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IMF REPORT

The Future Belongs to Cities: The Essential Role of Technology

A report based on a presentation by Dr. Jonathan Reichental
Chief Information Officer, City of Palo Alto, California



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Executive Summary

Over the past century, the world has become more and more urbanized, with an almost endless migration from rural living to city living. Different parts of the world have experienced this migration at different paces, with the developed world seeing the most massive shift, and the developing world poised to begin their journey along this same route. This increase in urbanization presents a large number of challenges in the present and even more challenges as we move into the future. Climate change, waste management, energy production, transportation and infrastructure, limited resources – the list of problems facing us as a species is large. Current increases in urbanization have brought many of these problems to the forefront in cities around the world. Continued urbanization and population growth could very well push some cities to the brink of collapse. But this CAN be averted. A fusion of technology and tech experts, innovation, private and public investment, engagement, political will, and intelligent planning can move us forward, not only by solving these problems, but by helping all of us to live healthier, more productive, happier, and ultimately better lives in the cities of tomorrow.



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Presenting:

Dr. Jonathan Reichental

Chief Information Officer, City of Palo Alto, California

Dr. Jonathan Reichental is often called a visionary technology leader. For over 20 years he has been helping organizations leverage the value of information and communications technology to solve business problems, increase effectiveness, and support revenue growth opportunities. His current focus includes IT strategy and innovation, and he delivers specific expertise in emerging technology, Web 2.0, social computing, consumerization, and the impact of macro trends such as demography on organizational success.

Dr. Reichental presents often on a range of subjects. He has recently addressed audiences at Harvard Business School, Information Management Forum, and the Conference Board Council of CIO Executives. He is interviewed often and has been featured on NPR, CIO magazine, InformationWeek and Computerworld. His TV appearances include a recent segment on CNBC.

He is currently the Chief Information Officer (CIO) for the City of Palo Alto, CA. When not consumed with work or research he enjoys being a private pilot and scuba diver. In addition, he is an avid tennis and chess player, photographer, and plays piano and guitar.

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The Future Belongs to Cities: The Essential Role of Technology

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Introduction

The rise of cities as the predominant centers of population in the United States and other developed nations foreshadows a trend that will continue in the near future – namely, that developing countries will become increasingly urbanized. This presents a number of challenges for individual cities, countries, and humanity as a whole. While not traditionally the purview of information technology specialists, technology holds many of the keys to turning these challenges into opportunities for innovative and effective solutions. Therefore, the cities of the future are going to need well-trained, creative problem-solvers from the technology sector to provide the expertise and ideas necessary to allow humanity to continue to flourish.

City and Population Trends

The clear pattern of activity over the last century has demonstrated that people in developed countries tend to group together in cities, and existing cities tend to increase inside, while rural populations dwindle. This took place in Europe and America, from the Industrial Revolution onwards. According to statistics from the US Census Bureau, in 1900, 40% of the American population lived in urban areas, while

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60% lived in rural areas. By 2010, the numbers had more than reversed, with 80.7% urban and 19.2% rural. This mirrors the patterns found in Europe and other developed countries.

In fact, global population data suggests that during any given week of the year, around 3 million people globally migrate from the “rural” column to the “urban” column of these statistics. Globally, around 50% of the population is currently considered urban (around 3.7 billion). At the current rate of change, that 3.7 billion will grow by around 0.15 billion per year. In less than 3 decades, this will likely mean the overall statistics will look something like current US statistics, with about an 80% urbanization rate and 20% rural rate. Coupled with natural population growth, which sees the world adding, on average, around 1 billion people per generation (approximately 20 years), this works out to something like 9 billion people by 2050, with 7.2 billion living in cities and only 1.8 billion in rural areas. Put another way, this will see almost as many people living in cities by 2050 as exist on the planet entirely today.

This presents many problems for humanity. In general, cities aren't the best right now in dealing with the basic service needs of their inhabitants. They don't function well, on an overall scale, in addressing the transportation, environmental, energy, waste management, and infrastructure needs of their citizens. Some certainly are standouts, but the majority of cities worldwide do not offer a sustainable model for growth. Without some serious shifts in urban planning, investment, and technology implementation, the problems of today's cities will become more and more insurmountable in the future. The time to start thinking ahead and acting for a better future is today.

And this is not limited to "major" cities – it impacts all urban areas, which are all likely to grow in the future. Statistically speaking, this means that most everyone reading this will be affected – it is not a problem we can afford to ignore, as individuals or as a society.

Challenges – Climate Change

Despite political posturing, the data on climate change is fairly conclusive. Cities both contribute to climate change, and can be radically affected by it. Unsurprisingly, with the migration of more and more people into urban/city settings, it's going to be cities that need to be the foundation for environmental change to combat the effects of climate change.

