Technological innovations in government auditing

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In addition to being an Information Technology professional, Cezar Taurion is an avid scholar in this area since the late 1970s, having produced nine books on the most varied branches of IT, such as open-source, grid computing, embedded software, innovation, cloud computing, big data and digital processing. His academic training includes knowledge in Economy, Computer Science and the Marketing of Services. He was a professor of the MBA in Strategic IT Management at FGV/ RJ and of Internet Entrepreneurship at NCE/ UFRJ. In recent years, he has actively participated in the development and application of new technologies, both in Brazil and abroad, which allows him to follow real cases with the most diverse characteristics and complexities.

While performing these activities, Taurion seeks to understand and evaluate the impacts of technological innovations on organizations and their business processes. In his opinion, thinking outside the box is insufficient because "the box still restrains us to a source of reference, limiting innovative thinking." In this interview with the TCU Journal, the IT expert tackles topics such as digital transformation, exponential technologies, Artificial Intelligence (AI) and the impact of all this on society, business and on the activities of the Federal Court of Accounts of Brazil.

It is the Federal Court of Accounts´ responsibility to verify if government institutions are using public resources effectively and efficiently. How can technological innovations help TCU fulfil this mission and "do more with less"?

Technological evolution advances at an exponential pace, surprising those who are most unsuspecting. The computing capacity of a $10 million supercomputer in 1985 is now embedded in a smartphone. The Internet is becoming more and more popular. A quick look at the recent past shows how impressive the pace of change has been. In 1995, a mere 21 years ago, there were 35 million Internet surfers worldwide. Today we amount to almost three billion, about 40% of the world's population. 80 million used cell phones - today three out of four people in the world have one, or more than 5.2 billion people. We should not think of the digital revolution as a simple automation of current processes. We are in a whole new game. Work, business models, organizational structures, products and services will be transformed effectively through digital technologies. Today, technologies make it much easier and cheaper than 10 years ago to cross-reference

data from a variety of sources, ranging from conventional databases to social networks, where we all leave our fingerprints. Citizens are more empowered and, with their smartphones, are connected to thousands of others through social networks, sharing their viewpoints, opinions and comments. Thus, in addition to technologies cheaper and more available technologies, oversight activities can rely on the collaboration of society itself.

Which technologies would you rate as most important for External Control? Why?

Some technologies like the Internet and smartphones allow for quick and easy access at any time. All governing bodies can and should be connected, continuously sending information. Why wait weeks and months to analyze data if such data can be analyzed continuously? The actions will have a much more immediate effect. Analyses can be much more effective if we use algorithms and artificial intelligence. Algorithms are already everywhere, from recommending books and movies to fraud detection by credit card operators. We are immersed in an ocean of data and little use is made of them. Estimates indicate that in 2020 we will be generating 73.5 zettabytes of data throughout the globe or 73 followed by 21 zeros! Results from algorithm applications show that good results can be achieved in almost any situation. For example, an American Psychological Association study analyzing 17 case studies on hiring practices by large firms showed that algorithms beat best practices (usually based on intuition) by 25% when considering the success of the hiring; in other words, hiring a new employee at the company. With the use of predictive algorithms, we can not only content ourselves with describing and analyzing past facts, but also making predictions for the behavior of a public agency based on the patterns observed so far.

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In your opinion, what is the biggest obstacle when introducing technological innovations at the workplace? Cultural barriers or financial constraints? Why?

Of course, there are financial constraints. However, the cost of technology has been dropping and will continue to fall dramatically. Nowadays, you can buy for about a hundred reais one-terabyte (one trillion bytes) storage devices that cost hundreds of thousands of dollars a little over ten years can now be bought for about a hundred reais. The great barrier is the cultural one. Thinking in a linear way, when evolution is exponential, leads us to the terrible trap of underestimating the impact of transformations. An example of how exponential change is underestimated was the Human Genome Project. It was launched in 1990 and estimated to be completed in 15 years at the cost of $6 billion. By 1997, or half the timeframe, only 1% of the human genome had been sequenced. Through the linear planning that we adopted, assuming 1% in 7 years, it would take us 700 years to complete the sequencing. Sounds logical, right? The pressure to end the project was immense, but when the futurist Ray Kurzweil was asked, he said "1% means halfway. Go ahead!" He thought exponentially. One percent doubling every year means reaching 100% in 7 years. The project was completed in 2001, four years ahead of schedule and costing much less than what was estimated. Linear, traditional thinking has missed the mark for 696 years! Often thinking outside the box is insufficient because the box still attaches us to a reference source, limiting innovative thinking.

