Higher education in the 21st century. Strategic threats and opportunities in a digital world

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Good morning to all. We have gathered from all corners of ORT´s world to discuss once more about our mission and our contribution to our societies. When people learn that ORT was founded in the 19th century they are impressed that it has been able to survive for almost 140 years (a period of time that included a major revolution in its country of birth, two World Wars and the Shoah). ORT did not survive by hibernation, it survived by adaptation. It found a way to adapt to changing social and economic trends while staying true to its spirit and mission. It diversified its geographic base, refocused its curricula and reconfigured its organisation to stay relevant through the century of most intense science and technological development in human history.

But we are not here to congratulate ourselves on our endurance. My intention today is to discuss some powerful social and economic forces that I believe will create major shifts in educational paradigms and will require our will and capacity to change once again. Universities today look like castles; unassailable and impervious to external change. But this calm may be a mirage. From a historical perspective universities are much more vulnerable than they seem to be.

Harvard, Stanford or Oxford look indeed unassailable. However, what about Heidelberg nowadays? Or Bologna? Or Salamanca? In the 1920s, the most active science scene was in Germany. As shown in Figure 1, a larger percentage of the science (Physics or Chemistry) Nobel prizes from 1900 to 1933 were awarded to researchers from German universities than from any other country. After the war, the scientific leadership of German universities started to decline, and after 1965 they were overtaken by American universities. Regarding Bologna (the oldest university in the Western world) and Salamanca (the oldest university in Spain and third oldest in Europe) none of them rank among the best 200 in the world in the Academic Ranking of World Universities[1]. Only one Italian science Nobel Prize was awarded to an Italian working in Italy in the last 100 years[2] (Giulio Natta, Chemistry, 1963).

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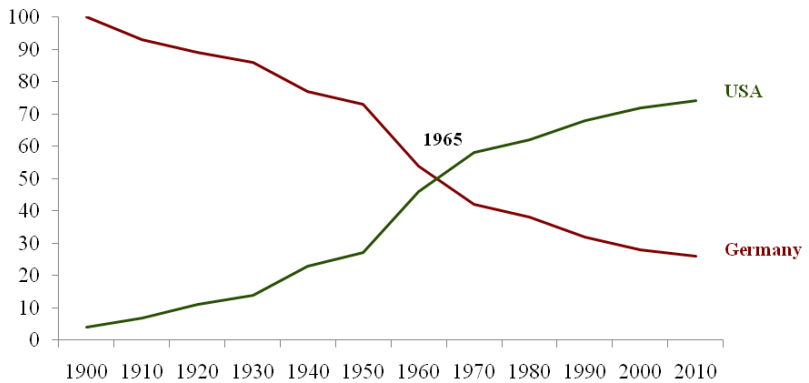
Percentage of science Nobel prizes by citizenship, USA and Germany.



Source: Schmidhuber, J. (2010). Evolution of national Nobel Prize shares in the 20th century. Accessed June 5, 2014, from http://www.idsia.ch/~juergen/phys.html

Fig. 1

1 http://www.shanghairanking.com/

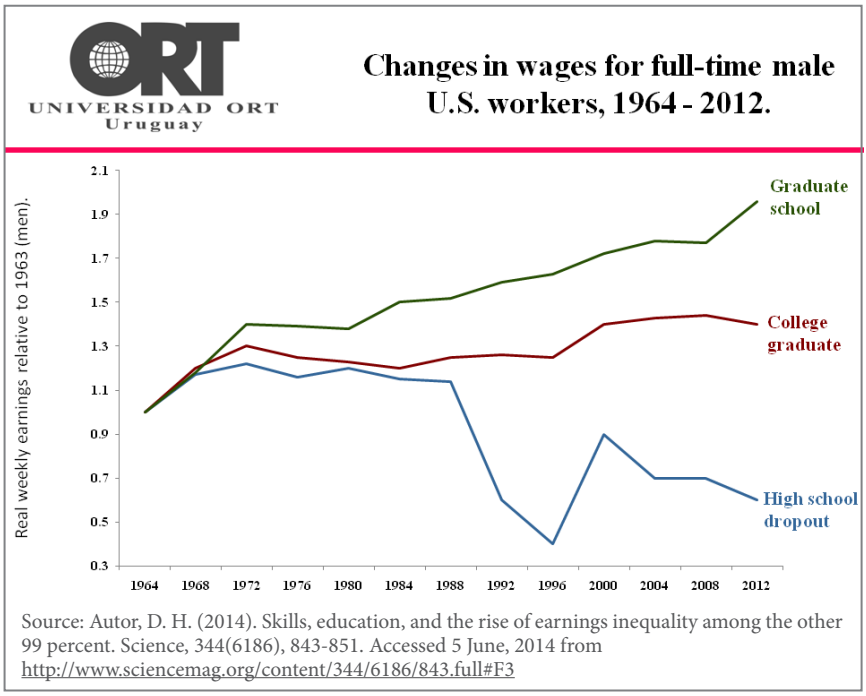
2 Four science Nobel Prizes were awarded to Italians working abroad during that period: Enrico Fermi (Physics, 1938, USA), Emilio Segré (Physics, 1959, USA), Carlo Rubbia, (Physics, 1984, Switzerland) and Riccardo Giacconi (Physics, 2002, USA).

Which are the social forces at play in the 21st century that may reshuffle the education world? One of the most important ones is the **valorisation of knowledge**. Which are now the wealthiest countries? Those which have oil or those which have talent? Producing knowledge, applying it creatively and cultivating talent are the requisites for development in the 21st century. Wars in the past were fought over territory or oil. The valorisation of knowledge will engender new forms of conflict over data and knowledge that we begin now to appreciate for example under the form of ciberwarfare.