In the IT field, we like statistics, data, and metrics. Temperature data from the past 100 years indicate a progressive increase in warming. This especially accelerated in the last 20 or 30 years of the 1900s, and into the first 18 years of this century. The last 3 years have been the 3 hottest years on record (dating back to 1880), and 9 of the 10 hottest on record have been

since 2000 (with the other being 1998 – all in the modern era). The total degree of change has been rapid, with an average deviation from normal amounting to nearly 1-degree C just since 1980. While this may not sound like much, it really is quite a big deal. The Paris Climate Accords goal is to keep global change to a maximum of 2 degrees C above pre-industrial baseline levels. As we're already around 1.1 degrees C over those baselines, we're flirting dangerously close with crossing that max.

Beyond 2 degrees, things start to really deteriorate. 3 degrees of increase and things become disastrous. Extreme weather events increase, both cold-weather driven and hot-weather driven. Increased frequency and intensity of natural disasters become much more likely. Plant and animal life begin to die off, which spells eventual doom for human habitation of the planet. Climate change is, without a doubt, the most pressing challenge facing our cities and our populations as a whole. The last 10 years alone have seen an increase in average temperature of 0.4 degrees C. At that rate, we could exceed the Paris maximum goal of 2 degrees by 2040, and the 3-degree mark by sometime in the mid-2050s – well within the lifetimes of the majority of the world's population today.

This is important, not just because of the potential negative effects on population globally, and specific effects on cities – especially those in vulnerable coastline areas – but because cities can help lead the way to fighting climate change. A shift in how we manage resources and



zoning, the way we invest our public and private sector funds, and the infrastructure, transportation, energy, and industry of the future can all be shaped by cities and helped in the right direction by technology.

Unfortunately, at present, cities are one of the largest contributors to the climate crisis. Between transportation, factories, and even agriculture in outlying areas, the amount of greenhouse gas generated is significant. This has largely gone unchecked with the growth of cities – though some have done well with public transit, for instance, there’s still a massive amount of car and truck emissions contributing to climate change.

Another factor contributing to global warming is agriculture. There’s a growing need to move away from meat as a primary source of protein in our diets. In Northern California, for instance, around 70% of greenhouse gases are produced by transportation, and the balance is mostly from meat production. Aside from the growing body of scientific evidence that most forms of red meat, in particular, are very bad for human health, raising animals and grazing

land, in general, are poor uses for land and create a lot of greenhouse gas. As standards of living rise in developed countries, more and more meat is consumed, leading to an increasing level of meat production. It is a vicious cycle. And no one wants to radically change their eating habits, either. So, it’s easier to target the other 70%, the transportation side of things as a place to start. We’ll highlight transportation solutions later in this document, but let’s look at it in more detail first as a challenge to be solved.

Challenges - Transportation

One of the most visible examples of how cities and urban areas are not functioning well can be found in the transportation sector. Daily commutes, traffic jams, and single accidents leading to a cascade effect of highways turning into parking lots are becoming more and more common. It’s simple, really – the number of vehicles in many cities and urban areas has far out-paced the transportation infrastructure’s

capacity. In computer terms, it would be like trying to load a modern webpage on an old 56k modem dial-up line – it would take quite a long time, an unacceptably long time. And this is exactly what happens with transportation. In many major areas, commutes or trips of 10-15 miles can easily take an hour due to traffic. And all that time, vehicle engines are running and outputting harmful emissions.

This is also a major problem well apart from climate change alone. All that time in traffic is lost productivity or leisure time for people. Worse traffic means slower deliveries of products and services, and a slower response for police, fire, and emergency medical personnel. It adds up to a higher material cost in goods and services, and can even have a cost in lives lost due to delays in emergency response. Not to mention it's a major nuisance factor for many people. It drives down property values, it decreases leisure spending on dining, shopping, and other experiences – these are documented effects of poor or congested transportation infrastructure.

Transportation challenges, however, can be solved. There is a wide range of ideas that have been successfully implemented in some cities, and many more on the horizon – the majority of which are backed by and driven by technology.

Challenges – Waste Management

Waste management infrastructure is another important challenge to deal with from increasing urbanization. Sewage, solid waste/garbage, and recycling are important considerations. Without adequate systems and infrastructure in place, trash can pile up, sewage can contaminate aquifers and water systems, and in general, developed cities can turn into third-world cities, at least from the standpoint of utilities, in short order.