The involvement of a citizen in the analyses and decisions taken by the government seems to be an approach that has come to stay. Nowadays, this participation is considered an essential element in a democracy. What technological tools do you think are most effective in promoting a dialogue between public institutions and society?

Social networks are already a part of everyday life for much of society, and this number is trending upwards. If we take a closer look at this phenomenon, we find that the Internet and social networks can be seen as decentralising cognitive technologies through which more and more people can express their ideas and opinions very quickly away from the control of the centra-

lising mechanisms. Let us compare an event broadcast live on a unidirectional TV with a social network. On TV, we are obligated to see the images and listen to the voice that the broadcaster emits, while on the networks, everyone who is present at the event films from a certain angle and emits their own perceptions of the fact, sharing with thousands of others in real time. It creates a less vertical and much more open power topology. Centralized control of the distribution channels of ideas no longer exists, and horizontal exchanges have replaced the vertical and centralized model.

In recent years, oversight activities have migrated from a *lack of information to an abundance of data*. What is the most viable way for an institution - whose main activity depends on the analysis of information - to identify the best data and decide how to use and/or interpret it?

The immense availability of data causes changes in the way we think about data. When we move from thinking based on scarcity to an abundance of data, we must think differently. Because of the difficulty and technological limitation that existed, we ended up building a mental model of data scarcity. Thus, we refine a series of practices, such as statistical analysis by sampling. From a small sample of data, we extrapolate to a broader scenario. With time, we refined the models and they are pretty reliable today. There are, however, some gaps. Accuracy depends greatly on sampling. For example, an opinion poll based on a random sample of landline users has a bias: if the collection was done during work hours, whoever is going to answer the phone does not necessarily represent the opinion of the people who work outside their home. They may have a very different point of view from those that can answer their home telephone during the day. In addition, if we want a more detailed research, a small sample universe, as we do today, will not be statistically representative.

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What would be a good example of this?

Surveys on voting intentions. They usually take about two thousand people and a general picture is presented. However, if we want to detail to the point where we want to know the intention of young people between the ages of 18 and 25 from the state of Paraíba, the sampling will be insufficient. We are stuck with the initial questions and we cannot get out of them. This thought is different with large volumes. When the variable becomes "N = all" we can make unimaginable granulations on the scarcity model. We can identify trends and detect correlations never thought of before. We can ask new questions and go down to new levels of segmentation. We go to a more opportune mindset; that is, we take advantage of opportunities to ask questions not thought of before analyzing the data. Another interesting feature that affects our way of looking at data is that large volumes do not demand extra precision from each piece of data. In fact, we already do that today. Think of a large number, such as the GDP of a country. We do not detail the cents; we restrict ourselves to the large numbers and the trends they point out.

What is needed in order to get concrete data when faced with an abundance of information?

We have to follow a few steps. First, having a high-level sponsor in the organization is essential. It cannot be an action limited to a certain area or restricted to the IT sector. Afterwards, to define clearly the business objectives and which problems the initiatives for massive data analysis will solve. One key factor: the team. It will be tough for us to get people who meet the hackers + deep statistical and mathematical knowledge + good business knowledge equation. One suggestion is to set up a multidisciplinary team and operationalize the processes involving data analysis projects. Of course the team must have a good manager, one who can understand the different languages spoken by professionals that are quite different from each other and who is passionate about the concept of analyzing data. A bureaucrat manager will not be able to unravel the inevitable problems of inter and intra-team communication. Moreover, setting up a team with only hackers, for example, could generate a sensational predictive algorithm, but of little value to the organization. After all, the goal is not to generate

fantastic analytical models, but to solve business problems like oversight effectiveness and efficiency. Finally, there is governance. Due to the characteristics of dealing with very large and varied volumes with unstructured data (antithesis of the structured and relational model we are accustomed to), the tendency is to not document or create governance processes. Thereby, there is the risk of constantly reinventing the wheel.

IT tools are very efficient in collecting and sorting data, but do you believe they can be trusted when dealing with interpretation?

It really depends on the efficiency of the algorithm. However, the evolution is very rapid. In 2009, when Google was talking about self-driving cars, it was a futuristic curiosity. Today it is almost a reality. These days, Facebook recognition and imaging systems are more efficient than a human being at recognising faces in photographs is. Therefore, we have to think exponentially. That means that if a digital technology is not as effective today, maybe it will be ten or twenty times better in two to three years.