In an agricultural economy nothing is more important than the quality of the land. In an industrial economy, nothing is more important than the quality of the production systems and machinery. In a knowledge economy nothing is more important than the cognitive abilities of those who produce goods and services. As learning is the process by which cognitive abilities are developed, education has become, and likely will continue to be, ever more important for economic performance[3]. Social unrest and economic stagnation might be the consequences for any country that fails to harness its intellectual resources. The ability to learn autonomously, to synthesize knowledge from different disciplines and to apply innovatively such knowledge, are becoming the abilities required to compete in the knowledge economy. Those citizens excluded from quality higher education will be increasingly excluded from the spoils of the knowledge economy.

As Figure 2 shows, less educated workers have seen their salaries decrease over the last 40 years. If you are a college graduate, your salary has reached a plateau. You are better off if you hold a graduate degree. These results suggest that in the future a degree from college will become the minimum certification needed to compete in the knowledge society.

3 I am paraphrasing Lawrence Summers´ foreword in Eric A. Hanushek, Paul E. Peterson, and Ludger Woessmann. 2013. Endangering Prosperity: A Global View of the American School. Washington, D.C.: Brookings Institution Press.



Source: Autor, D. H. (2014). Skills, education, and the rise of earnings inequality among the other 99 percent. Science, 344(6186), 843-851. Accessed 5 June, 2014 from http://www.sciencemag.org/content/344/6186/843.full#F3

Fig. 2

A second major social trend is the **confluence of globalization, automation and digitization**. Globalization was fuelled by political drivers (the end of the cold war, the relaxation of barriers to international trade), cultural factors (the spread of English as a global language, the celebrity culture enabled by mass media) and technological developments (telecommunications, air transport, the Internet). This interconnected and technified world gives rise to threats and opportunities. For example, a university student in Uruguay is now able to design and deliver websites for restaurants in Barcelona or Mexico City from his home in Montevideo, and earn more in a week than in a month of a local full time job. The negative side of globalization is that whatever you do in your country may be done quicker, cheaper or better by someone else in Bangalore, Seoul or Manila.

Fig. 3

Furthermore, your job may be increasingly performed not just by somebody else in a distant land, but by s*omething* else. Depending on the job you do, you might be at risk of being outcompeted by a robot, computer software or some other technology. To appreciate the magnitude of the impact that automation and digitization might provoke in the labour market, consider that Kodak which filed for bankruptcy protection in 2012 employed 140,000 workers. Approximately at the same time, Instagram was sold to Facebook for a billion dollars with only 13 workers after achieving dominance of the digital photography market (Fig. 4).

Fig. 4

As Figure 5 illustrates, people who fail to acquire college-level skills will find it increasingly hard to make a good living. Large scale automation and digitization will threaten many lower-wage jobs: production line or supermarket checkout jobs are already disappearing. As computers get cleverer, even some accountants and lawyers tasks will become automatable. As Isaac Asimov conjectured in 1964, "in 2014 the lucky few who can be involved in creative work of any sort will be the true elite of mankind, for they alone will do more than serve a machine"[4].

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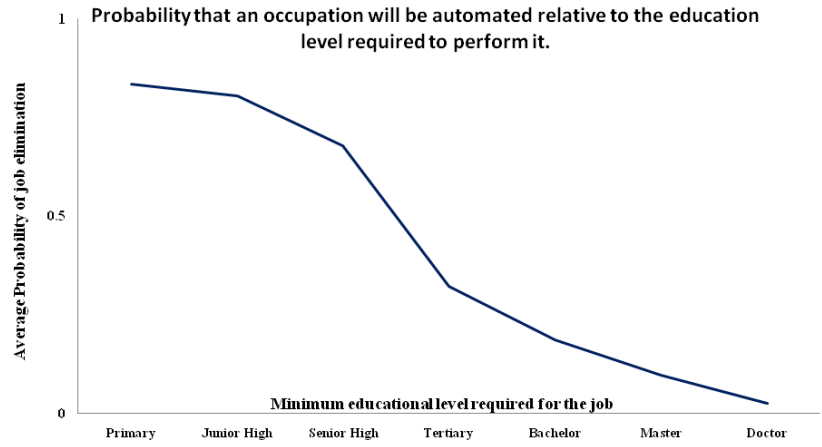
The effects of automation: Probability that your job will dissapear.



Source: Calculations of Julio Fernández based on Frey, C.B. & Osborne, M.A. (2013). The future of employment: how susceptible are jobs to computerisation?. Accessed 12 May, 2014 from http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

Fig. 5

4 http://www.smithsonianmag.com/smart-news/what-isaac-asimov-thought-2014-would-look-like-2607612/?no-ist

It is not the first time in history that jobs are affected by social and technological changes. In 1900 almost half U.S. jobs were in agriculture. A century later agriculture employed only 2% of U.S. workers. In recent decades computer advances have enabled the automation of many manufacturing or service jobs based on routine, codifiable, cognitive tasks (e.g. bookkeeping). It has been widely accepted by economists that the net effect in the long run of technological advances is positive. However, it is possible that past historical experience might not shed much light on the scale of job market restructuring that accelerating automation and digitization processes might entail. Figure 6 shows a list of traditional occupations likely to disappear in the next few years due to automation as reported in a recent article by Carl Frey and Michael Osborne, two academics from Oxford University[5].

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Occupations at high risk of disappearing due to automation.

Probability	Occupation
0.98	Models
0.98	Sports umpires and referees
0.97	Cashiers
0.96	Cooks
0.96	Secretaries
0.94	Accountants and auditors
0.86	Taxi and bus drivers

Source: Frey, C.B. & Osborne, M.A. (2013). The future of employment: how susceptible are jobs to computerisation?. Accessed 12 May, 2014 from http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

Fig. 6

5 Frey, C.B. & Osborne, M. A. (2013). *The Future of Employment: How susceptible are jobs to computerization?*. Accessed June 6, 2014, from http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

So if you earn your living performing one of such occupations, for example as a model, as an umpire, as a cashier or as a cook, the probability that your job will disappear in a few years is close to one. It is interesting to note that one of these threatened occupations is "driver". In 2001, David Autor and Richard Murnane (two academics from MIT and Harvard, respectively), argued in their classic article "The skill content of recent technological change" that while bookkeeping would be rapidly automated, driving would not[6]. A decade later, driverless cars are already operational.

