of Pittsburgh, offers the Science Supercourse (<http://ssc.bibalex.org/>), a collection of over 170,000 PowerPoint lectures that can be used as is, or from which individual slides can be taken to compose your own lecture, and there are many other examples, with more being created every day. Another initiative, by The Jack Parker Corp. and Big Think, called "The Floating University", aims to offer online Ivy League courses a la carte for a relatively cheap cost... and there are many other examples.

Indeed the challenges to the classical model multiply every day. Thus, when Stanford University professor Sebastian Thrun first offered a free online version of his "Introduction to Artificial Intelligence" class, 160,000 students from around the world signed up. Impressed

by that and inspired by the Khan Academy, he created a startup, called Udacity, to pursue that model⁷.

He is not alone. Others have moved into the area of Massive On-Line Open Courses (MOOCs). Two other Stanford professors have started a new start-up called Coursera that has been joined by a number of major research universities, with the purpose of offering MOOCs.

It is not clear whether all this will impact on the for-profit on-line universities and training programs and/or will impact the enrolments at the universities at which these professors learned and are or were teaching until recently. It is clear however, that the overall landscape of higher education is changing dramatically, even if the university, albeit a much transformed university, will remain a central player in that system in all societies.

Thus we can say that the landscape for higher education institutions is rapidly changing and is going to change even more dramatically. Pluralism of approaches and institutions is the new norm. The old effort to fit universities into models and to strait-jacket the models with equivalences is likely to be further eroded by these new creations with every passing day. I say that fully realizing that various universities will want to consider equivalences for learning done elsewhere or not under their purview if they are to acknowledge these in some sort of credit to some sort of degree or certification. But too many of these will exist for each to be recognized, and many of these options will survive whatever the old-line existing universities think of them.

Yet, none of these will actually replace the university as a physical institution, where things important to society are undertaken. They will be seen as complements to the transformed university, which will have many manifestations.

3. The University and Society

The University will be the locus of change in society. It is where the young learn to be adults, and where dependents become independent and active citizens. But it will be more. With continuing education becoming a must, I expect that the University of Tomorrow will have a large presence of ongoing adult learning programs. This will mean that the traditional concept of the community of scholars will be supplemented by returning adults. This will help intergenerational communications as much as lateral communication. That and a major expansion of community outreach will be part of the University of Tomorrow, diminishing if not abolishing the old town/gown dichotomy.

4. The University and the Economy

We all know the dual role of the university: from preparing young people for the rapidly changing job market to driving research and innovation in a society. Both of these functions shall remain. But with the much greater blurring of the boundaries that I expect in the years ahead, it will be necessary for the University of Tomorrow not to lose sight of its fundamental functions and get attracted into the profit-making mode which is the rightful preserve of the private sector. Having cautioned against the wrong choice of business model, I also caution against turning away from the broader socio-cultural mission of the university towards the profitable and the excessive service of economic interests.

5. The Core Functions of the University

Many of the traditional functions of the university, such as the search for truth through research and dissemination and discussion, the defense of values, the mediation of transitions in young people's lives and the certification of having achieved a certain level of marketable skills, will remain. But the last, the certification function, will change dramatically in its content and in its manner of application as continuing education, and upgrading of these skills will become mandatory de-facto if not de-jure. Thus the university will not be just a stage in everyone's life, but a lasting presence in our community, our society.

As we learn to learn, and use a wide array of self-learning and guided learning in addition to more traditional instruction, and as traditional instruction itself changes, we must be aware of the possible risks associated with such a transformation. Our pursuit of personal choices could lead to dilettantism, and the pursuit of Pluri-Disciplinarity may produce a generation of generalists who lack the proper disciplinary foundations to keep driving the boundaries of knowledge and the machinery of the Science, technology and innovation (STI) triangle, so necessary for socio-economic well-being.

This balancing act will be the biggest challenge before the universities of tomorrow. Those who succeed will be able to retain or achieve that aura of excellence that is difficult to define precisely, but that great institutions of learning have always had.

6. Curricula for Tomorrow

There will be multiple offerings on-line, not just at large but involving participants on campus as well. Such MOOCs and more specialized versions of it will also allow for "flipped classroom" instruction.

The content of the regular curriculum will probably be a three-tiered structure, with emphasis on streamlined but bedrock core programs, then lots of variation. The three tiers would cover:

- The foundation (a broad liberal arts and scientific exposure);
- The specialization in a discipline; and
- The trans-disciplinary exposure.

The teaching will teach above all "learning to learn" and an approach to knowledge and research, as specific content is likely to evolve rapidly. A firm and broad foundation in these attitudinal skills, learning skills, inter-personal skills, and socialized behavior, as well as good grounding in one discipline and a broad exposure to the values of the university, will lead to

graduation and the job market, but then followed by continuing life-long education, through formal instruction either on-line or in person, or a combination of both.