Artificial Intelligence (AI) and Advanced Machine Learning are among the so-called Strategic Technology Trends, as they allow the creation of systems capable of understanding, learning and predicting events that can improve decision making. In your opinion, what are the challenges and benefits of using these technologies for a Court of Accounts?

The revolution led by AI is so fast that we have trouble figuring out how it will turn out. Science fiction imaginary still prevails. I remember one phrase from one of the

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movies that I had at home, "2001: A Space Odyssey," where the computer intruded in the life of the astronauts aboard the vessel: "Just what do you think you're doing, Dave?" Since then, we have seen robot movies like "Terminator", I, Robot, Her and Jarvis, Tony Spark's personal assistant in Iron Man. By the way, Jarvis means 'Just Another Rather Very Intelligent System'. Science fiction might very well be defined as cinematic anticipation. Much of what we see in Jarvis is already in our daily lives in some way.

Jeff Hawkins, Founder of Numenta (and the inventor of the Palm Pilot), says that AI is at a point today similar to where computing was in the early 1950s, when pioneers established the basic ideas of computers. Less than 20 years later, computers made airline reservation systems and bank ATMs possible and helped NASA put a man on the moon, results that no one could have predicted in the 1950s. Guessing the impact of AI and robots in a decade or two is becoming even more difficult." In 20 years, this technology will be one of the main drivers of innovation and technology, if not the primary one," Hawkins says. One cannot be deny that AI will affect society and employment, as we know it. At its inception, automation affected production lines in factories. Now, the risk of unemployment affects functions that were previously reserved for humans. For example, a truck driver. It is one of the most common jobs in the world. There are 3.5 million of them in the United States, and we have more than one million registered to transport cargo here in Brazil. The Dutch government has already conducted a successful test of unmanned trucks crossing Europe. Uber recently paid US$ 680 million to buy Otto, a start-up that develops technology for self-driving trucks founded by Google's AI specialists. The consultancy McKinsey predicted that, within eight years, a third of all trucks on the road will be self-driven, running without drivers. In perhaps 15 years, the truck driver, like the elevator operator, will be an anachronism. Uber invested in Otto not only to operate trucks, but because it wants to operate self-driving car fleets. In September, it began tests on this fleet in Pittsburgh. Canada's postal service wants to send drones, instead of vans, to deliver rural mail.

At the TCU, it seems clear to me that the role of AI will be that of an extremely effective aid in account analysis, analyzing broadly and quickly millions of documents, making comparisons and identifying correlations that we cannot always do as humans. We do not have the ability to handle large volumes of data very quickly. Thus, our decisions are often influenced by personal experiences.

Government institutions are increasingly dependent on systems, technology, and data. With this in mind, the security of information and cyber security play an extreme-

ly important role. In your opinion, what are the main challenges and barriers to making systems and information more secure?

This is one of the biggest challenges. We have two points to validate. One is the guarantee of data security. Another is ensuring privacy. This is a subject that is quite fluid. We leave a huge digital footprint in our day-to-day life. Social networks like Twitter and Facebook are gigantic repositories of opinions and comments. For example, there will be more words written on Twitter in the next two years than those contained in all the books that have already been printed. Facebook, with its more than 1.4 billion users (936 million log on to it every day), is today the largest network in the history of humankind. Looking at this huge amount of users and considering that approximately a quarter of the world is less than 14 years old, this means that about 25% of adults on the planet have a Facebook account. Another inexhaustible source of information about who we are is the famous Google homepage, containing just a single field for data entry. It is a repository for the collective id of humanity. It listens to our confessions, concerns and secrets. We type in what we want into that rectangle, without censorship. Since they are searches that people can do without censorship, they express feelings of hatred and prejudice in them, which are usually camouflaged by social behavior in public. This is the social scientist's problem: what they most want to know is precisely what their objects of study try most to hide. The simple act of asking something uncomfortable creates self-censorship. In the searches, you get information that

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is practically impossible to obtain through traditional searches. Google Trends can generate excellent samples of the private mind, what people really want to know and do not always share with others. They search alone. Only Google knows ... Several projects already show how much can be known with Google Trends, such as stock market forecasting, what drives economic productivity, influenza and dengue epidemics, incidence of racism and entrenched prejudices. As we are discussing something very recent, there is still a long road of learning ahead. The Internet is very young as the predominant human registry and Facebook itself has only gained this share over the past six years. Information on human behavior is still being built, and maybe ten or twenty years from now we might be able to respond more precisely to questions such as how we relate, how new ideas infiltrate and spread through society, how Facebook's timeline will express a person's life (today it receives an average of 0.6 Mb of new data per user per day), how Tweets will show society's reaction to certain events and how Google's rectangle will express the corners of our minds.