Figure 7 below depicts the other end of the range of job automatibility, those jobs with least risk of automation in the medium run. A common pattern among these apparently very disparate jobs is that they need human inspiration, original thinking and interpersonal skills. Automation and digitization continue at a fast pace. If you are a police detective you may feel secure for now, but maybe in a few years some new technology will force you to radically reinvent your skills. Already predictive policing technologies, intelligent vision systems and other technologies are redefining the frontiers of law enforcement.

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Occupations at low risk of disappearing.

Probability	Occupation
0.004	Choreographers
0.004	Fire fighters
0.004	Physicians and surgeons
0.004	Police detectives
0.004	Teachers
0.005	School principals
0.007	Athletic trainers
0.01	Artists

Source: Frey, C.B. & Osborne, M.A. (2013). The future of employment: how susceptible are jobs to computerisation?. Accessed 12 May, 2014 from http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

Fig. 7

6 Autor, D., Levy, F. & Murnane, R.J. (2001). *The skill content of recent technological change: an empirical exploration*. (Working paper 8337). Cambridge: National Bureau of Economics Research. Accessed June 9, 2014, from http://nber.org/papers/w8337

Automation may create a new equilibrium between capital (technology) and labour balanced favourably towards the former. In such a scenario, the number of jobs may increasingly fall behind the number of job seekers especially those with lower levels of education. Societal strategies to tackle this challenge should be a topic of thought for political leaders and academia. In my view, helping people acquire innovation, relational and entrepreneurial skills might be the way forward. We should help our students think about themselves as entrepreneurs and eventually job-creators rather than focus on chasing jobs.

A third major social force reshaping our world is the **strengthening of citizens' voices**. The number of democracies in the world is at an all-time high (the number of democratic countries almost doubled from 69 to 122 in the last 25 years according to Freedom House)[7]. It is true that not all countries with elections are real democracies in the liberal tradition sense, and that some promising democratisation processes have stopped or reversed (think about the Arab Spring or the Chavista-like regimes in Latin America) but, on the whole, and not least because of new available technologies such as social networks or mobile telephony, citizens are much more difficult to ignore, deceive or indoctrinate that at any time before in history and authoritarian, dishonest or incompetent deeds (police beatings, acts of corruption, environmental negligence) are much more difficult to keep secret.

In summary, three main forces are reshaping our society and economy: the valorisation of knowledge, the confluence of globalization, automation and digitization, and the spread of citizens' voices (Fig. 8). The first force is economically important because it is redefining the sources of national and personal wealth. The second is socially important because it involves large-scale realignments in job markets and in the relation between capital (technology) and labour. The latter one is politically important because as people realise that their future will be contingent to their education, they will have the power to push forcefully their demands for access to educational opportunities into the public agenda.

7 Freedom House. (2014). *Freedom in the World: electoral democracies*. Accessed June 9, 2014, from http://www.freedomhouse.org/sites/default/files/Electoral%20Democracy%20Numbers%2C%20FIW%201989-2014.pdf

Higher education is no longer a “luxury good”. It has become the survival kit in the knowledge economy. Thus, there will be strong social demands for more and better higher education that, if not met adequately, might fuel political instability and eventually erode the legitimacy of democracy (Chile is an interesting example).

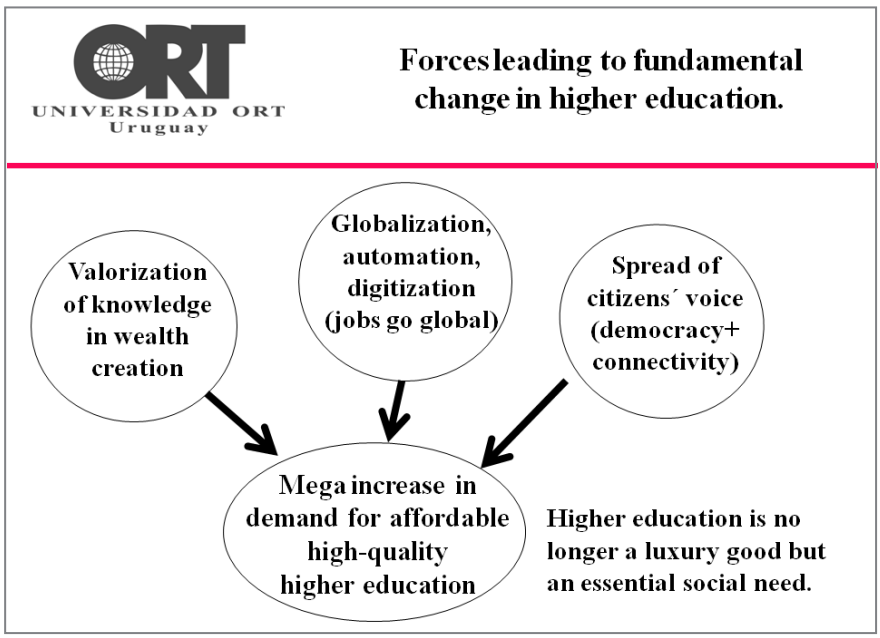

Fig. 8

In the knowledge society personal development is a **race between education and technology**. Technological progress widens inequality unless it is countered by increases in the supply of human capital. Personal development has been a race between education and technology since the Industrial Revolution, although the speed and stakes of this race are increasing. A century ago, physical strength was a key job skill. During the 20th century, technological innovations such as electrification, motorized transportation, telecommunications or computerisation have reduced the need for physical labour.

These processes of replacement of human labour by technology devalue the skills of workers without postsecondary education, whom are more likely than more educated workers to perform automatable activities. As a result, employers´ demand for formal analytical abilities, written and oral communications and specialised technical knowledge (called "cognitive skills" by economists) has raised spectacularly[8].

