

1.1 The technology that changes minds



1.2 Technology, the engine room of history

The Huns had a good understanding of the concept of "disruptive technology".

In its original meaning, the term "disruptive" is associated with an organisation capable of upsetting the market and defeating apparently far stronger rivals, thanks to particularly effective innovation. Usually technological.

The Huns' *disruptive technology* was a special bow. A bow made of wood, deer horns and tendons. A very powerful bow sending arrows twice the usual distance, and capable of piercing the metal armour worn in the 5th century. It was a small, asymmetrical bow, due to one limb being shorter, made specially for use by a galloping horseman. We have seen similar things in western movies, but in those days it had never been seen. Germanic peoples were swept away, and even the legions of Rome and Byzantium took severe beatings.

At the time of Attila, the Hun Empire was at its peak, spanning from present-day Russia to Germany, from the Caspian Sea to the North Sea, with incursions into northern Italy, the Balkans and Greece.

All thanks to a bow?

1.3 The right thing at the right time

The Hun bow was effective, but above all it was "the right thing at the right time". Because it possessed the two salient features of "disruptive" technologies:

- It was exactly what was needed at that time to make a difference on the battlefield
- It perfectly suited the culture of the steppe people who, it was said, learned to ride a horse before they could walk

The history of the Huns' bow is not unique. A new type of plough, a horse-riding stirrup, the printing press, the steam engine, electricity, the radar: technological innovations that have made the difference, building and knocking down political and economic empires, revolutionising people's lives and social relationships.

At this point we should ask ourselves: if technology is one of the driving forces of history, what effect does it have on the mind?

1.4 Writing? No thanks

Everyone knows about Socrates' reluctance and, perhaps, aversion to writing. As far as we know, Socrates never wrote anything down. It was Plato that told us about the reasons for so much mistrust.

Plato first stresses the limitations of writing as an instrument of knowledge: a written text is addressed to everyone in the same way, but each reader interprets it in its own way. To convey its "true" message, a script needs the presence of its author.

Or we might say: a text on its own is not interactive enough.

1.5 Losing memory

The second point is just as interesting to us: when we use writing some functions of our mind are altered. In particular, by transferring information from one medium (neuronal connections) to another (papyrus, parchment or paper), the need to use and train the memory is lost.

The result being that the ancient bards recounted from memory the Iliad, the Odyssey and the stories of gods and men, but also the laws and the refined ideas of the philosophers.

We, on the other hand, need a piece of paper when we go shopping so as not to forget anything.

1.6 Not knowing how to "count"

Socrates and Plato are in fine company. Virtually all knowledge technologies have had their enemies. Even in recent times.

When the first digital calculators appeared at a reasonable cost in the late 1970s, students were among the first enthusiastic users. Even then, the criticism travelled in two directions:

First of all, it was said that effectiveness would drop. Old engineers would claim "The calculator is useful for additions, but for everything else nothing is better than a slide rule".

Secondly, a loss of some mental capacity, in this case calculating on paper or in one's head. There are two sides to the question. Not only has the ability to calculate square roots or simple divisions been lost almost completely, letting machines do everything makes it more and more difficult to evaluate results.

The users of the first pocket calculators found to their cost a rather serious defect: when the battery was exhausted, the calculator would give absolutely random results before switching off. These results ended up in maths, physics and electronics exercises.

After the calculator came the computer of course.

1.7 Computers, computers everywhere

The computer is a pervasive machine. Few decades have passed since the gigantic Eniac computer of 1946. With its 18,000 valves and weight of 30 tons, it marked the beginning of the digital age.

From that time on, the evolution of the computer is a dizzying history made up of shrinking and multiplying. With reductions in size, consumption and costs. Increasing performance (in terms of computing power) and more functions. Today computers don't just calculate, they can communicate, interact with the environment and, to an extent, think.

They are not only on our desks and in IT classrooms, a clearly visible and, we might say, quite reassuring presence. Today we can carry incredibly powerful computers in our pockets, and among other things they allow us to make phone calls. They are in our cars, in domestic robots, in industrial machines, in bank terminals, in cameras, in televisions and in washing machines. Soon they will be part of our clothing and inside our bodies. Invisible, very powerful and inexpensive: inserting a microscopic

computer inside objects is the simplest and cheapest way to equip them with advanced functions.

We feel, and indeed we are, surrounded by machines that we are not fully able to understand. That is why certain reactions should not be too surprising.

1.8 Computer "damage"

If we enter in a search engine "computer damage", we find 17,500,000 hits, ten times more than what we would get for "television damage". The list of charges is varied:

- Eye-related problems
- Increased risk of heart attack
- Back pain
- Carpal tunnel syndrome
- Addiction syndromes
- Insomnia
- Damage to brain neurons
- General drop in cognitive abilities
- Sociopathic tendencies
- ...

In these 17,500,000 web pages we find, mixed in with serious scientific contributions that highlight real, physical problems, a large number of observations, fantasies and prejudices, which are passed around, distorted and amplified by a media train that, in a clear contradiction, chiefly uses web channels.