7. University Governance in the 21st century

The University needs to involve as partners in its decision making the broad gamut of social actors with whom it must interact, and who are affected by and can affect, the institution's decisions. Thus it should involve:

Opening up the University to this broader set of partners will not demean it or diminish its commitment to excellence and the core values it stands for. Indeed, no less an authority than the late Stephen Jay Gould observed:

It is important that we, as working scientists, combat these myths of our profession as something superior and apart. ... science can only be harmed in the long run by its self-proclaimed separation as a priesthood guarding the sacred rite called *the* scientific method.(emphasis in original) Science is accessible to all thinking people because it applies universal tools of intellect to its distinctive material⁸.

8. What Business Model for the Future?

The attempt to copy the manufacturing business model into the university should be avoided. The business model it should adopt however is one where it can have a clear set of functions, and broad consensus by the social actors through its open governance structure, and seek to involve those whose decisions on funding will make the execution of these functions possible. That means the involvement of what are traditionally seen as external parties, but must become part of the University's business partners: The private sector, government and the civil society. The nature of the partnership is to have clear expectations and transparency in the use of the funds that each party has allocated to the university.

The fine-tuning of this business model will raise the question of the right balance between research and teaching, the role of the university as advisor to the government and the undertaking of programs simply because they are popular with the civil society. It will also raise questions about changing the profiles of the faculty. But that is where the governance structure comes in as a corrective to ensure that the university does not drift towards a profit-making business model at the expense of its educational and cultural mission.

9. Values and Modernization

The University requires free enquiry for the practice of research and the pursuit of knowledge. That requires the adoption of certain values that I have referred to elsewhere as the "Values of Science"⁹. We all know that effective pursuit of science requires the protection of independence. Without independence of inquiry, there can be no true scientific research. The safeguards which independence requires are obvious: free inquiry, free thought, free speech, tolerance, and the willingness to arbitrate disputes on the basis of evidence. These are societal values worth defending, not just to promote the pursuit of science, but to have a better and more humane society. A society that is capable of adapting to change and embracing the new. A tolerant society¹⁰.

Tolerance based on the adoption of the values of science is different from the tolerance begotten by indifference to the behavior of others, dismissing them without engaging them.

Tolerance among scientists must be based on respect. Respect as a personal value implies, in any society, the public acknowledgments of justice and due honor. ... If these values did not exist the society of scientists would have had to invent them to make the practice of science possible. In societies where these values did not exist, science has had to create them.”¹¹

All of these values are the core values of the university. They are values honed by teacher example and student practice. But broader still, are the functions that allow us to teach our children that words such as truth, goodness, beauty, equality, liberty and justice are not empty words, but ideas that civilized humans live by¹². The university is the place where citizenship is first exercised, and it is where youth – and the returning older former students joining the adult education programs – can be exposed to the notions of civil discourse, dialogue and orderly debate of complex ideas in the framework of pluralism and mutual respect. That is a core function of the University of Tomorrow, especially in these times of rapid change and globalization.

10. Building in Change

Whatever we do, and however much we reflect and plan, reality will overtake us with more change than we can anticipate. Thus it will be essential to build-in change into whatever plans we strive for. The mechanisms of constant and ongoing monitoring and evaluation of university performance and the changing socio-economic context in which it operates should feed back to the decision making machinery in the governance model of the university. The ability to introduce change rapidly will be important. This will happen anyway in a pluralistic Higher Education sector as some of the institutions disappear and other, new and innovative, institutions appear.

A Global University?

While the internet has opened many avenues, and social media have become a part of everyone’s life, it remains true that recent research finds that people who rely on Facebook for their socialization are less happy than those who actually have real world social interaction¹³.

It behooves us therefore to also raise the question about whether a global consortium of universities could join to offer at least some students a global university program, that would allow real experiential learning about real people and real social contexts. Here are some thoughts, defined in mid-2013, suggesting what such a program could look like.

A global Consortium and a global program:

The nature of the global society towards which we are moving at frightening speed, opens up new avenues for us to reflect on the possibilities that were barely feasible in the past. Already in Europe an acceptance of common standards and a systematic agreement between countries allows young people in the Erasmus Mundi program to take different semesters in different establishments in different countries as they work towards their degrees. This allows these young people to mix with youth of their age in differ countries as they study with teachers of different nationalities and get exposed to the societies and cultures of various European countries. This undoubtedly broadens their perspectives, widens their networks of acquaintances and expands their horizons, regardless of the content of the courses they are formally studying.