If your education lags behind technological advances, your skills become less useful and eventually obsolete and your salary and job security will decrease. Wage inequality increases, because employers need to compete for relatively scarce knowhow by providing higher wages and other perks (Fig. 9).

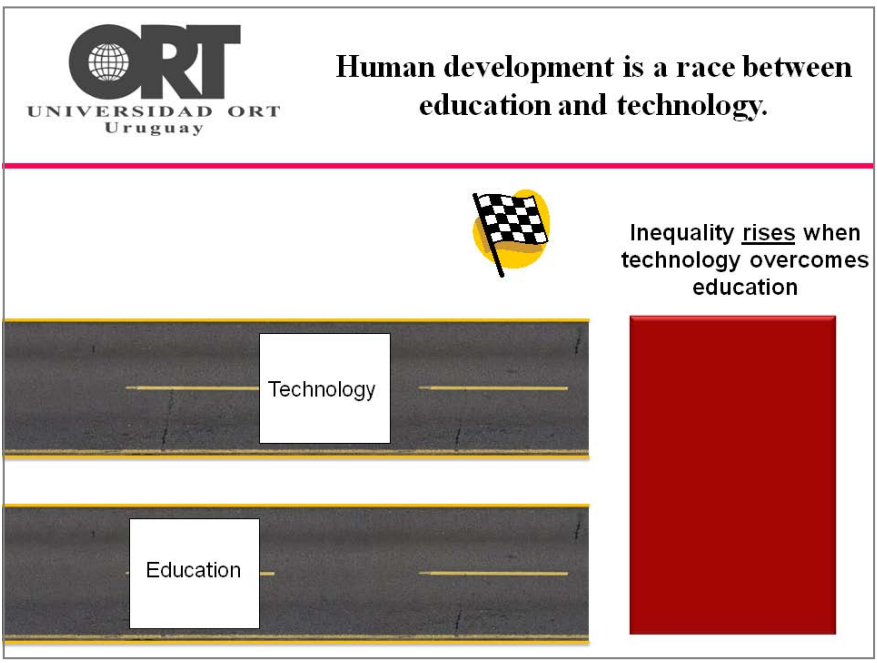

Fig. 9

If education moves quicker than technology (Fig. 10), inequality decreases because a larger supply of skilled labour diminishes the wage premium of knowhow because there is a larger supply of skilled people.

8 See Tinbergen, J. (1975). Income distribution: analysis and policies. Amsterdam: North-Holland Pub. Co. and Goldin, C. & Katz, L. F. (2008). The race between education and technology. Cambridge: Harvard University Press.

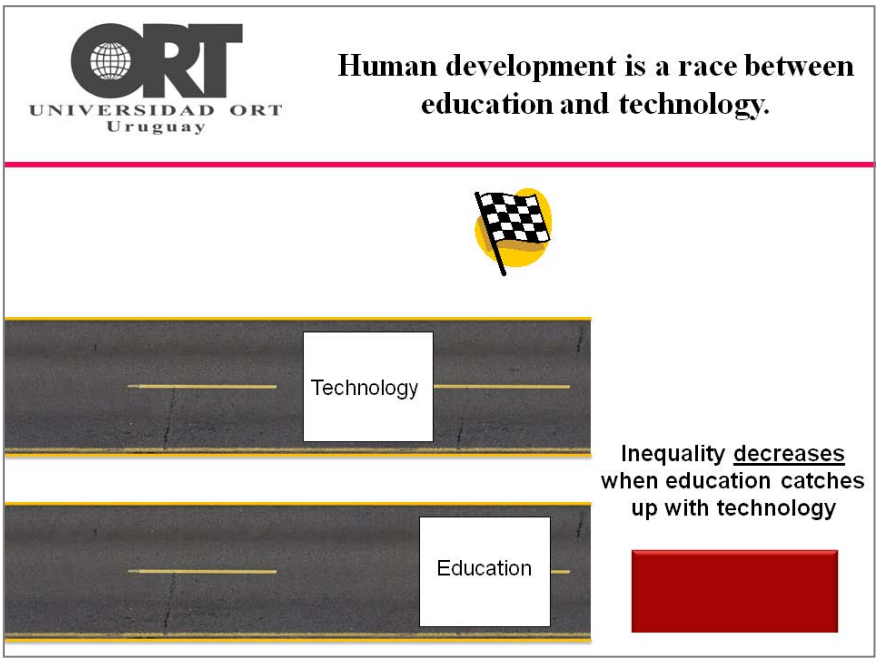

Fig. 10

In a context of fast technological development and job automation, millions or tens of millions of high school graduates will demand access to quality higher education, many others will aspire to postgraduate education and all of them (plus the current stock of university graduates) will need continuing education services and eventually recertification (as specialized knowledge changes ever more rapidly, societies will demand regular certification of their professionals). To face this challenge, higher education systems will have to expand by an order of magnitude. Failure would be costly. Those societies which fail to provide inclusive access to quality higher education will curtail their citizens' livelihood, and will be outcompeted by more educated nations in the race to produce knowledge and innovative ventures.

However, **the educational system itself, with its current organisational principles, is itself a bottleneck for the expansion of educational opportunitie**s (Fig. 11). Teaching is currently constrained by "linearity" (more students require more resources such as teachers, classrooms, libraries, laboratory equipment and so on) or, as economists would say, by high marginal costs.

It is also constrained by co-location and co-temporality (teachers and students must be physically present at the same time in the same place). As a consequence of these constraints, major expansions of higher education require very large resource increases that most countries are unable to undertake. Even for rich countries, doubling or tripling the number of academics might be too costly, both for financial reasons and because of the diversion of talent away from the private sector (or Government).