Fears are destined to grow, since the future is full of disruptive innovations. And this is the near future, one that has already begun.

1.9 Next-generation computers

We have barely had time to digest first the computer, then the Internet and, finally, smartphones. But below are four developments that are likely to radically change things again.

The first two have to do with the technology itself. They are artificial intelligence, and virtual, augmented reality.

The other two disruptive developments have to do directly with making the physical world "smart" in a totally new way. They are the Internet of things and robotics.

After many years of muted development, artificial intelligence systems are entering our everyday devices, for example in the latest generation smartphones. For now the changes are coming relatively slowly: we are astonished every time we take a snap with a mobile phone, for instance, and the machine "understands" that we are framing a face, a landscape or the meadow.

Virtual and augmented reality is no longer an actual novelty. But now, thanks to new glasses and visors, they are really starting to work. Making it possible not only to perceive, but also to move in totally virtual worlds. Or, conversely, they can "augment" the actual physical world by adding information of all kinds.

The Internet is moving silently towards a new protocol, that can assign a practically unlimited number of distinct addresses. Having an Internet address means, in practice, existing. Any object can be connected to the Internet, with a certain degree of autonomy: the house, the car, the refrigerator or a single slab of butter. They can warn us in time when items are reaching their expiry date. Or they can add themselves to the shopping list...

Robots are among us, but they don't look like Star Wars at all. They are industrial machines that can perform any operation with great ease: home robots that learn the layout of the rooms and furniture, cars that park themselves, brake and now even drive on their own.

Certainly, like Plato and the detractors of the first calculators, those who fear or hate these things have their own reasons for doing so. They are technologies that, more than the Huns' bow and even writing (in a much shorter time span, and several times in the course of one's life), are turning upside down the very idea of reality, intelligence, relations. And the way we think about ourselves.

Let us see how...

1.10 The digital big bang

We are used to conceiving processes of thought, emotions, interpersonal relations and the functioning of the brain as relatively constant. We believe that people immersed in different experiences may think different things, but basically think in the same way.

This, according to Prensky, is the first idea that must change. Mark Prensky, teacher, writer and educational videogame designer, works more in the area of communication than research. He came up with the universally known metaphor

that distinguishes between digital "natives" and digital "immigrants".

The starting point is to conceive the basis of mental functioning, that referring to brain neurons, as being like a plastic structure. One that changes its way of functioning in response not to a single stimulus but to the type of cognitive activity in which one is immersed for long periods and every day.

"Reading", says Prensky, "requires a different neurology than the spoken language". This change, which so worried Socrates and Plato, is like a sort of big bang. Just like that brought by the digital age. Only this time the change has been sudden.

That is why "natives" and "immigrants" are so different.

Let us see how, starting with immigrants. That is, with us...

1.11 Digital immigrants

Digital immigrants have come to new technologies as adults. They have learned to use them as you learn a second language. You may learn it very well, but using the traditional approach. And preserving the "accent" of one's mother tongue.

What does this mean in practice? For example...

- printing documents to keep them read them again later
- preferring CDs to playlists listened to on the Internet
- preferring a registered letter to certified e-mail
- approaching problems with a linear logic

The latter aspect deserves further study, because it derives from the way we have learned to learn from lessons, books, films. They all have a linear structure: a beginning, a middle and an end.

The same goes for digital processes: we try to understand "before" acting, we use deduction, we study computer manuals before turning the machine on. In short, we apply pre-existing mental patterns to innovations.

Even when we are dealing with routine processes...

1.12 Digital natives

Digital natives have known only a world of networked computers. Digital is their mother tongue, and they use it as easily as the Huns rode on horseback.

For example:

- they normally access multiple information flows at the same time (music, video, reading)
- they follow a hypertext rather than linear logic, jumping quickly from one point to another
- they turn on the computer and play with it to understand how it works, without opening the manual
- they prefer graphics to text
- when they have a problem to solve, instead of going from the general to the particular, they proceed by guesswork: trying, verifying, correcting

From the viewpoint of a digital "immigrant", the skills possessed by a "native" are stunning. But we are like Socrates and Plato regarding the written word: we have the feeling that something important has been lost...

1.13 What we are losing: patience and reflection

But what have the digital natives really lost. Three aspects in particular are of concern to teachers:

- The lack of ability in putting off the satisfaction of needs.
At school these needs are cognitive in nature: need to know, consequences, the details of something.
Curiosities that need to be satisfied immediately, via a quick Google search on a mobile phone. But if the answer is not so easy, the searcher surrenders easily. Sometimes unconditionally.
- A lack of ability to reflect.
Reflecting means taking time out to order information in one's head, look for meaning, generalise and draw up mental patterns. It means, therefore, learning from experience.
All of this takes time. But time is just what is lacking in the incessant flow of new information that can only be summarily elaborated.

Then there is the problem of concentration...

1.14 What we are losing: concentration

Many educators consider the inability to concentrate for more than a very brief period of time to be particularly alarming.

The question is controversial however.