Recent history has seen some progress on these kinds of problems in major cities like New York and Los Angeles. However, a lot of the solutions have involved trucking large portions of waste to processing locations or dumps outside the city – it doesn't resolve the production and utilization of waste, and certainly not in an environmentally-friendly way. Nevertheless, great strides have been made in many cities to better manage waste, encourage recycling, and build adequate sewage infrastructure. Additional technologies and initiatives can be brought to bear to improve on these efforts and expand to under-served cities, regions, or countries, that may have more significant sanitation challenges at present.

Challenges – Energy

One of the other key challenges that cities (and humanity as a whole) face is growing energy needs. Increased urbanization and increased population necessitate increased electric generating capacity and distribution capacity. This is especially true in the developing world. Unfortunately, most of our current energy production methods are extremely dirty environmentally, with coal, natural gas, oil, and other fossil-fuel-fired plants producing massive quantities of greenhouse gasses. It's also not a sustainable model, as scarce fossil fuel resources will continue to become scarcer over time, driving up prices among other effects.

Even nuclear power is not a solution. While it solves most greenhouse gas emission issues, the nuclear waste continues to be an unsolved problem (not necessarily due to technology, but more political will). Not to mention, despite the overall high-quality safety record in the first world, the public perception of nuclear

energy has, in general, contributed to its decline in adoption.

The need for sustainable power and a dynamic, responsive power grid are already starting to be addressed in many parts of the developed world. Solar, wind, hydro, geothermal, and other power generation options can outperform our current, and future energy needs several times over. At the same time, smart grid technology can help better manage electricity usage and distribution, within cities, from city to city, beyond state and country lines, and even internationally. As usual, technology, manufacturing, and innovation are going to be key to deploying environmentally-friendly, sustainable power solutions for the cities of the future.

Challenges- Asynchronous Progress

The pace of change between countries is, naturally, not equal. Developing countries are dealing with problems that the US and Europe may have first been confronted with decades ago. At the same time, some problems that have fes-

tered in more developed countries may be the focus of planning and innovation efforts in developing countries, to avoid the pitfalls and trials that first-world nations have gone through. This asynchronous, often non-parallel progress presents challenges in and of itself.

The good news is that as more countries become developed, poverty and famine levels continue to decrease on a global scale. 50 years ago, 30% of the world was in poverty, subsisting on less than \$1 a day. Today, that number is around 8% of the total population and continues to decline. Technology, from genetic engineered-crops to smarter and better-planned public services, has been a key driver behind this improvement.

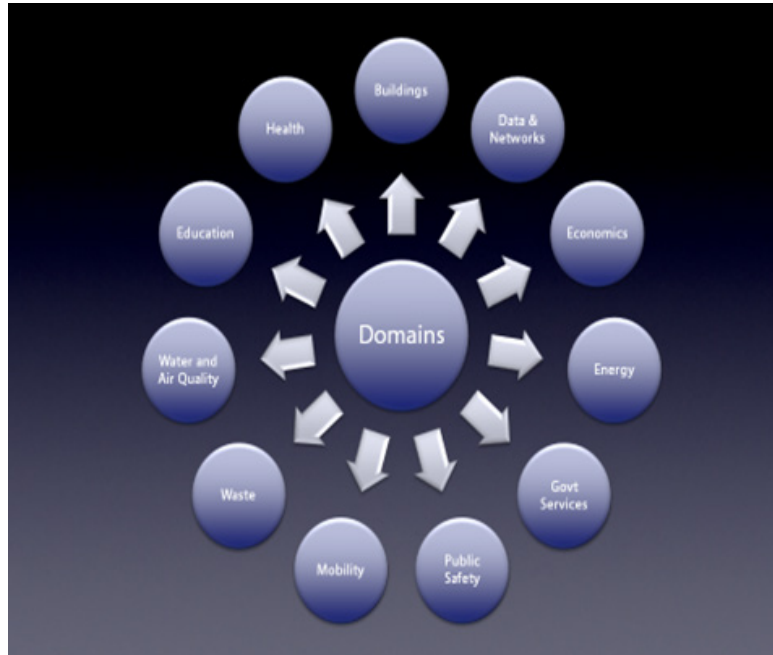
At the same time, a lot of barriers remain between the developing and developed world. Careful planning and open dialogue and exchange of ideas and technologies can help solve some of this discrepancy. For example, around



half of the world's population does not have reliable internet access. Imagine the potential for human achievement when the sum total of human knowledge becomes available to 100% of the population on the planet. There are still many places in otherwise modern developing countries where electricity and running water are unreliable or sporadically available.