In sum, the size of the expansion needed to accommodate the increasing demand for higher education might be difficult for most countries to achieve. Faced with similar challenges in the past some countries have used quality as an adjustment variable. They expanded access to universities without increasing proportionally teaching resources. Enrolment increased but graduation rates plummeted, knowledge creation slowed or halted and employers started to complain about college graduates abilities.

To increase access affordably without compromising quality it is necessary to increase higher education systems' productivity (teaching many more students with only a fraction more resources). Teaching productivity is constrained by what economists call the "Baumol effect" [9] which refers to the difficulties involved in increasing productivity in personal and performance services. In car manufacturing or banking for example, workers are continually getting more productive due to technological innovations. In contrast, in labour-intensive sectors that rely heavily on human interaction, such as nursing, education or the performing arts, improvements in productivity have been much less. It takes nurses the same amount of time to change a bandage, or college professors the same amount of time to mark an essay, in 2014 as it did decades before. When Mozart composed his String Quintet in G Minor (K. 516), in 1787, you needed five musicians to perform it. Today, you still need five musicians and they cannot raise productivity by playing faster.

9 Baumol's cost disease (also known as the Baumol Effect) is a phenomenon described by William J. Baumol and William G. Bowen in the 1960s. It involves a rise of salaries in jobs that have experienced no increase of labor productivity in response to rising salaries in other jobs which did experience such labor productivity growth

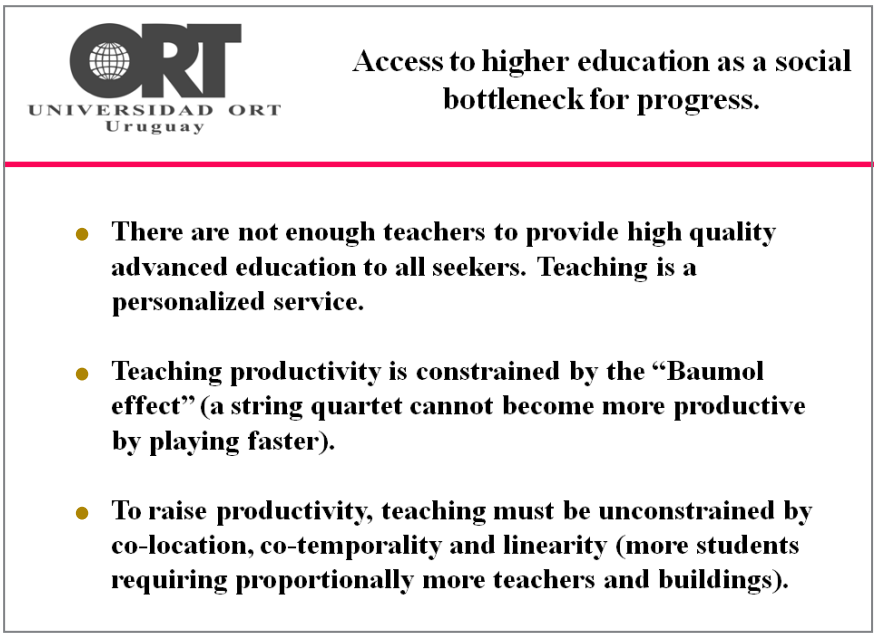

Fig. 11

Thus, we have to find ways to improve teaching productivity (or more precisely *learning* productivity). New technologies might provide us new alternatives. Let us first review the **historic development of educational organisation and technology**. Since antiquity and up to Enlightenment, quality higher education was organised following a Socratic approach, which could yield excellent learning outcomes. However, it was inherently restricted to very few students since it relied on intense personal interactions with highly educated and experienced tutors; which are never cheap nor in great abundance (Fig. 12).

Fig. 12

After the Industrial Revolution, economic and political imperatives created the need for a literate citizenry. Teaching systems were reorganized with the goal of providing a minimum level of literacy and numeracy to large numbers of people in regular time periods (the school year) [10].

10 Ironically for a system designed for the industrial age the school calendar still largely follows an agrarian calendar (school ends near the beginning of the summer, a date picked so children could help harvest the crops grown by farming families).

Fig. 13

As described in Figure 14, when the economy was basically agrarian, Socratic teaching fulfilled societal needs for leadership formation. There was no economic need for universal literacy or numeracy. It is estimated that the literacy rate in Ancient Greece did not exceed 5%[11]. Industrialised economies require a literate and numerate working force. Mass education need not be particularly advanced or high quality; it should be extensive and uniform following the organising principles of industrial organisations. To teach basic cognitive skills to the children of 19th century farmers and labourers it was sufficient to create enough schools where they could learn to read, write and do arithmetic. Teaching productivity was increased by uniformization of content regardless of personal interest and abilities, use of passive, impersonal teaching techniques and grouping of students by age rather than by content mastery (Fig. 14).