Nowadays, innovation is a critical success factor for organisations, including the government. The adoption of new methodologies and technologies is often an essential requirement for innovation. In this view, what methods and techniques, in their assessment, would have the potential to promote innovative control practices?

The impact of digital transformation should be much greater than the concept of e-commerce some 15 years ago. Most of the transactions of whole sectors of industries with their customers today are already done via the Internet, such as banks, commerce and airlines. Buying online is routine. New business models emerge, like AirBnB, and put consolidated sectors in check such as the hotel industry. In many countries, new lending models like those provided by LendingTree (United States) and Kiva, are changing the relationship between society and traditional lending providers: financial institutions. In Germany, Friendsurance is a rupture in the traditional model of the insurance industry.

It is clear that society is already used to using the Web and smartphone apps for their day-to-day activities, whether to take a taxi, buy a product, check-in a flight or transfer money between checking accounts. Cosmetics is an interesting example. Five years ago, Brazilians did not purchase using

the Web. In 2014, they spent 1.3 billion reais. This is still only 1.5% of sales in this market, compared to 6% in the US. Imagine the potential for growth. Again, the one who started it was a business outside the traditional companies from the industry, BelezanaWeb. Using apps like WhatsApp has changed the way people interact. Families exchange more messages between them than speak by phone. Practically all of us share, even compulsively, our ideas, opinions and just about everything we do on social media platforms like Facebook and Instagram. Society is becoming more technological and the consumerization process of IT is a movement that puts pressure on companies to provide the same technologies that their customers already use. They adopt them first!

Organizations have to adjust to the speed of digital transformation. Transforming an organization depends on a change in the mindset of upper management. Managers need to understand the urgency for change in order to provoke it. With this support, a new mentality that encourages change leads to the hiring of talents that do not exist today. Digital transformation requires an organization to move out of its comfort zone. The speed of change no longer allows for long-term planning based only on incremental developments, such as expanding a market or launching similar new products. The unexpected appears at every turn. The business scenario becomes increasingly volatile, ambiguous, uncertain and complex. Big banks only moved quickly towards the digital bank because they were provoked by the Fintechs. The speed of change was not their choice, but

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a necessary reaction. To visualise and build the future, we have to be optimistic and realistic at the same time. It is not easy, but we have to build it so we will not be run over by it.

Knowledge Management (KM) is still a major challenge for organisations like the TCU, whose main raw material to carry out their activities is information and knowledge. Which approach do you believe will have the greatest impact on KM strategies in the coming years and why?

Knowledge management has a lot to do with the use of algorithms and AI. For comparison sake, let us take a traditional profession, law. One provocation we can make is: “will there still be lawyers in the future?” The rate of success in futuristic predictions is the same as for chimpanzees playing darts and hitting the target, but we can debate some ideas and draw conclusions for ourselves. That is, as long as we do not cling to beliefs and paradigms that limit our critical eye. Let us look at the context. The work practices of lawyers have not changed much in the last few decades. In general, lawyers offer high-cost, personalized advice, and partners in prestigious firms preside over pyramid-shaped organisations receiving high commissions, while battalions of incoming lawyers do the hard work of searching precedents and drawing up contracts. The high costs of these firms and their fees provide a scenario that is open to disruption. There are already some very interesting initiatives that, although still disdained by traditional lawyers, can provoke an Uber effect in the next few years.

Some U.S. law firms already use AI as a “digital associate”, delegating predictive algorithms to the task of performing intelligent searches for documents, opinions, and case law related to the cases under review. Interestingly, an analysis carried out in Europe and the U.S. of the use of AI in law shows that, with rare exceptions, it is not traditional law firms who invest in the concept but new entrants. We can see that the Uber, Airbnb, Skype and WhatsApp moment repeats itself. Established businesses tend to be conservative and strive to preserve their business model. We are finally facing significant changes in society, and virtually no function or business sector will be safe from the transformations. The turbulent scenario, like the context we see today involving Uber and taxi drivers, is bound to happen when law firms feel real threats to their current model. However, some will understand that the process is irreversible and the winners will be the ones who can make the right mix between lawyers and technology. We can say the same about TCU. Aggregate knowledge becomes quite useful when it is handled with agility by AI engines, supporting the work of the ministers.