The ability to concentrate remains extremely high when activities are fully engaging, for instance when playing some videogames, which often require absolute concentration, or performing interactive online activities that can last for hours.

The concentration of digital natives is considered to be a precious asset, which they choose to use for what they really care about.

On the whole, what we see as an "educational catastrophe" is perhaps "just" a revolution. A cultural revolution that is to be faced by changing one's point of view. Instead of feeling that we are obliged to defend a besieged fort at all costs, we should begin to ask ourselves some questions.

Because there are at least four points on which to reflect.

1.15 Losing something is not so important

Faced with a change as big as the digital big bang, it is natural to weigh up the gains and losses and see what comes out of the balance. Which is just what we are doing now.

Before moving on to gains, we must be aware of an important cognitive distortion, because gains and losses are never perceived in the same way. The first point to reflect on is the "endowment effect", according to which the mourning felt for what we once had but have lost weighs much more heavily than the pleasure felt for the possible new gains. On average, twice as much!

Nobel Prize winner Richard H. Thaler demonstrated this with some famous experiments in economic psychology, whose research revolutionised the way human behaviour is viewed in relation to the economy.

Being aware of this helps us not to overestimate the supposed golden age, and to look more objectively at the cognitive world of digital natives.

1.16 What we have gained

The second point to reflect on is the answer to the question: "What extra does the mind of digital natives have more than ours, the immigrants?"

Prensky suggests a number of factors:

- Greater reaction speed, including responses to unexpected stimuli
- The development of a new capacity for "parallel thinking", which in turn has led to some important changes:

- Concentration on a single task, or a stimulus to multitasking, i.e. the development of strategies to focus on several things at the same time. And, of course, to do several things at once
- From the linear representation of knowledge, typical of the book instrument, to a visual-spatial representation, typical of hypertext and mental maps
- From sequential access to "random" access to information
- The greater weight of audiovisual information compared with purely text-based information
- The greater relevance of inductive thinking

In addition to this are some particular social skills that arise from social networks and the systematic use of Skype or WhatsApp instant messaging.

Furthermore, the world of digital natives is in constant structural flux. A change that is not surprising, but expected. No digital native would think a frequent thought of the twentieth century: "there is nothing left to invent".

But there is a skill that natives possess only apparently. They use technology, they are not afraid of it, but they do not always master it. "They can play around with it", but not necessarily understand.

Although, in some ways, they are "smarter" than us...

1.17 Who is smarter

The third reflection relates to intelligence. There are many ways to define intelligence: one is "the ability to solve problems".

This is an important point of view, because it sees in intelligence a characteristic that is not just of man, but of the "man + technology" combination.

Our ancestors who knew how to use the stylus and wax tablets tended to perform better than those who could only speak.

Similarly, when we equip ourselves with a latest-generation smartphone, we are suddenly able to instantly communicate with anyone, have all the information in the world at our fingertips, produce, process and archive multimedia information and make our way perfectly around an unknown city.

But only if we know how to do what the Huns did: to successfully integrate technology in a material culture.

1.18 Precognitions of the future

The final point of reflection has to do with needs and with imagination.

What we can now do with digital technologies was something we had fantasised about and wanted even before we saw a PC.

Here are three examples.

- We are used to calling the virtual space created by the Internet and populated by data, applications and social relations "cyberspace". A space full of opportunities, but also dangers.
The idea of cyberspace came from 1980s literature. We owe it to William Gibson, the father of cyberpunk science fiction, even though he had no familiarity with the technology.
- In the 1960s Professor Clyde Crashcup was one of the protagonists of the cartoon *Alvin Show*, making bizarre inventions by drawing them. Inventions that magically became solid objects, anticipating 3D printers by half a century.
- The best application of the 18th century ideal of "encyclopedia", bringing together all human knowledge in a single object, is the infallible "Junior Woodchuck's Guidebook", in which Huey, Dewey, and Louie would always find everything. Which is what the Web now is.

Now that fantasies have become reality, we can realise in the digital world the dreams we once had

This means that there is no real separation between digital immigrants and digital natives. There are bridges between the two, which we can and must build.

Starting with school...

1.19 School: bad news from the digital world

It seemed like a good idea: if the world is going digital, let's get digital into schools. Let us put interactive multimedia blackboards in every classroom, create computer labs, make intensive use of computers... In this way digital natives will find the tools they are used to in the classroom, and things will only get better.

And yet... an OECD report, linking the use of technologies in schools to the results of PISA tests on student skills, showed that there has been no improvement in students' linguistic, mathematical and scientific skills. And that digital technologies are of no great help to remedial students.

This does not mean we should go back. The real problem is that adding new tools while leaving the school as it is (and has always been) may not be enough.

1.20 School: how we can change

How can we change school to really help students to learn better, grasping the positive aspects of the digital big bang?

Here we can identify at least two ways ahead, directly involving teachers and educators:

- The first is to adopt new tools within new methods, which however should continue to refer to sound, scientifically-grounded ideas on learning, communication and thinking
- The second, again suggested by Prensky, is to learn to talk in the mother tongue of digital natives, without forgetting one's own language