11 Harris W.V. "Ancient literacy", 1989, Harvard University Press, Cambridge, Mass

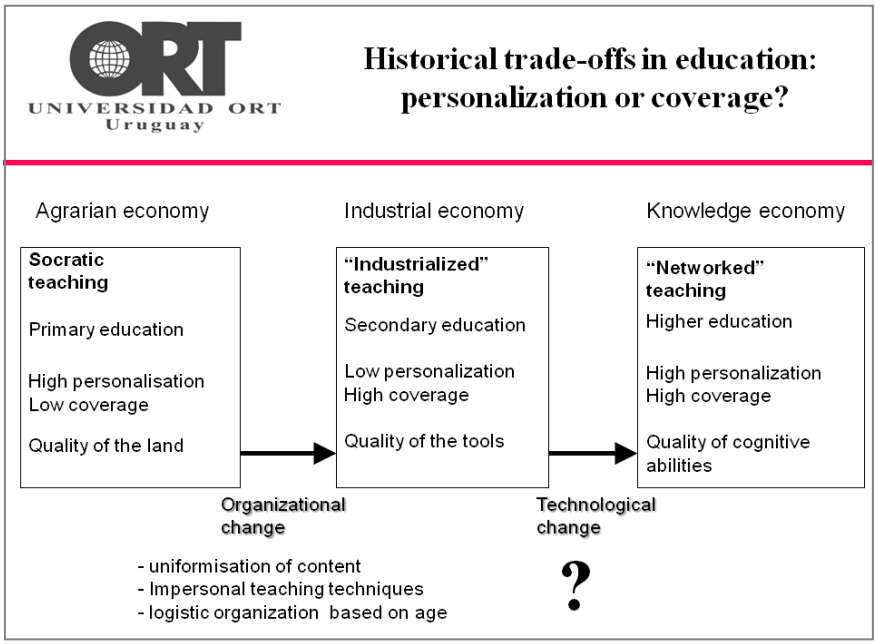

Fig. 14

High-quality higher education is much less amenable to massification using industrialisation techniques. In knowledge economies the quantity of education required to produce knowledge-based products and services is much higher, and the quality of learning is of paramount importance because creativity, transdisciplinarian thinking and self-learning are critical to create economic value.

The university operating model has remained virtually unchanged for centuries. The business model is based on a cost function of an era when travel was costly and students, teachers and books needed to be at the same place at the same time. This made rational the "bundling" of university services to amortise the costs of physically attending a university. This "bundled" model is still dominant in higher education. Universities "bundle" sets of courses in degrees and students are forced to enrol in all of them although they might prefer to select a different university for each course.

"Bundling" has so far protected universities from the choices consumers make for other purchases. For example, the music industry "bundled" songs so that consumers had to buy LPs or CDs just to acquire the song they really wanted. Digital technology has enabled music consumers to buy individual songs (happily for Itunes or Spotify, but less so for record companies that are still looking for new business models). Something similar is happening to the TV industry where consumers do not follow channels but specific shows that they can view in the platform and time of their choosing. In an industry unbundled by technology, consumers can purchase only the content that they want and bundled products become no longer viable. While the university's integrated model still has value, it is a depreciating asset.

How innovative is higher education? The most recent major technological change in education, the printing press, occurred 500 years ago[12]. What other major social activity has remained invariant for centuries? Think how religion has changed by adopting ICT, or politics or media. Can you imagine a hospital operating with 19th century technology? Can you imagine an airport working without radar? Do countries wage war in the same way than 500 years ago?

Fig. 15

12 There have been regularly expectations that new technologies might induce large-scale reform in education. Radio, TV and Computer Assisted-Instruction were heralded as catalysts of education reform in the 20th century but failed to do so. See Cuban, L. (1986). *Teachers and machines: the classroom use of technologies since 1920*. New York: Teachers College Press.

In sum, our societies face increasing social demands for quality higher education. Those are not marginal increments. Access to quality higher education may have to increase by an order of magnitude (think of the hundreds of millions of Chinese, Indians or Latin American who are just now reaching the middle class and will demand the educational opportunities they are entitled to).

However, the supply of quality higher education is insufficient to fulfil these demands and expanding it in the required proportion could result too costly for most countries. We need some ways to reconcile demand and supply. This means finding ways to augment the productivity of education as it has happened with most other human activities. Higher education is an industry whose organisational principles have remained static for centuries, as mentioned above. Other industries looked as immutable as higher education a few decades ago, but they have been transformed. In Harvard professor Clay Christensen´s words, they have been "disrupted"[13].

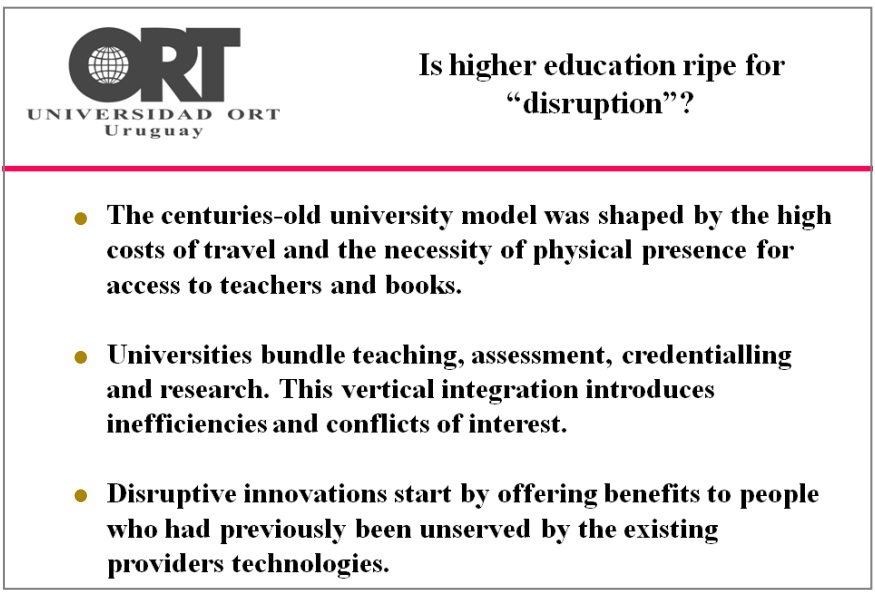

Fig. 16

13 Christensen, C.M. & Eyring, H.J. (2011). *The innovative university: changing the DNA of higher education from the inside out*. San Francisco: Jossey-Bass.

The theory of disruptive innovation describes a process by which a new product or service transforms an existing industry by introducing simplicity, convenience, accessibility and affordability. They often get labelled as low-quality options because they are not good enough to meet the needs of most mainstream customers. Disruptive innovations get their initial footholds not by being better than what was already available, but by offering other benefits that make them attractive to people who had previously been non served by the mainstream technologies. In time, the disruptive innovations improve to the point where they are good enough to meet mainstream performance demands and achieve their transformative potential[14]. For example, when Toyota started selling cars in the USA in the 1960´s, people were derisive (Fig. 17). Toyota seemed no match to the dominant car makers, especially General Motors (GM). Buying a Toyota for your children was like a punishment. However, it was a bit cheaper and it was quite reliable. Who is laughing these days? (Fig. 18).