We have long advocated as part of the Euro-Med schemes, that there would be an expansion of this Erasmus program to encourage youths from both sides of the Mediterranean to have the benefit of this multiple exposure to different cultures and different peoples. Today, thinking boldly, there is no reason why the idea of such a program could not be adapted to a global scale. It could be built upon a foundation of MOOCs where membership in a class is no longer confined to those who are physically located near the professor and his or her base of teaching, it could be refined in the sense of having a consortium of participating universities that will agree to have such a program among their offerings, and make that option available to their students who participate in that program at the university, and a number of these students could then be the ones that physically go in different locations at different universities, and continue their studies in an expanded international framework. It takes the American “semester Abroad” concept and the European Erasmus program to a new scale and would open avenues for the brightest among the students of the developing countries to explore new avenues and become the first students who are truly trained and socialized as citizens of the world.

Conclusions:

Have we even begun to plumb the depth of the challenge and its implications? Can we even claim to have properly sketched out the full range of implications that the seven pillars of the new knowledge revolution will force upon us? Do we know what the technologies of the future will do to our ability to summon the spirit of the past and conjure inspiring images to help us create a new future? Who can tell?

I hope that the recommendations that I have sketched out will help lay the foundations for a proper response to a rapidly changing world, not by trying to define that world accurately and prescribe actions precisely, but by proposing approaches that will involve the key actors and allow for maximum flexibility as we allow the institutions to evolve and the processes to adapt and the boundaries to move as we respond to that ever changing landscape. As we increasingly move into a world whose wonders we can only dimly perceive. It would be hubris to imagine that we – who could never have imagined the impact of the internet 20 years ago, or the reach of Facebook and Twitter ten years ago – would be able to lay down a precise path to the future for the next 20 years or so. We can only raise questions and express hopes...

Yes, there are no complete or even fully satisfying answers to many questions implicit in the discussions above. But in this modern age, we are “Questers”, to use the expression of Boorstin¹⁴, who understand that knowledge and cultural expression are a journey and not a destination, and who recognize that there is more importance in the fecundity of the questions than in the finality of the answers.

¹ A slightly different version of this material was presented at the International Association of Universities (IAU) meeting in Puerto Rico on 28 November 2012.

² see my earlier monograph: Ismail Serageldin, *The Seven Pillars of the Knowledge Revolution*, Bibliotheca Alexandrina, Alexandria, Egypt, 2010. That material was based on a distinguished lecture delivered by the author at the NSF in Washington in 2010.

³ See World Bank, *Development and the Next Generation*, WDR 2007, Washington DC, 2007

⁴ See Robert Putnam et.al., *Making Democracy Work*, Princeton University Press, 1993.

⁵ The World Bank then advocates that “To mobilize the economic and political resources to stimulate such reforms, countries must resolve three issues: better coordination and integration with national policy, stronger voice, and more evaluation”. Furthermore, the WDR 2007 also examines two other themes: youth migration, and the increasing use of new technologies. The former is not part of this essay; the latter is at the heart of it.

⁶ The National Research Council, *Research Universities and the Future of America*, The National Academies, Washington DC, 2012.

⁷ See, “Professor leaving Stanford for online education startup” by Jeremy Hsu in *Innovation News Daily*, updated 1/25/2012 6:33:58 PM ET, (see http://www.msnbc.msn.com/id/46138856/ns/technology_and_science-innovation/t/professor-leaving-stanford-online-education-startup/).

⁸ S.J.Gould *Time's Arrow, Time's Cycle : Myth and Metaphor in the Discovery of Geological Time*, Harvard University Press, Cambridge, Mass.,1987, p.7

⁹ See Ismail Serageldin, *Science: The Culture Of Living Change*, (second edition), Bibliotheca Alexandrina, Alexandria, Egypt, 2007.

¹⁰See Barrington Moore, Jr., “Tolerance and the scientific Outlook” in Robert P. Wolff, B. Moore, Jr. And Herbert Marcuse, *A critique of Pure Tolerance*, Beacon Paperbacks, Boston, 1969, pp. 53-79. Regretfully, in the concluding paragraph, this excellent essay uses some unfortunate references to Muslims and the Koran, attributing to them the willingness to see ..“other books...may be cast on the flames.” This typically ignorant comment is a use of a Western stereotype that is unworthy of the rest of the essay, which deals with Science and tolerance and reason in the Western context.

¹¹ See J. Bronowski, *Science and Human Values*, (revised edition with a new dialogue, “The Abacus and the Rose”, 1965) Perennial Library edition, Harper and Row, New York, 1972, p.63

¹² See Mortimer Adler, *Six Great Ideas*, Macmillan, New York, 1981

¹³ See: “Facebook Use Predicts Declines in Subjective Well-Being in Young Adults” By Ethan Kross, Philippe Verduyn, Emre Demiralp, Jiyoung Park, David Seungjae Lee, Natalie Lin, Holly Shablack, John Jonides, Oscar Ybarra; a Research Article from *PLOS One* at <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0069841;jsessionid=7B9DB8A5009547B7A59D5D4B353A09E4> (Accessed 22 08 2013)

¹⁴ See Daniel J. Boorstin, *Cleopatra's nose: Essays on the Unexpected*, Vintage Books, New York, 1994, p. 17