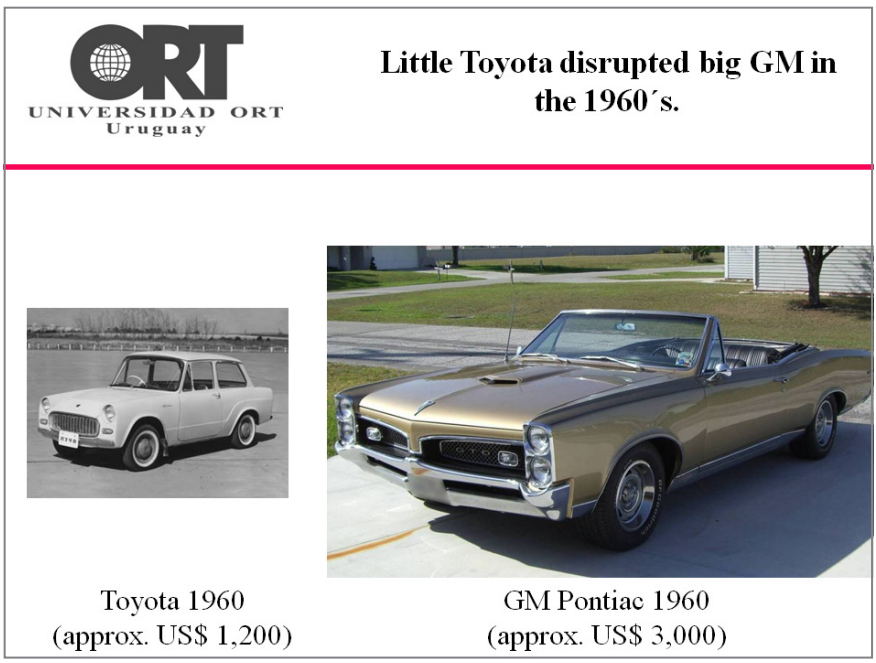

Fig. 17

14 Christensen, C.M. (2006). *The innovator's dilemma: the revolutionary book that will change the way you do business*. New York: Harper Collins.

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Who is the dominant car maker now?

GM Spark
(approx. US$ 12,000)

Toyota Lexus
(approx. US$ 43,500)

Fig. 18

Figure 19 illustrates waves of digital disruption. The firsts were music, books, TV or travel. They were disrupted by companies such as Napster, Amazon, YouTube and Expedia.

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Waves of Digital Disruption.

1995+	2010+	2015+	…
Music Photography Books	TV News Travel Recruitment	Retail Finance Transport Education?	

Fig. 19

Higher education may be ripe for disruption and that may facilitate the major changes that are required in the quantity and quality of higher education supply. The innovations that in my opinion might disrupt higher education are listed in Fig. 20.

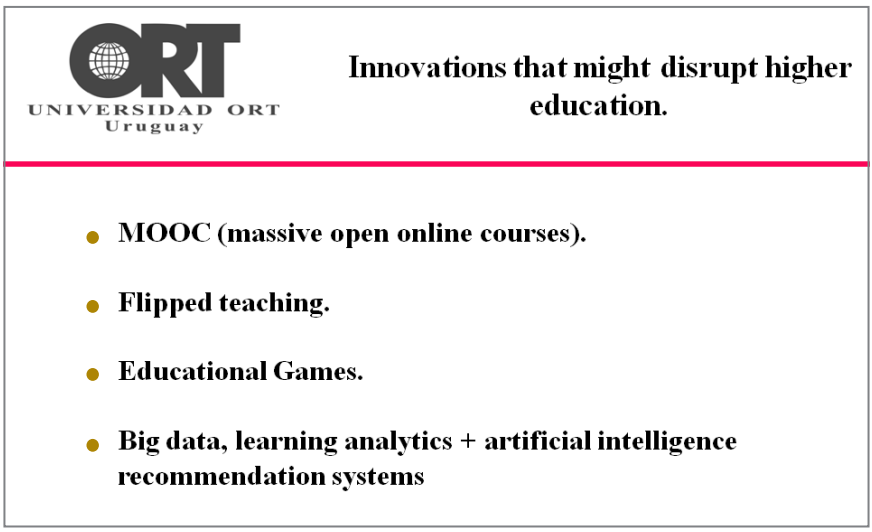

Fig. 20

For the sake of brevity I will discuss here only the first and last ones.

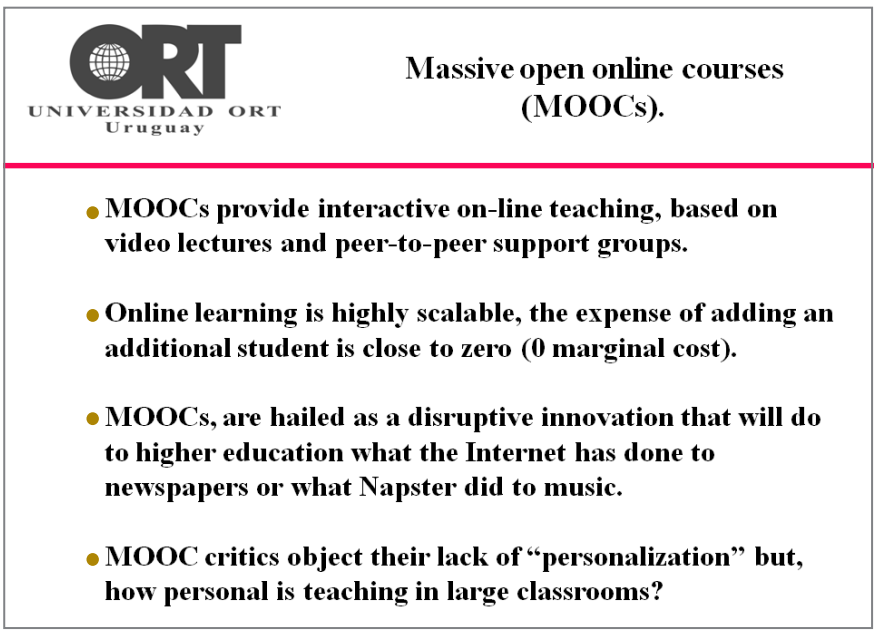

Fig. 21

Until now interactive learning required co-location and co-temporality (i.e. teachers and students present in the classroom). Massive Open Online Courses or MOOCs, which are not constrained by co-location and co-temporality requirements, are hailed as a new innovation so disruptive for academia that they might do to higher education what the Internet has done to newspapers, or what Napster did to music. Millions of students enrol each year (most for free) in MOOCs where marginal cost approaches zero (each new student who enrols costs almost nothing). You can easily reach tens or hundreds of thousands of students (very few complete their courses although the evidence collected so far suggest that many people enrol in MOOCs without the intention to attend to the entire course in the first place)[15].

There is discussion on whether the quality of learning achieved in MOOCs is comparable to the one achieved through face-to-face education. It is a legitimate discussion but in a certain way misses the point (and some of the central tenets of disruption theory). Firstly, it overlooks the fact that most of those MOOC students would never have the chance to attend those same courses physically, they are "non- users" as Clay Christensen describe them. The right comparison for them is between MOOCs and nothing, between MOOCs and books or between MOOCs designed and taught by top professors in top universities and traditional courses by much less qualified teachers at local institutions[16]. Secondly, it might overestimate the actual "personalization" of traditional face-to-face courses. Many courses in many universities are taught to very large groups which rend impossible the teacher-student interaction, by lecturers who lack pedagogical skills (or who are not interested in teaching as opposed to doing research), or in physical conditions of visibility or acoustics that make watching the course live or taped in video more productive (and more useful with the option of repeating any segment as many times as needed) (Figs. 22 and 23). Thus, in many cases the potential personalization of face-to-face teaching, remains an optical illusion[17].

15 This is an interesting example of "non-users" using a service that they would have never used if they had to enrol in traditional courses because of the financial and logistical costs involved.
16 See http://blogs.edweek.org/edweek/edtechresearcher/2013/03/moocs_and_higher_educations_non-consumers.html for a useful, brief discussion of MOOC students as non-consumers.
17 See http://higheredwatch.newamerica.net/blogposts/2013/moocs_robots_and_the_secret_of_life-85293 for a perceptive discussion of this point.


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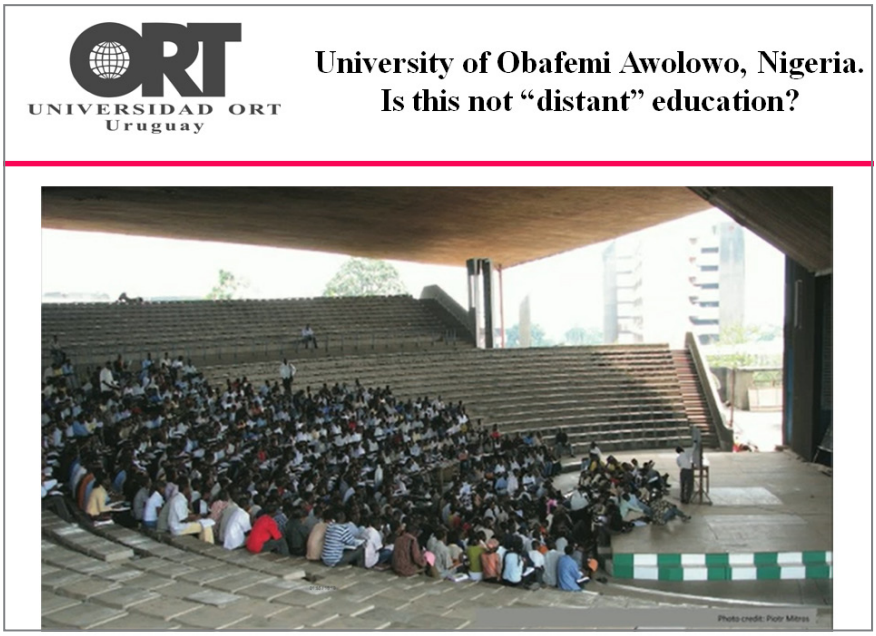
How personalized is this setting?
"Are you talking to me?"

Fig. 22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Is this not "distant" education?

Fig. 23

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Flipped teaching.

- Teachers assign lectures to watch at home and save class time for working on homework together.
- Flipping uses the resources on the Internet to free up valuable teacher classroom time, changes the teacher-student relationship and opens the door to "discovered" learning.

Fig. 24

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Educational games.

- Games are goal-oriented, have strong social components and simulate real world experience.
- Ideal method of assessing student comprehension, provides immediate performance feedback to the players.
- Allows for experimentation, the exploration of identities, and a safe place to learn from failure.

Fig. 25

Big data in education refers to the collection, aggregation and application of digital data related to individual students and their learning processes. This data will help personalize teaching approaches to student's content mastery, learning styles and personal interests. It can be used to guide educational processes, to select examples, bibliography or assessments that could be more appropriate for individual students depending on their learning attributes, age, gender, or cultural background.

Data analytics will also enable optimizing learning materials by looking at their comparative effectiveness across ages and cultures over time. It might also help to design teaching material repositories that individual teachers worldwide might be able to consult, utilize or modify for its own teaching purposes educational materials developed by other teachers and whose results will be tracked and documented for different types of students. Big data usage has already disrupted the advertising industry where Google for example gathers lots of information and uses it to personalize advertising. Academia may use the same model in the learning process to customize courses right down to the level of the individual.

We live in a rapidly changing world where major social and technological changes are bringing new threats and opportunities. As in the past, we should strive to survive and thrive by adaptation. Thank you for your kind attention today.

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