This also presents opportunities, however. Countries at certain stages of development, given access to modern technologies in energy production, telecommunications, industrial manufacturing, and similar, may be able to skip over certain developmental steps and build their infrastructure for a safe, environmentally-friendly future. Think of the US and Europe post-World War II. If we suddenly had access to solar power, the internet, satellite telecommunications, modern public transportation, recycling, etc. – and understood the impact of human activities on our living situation, water, air, and the planet as a whole – just imagine where we might be today! This could be a reality for a lot of countries that are just reaching that same level of development – helping bring equality in opportunity, development level, and technology to all humankind, while avoiding some of the environmental pitfalls that would otherwise arise from the natural iterative cycle of technological development – like skipping 1950-present in terms of greenhouse gas output.

There is less inertial resistance to change from, say, fossil fuels to green energy technologies - if you're at a crossroads and have to make a choice as to which to pursue, versus when you have an established fossil fuel infrastructure already in place.



Therefore, overcoming asynchronous progress may be less of a challenge, and more a great opportunity to bring equal access to technology and modern life to all people around the world, and do it in such a way that it helps, not hurts, the planning of cities and environmental conditions for the next generations of global citizens.

Cities are a Positive, but Their Challenges need Solutions

These are, of course, not the only challenges to preparing cities for the future. Local, state and federal governments have to deal with a whole host of different domains, across the spectrum of services they offer citizens. Most of these domains, are interrelated, including all the aforementioned topics like transportation, energy, waste management, etc., and also public services, utilities, safety, data, education, health, and more.

Despite this wide range of challenges, cities are still a net positive for humanity. They have enabled great prosperity and many of the advancements we've seen in the past century or more. Many things like economics, education, water, power, and culture we take for granted, but largely originated in or were enhanced by the urbanization of the developed world. The flip side of this progress is the massive environmental toll it has taken and continues to take, on the planet and human health and well-being..

It's clear we aren't going to reverse the trend of people concentrating in urban areas, and it's also clear that this would likely be a negative step for humanity, anyway. But we must find better ways to handle all the challenges in the different domains discussed above, or the increase in urbanization over the next few decades will literally break some cities apart.

Technology can be the key to enabling us to continue living in cities, to have more people living in cities in fact, but to reduce the environmental impacts of this trend. Air quality is just one example. Current factories and power plants output massive amounts of greenhouse gases and other pollutants that contribute to poor air quality. The WHO estimates that 7 million people die each year due to air quality-related causes. This can be addressed, reduced, and prevented, with better, cleaner manufacturing and energy generation technologies.



Another example is solid waste. There is no excuse that we've allowed a garbage patch the size of Texas to develop in the middle of the pacific, largely made up of plastics. Recycling technology exists or is being refined that can allow for virtually no waste in the plastic lifecycle 100% recyclable content. But that's meaningless if we don't fuse the technology with the individual responsibility and political will to ensure it is used.

Role of Government

It should come as no surprise to technology experts that technology can also help with this first crucial step – changing the way people engage with government and politics. As it stands now, the typical person interacts with the government only when required, such as at the DMV, for licenses or permits, to pay taxes, and so forth. It's not something anyone looks forward to or wants to do, and consequently, the image in people's minds is of a very inefficient, old-school bureaucracy that's hard to deal with, slow to change, and kind of obtuse to engage with. Bringing government into the 21st century with technology and customer (public)-focused efforts is a critical first step to accomplishing the kind of wholesale change necessary to meet the challenges of the future.

Something as simple as getting local governments up-to-speed with technology that makes dealing with them on the web or via smart phone far easier can go a long way towards helping people have more positive interactions with government. Likewise, this can help government to more effectively make decisions, allocate resources, and implement the kinds of change that are necessary to move our cities from unsustainable to sustainable. Small, tech-based solutions can reap big dividends. And for those solutions to work - with government or the private sector - skilled tech experts are going to be essential.

What Technology Experts Have to Offer

With the scope of issues now firmly established, the next logical step is to start looking at what we can do about them. Technology experts are, at the most basic level, problem solvers who can understand and fix complex systems. A city is, in many ways, one of the most complex systems there is. This makes solving these problems one of the ultimate challenges for technologists and engineers and the like. Every domain highlighted above needs problem solvers if we're going to thrive as a species. But it's far easier to illustrate the role between technology, technology experts, and these problems (and their solutions) in individual areas.

Transportation and energy are two key areas that we're going to address in the balance of this paper. This is for several reasons – they have some of the biggest impacts on the environment, and therefore improving these areas can reap the largest dividends in the fight to contain climate change. More importantly, these areas are very relatable for the vast majority of people, including technologists - everyone interacts with transport in some way on a daily basis, as well as energy. And

solving these two categories of problems are, essentially, big tech and computer science problems at their heart.

Opportunities and Solutions – Transportation

As mentioned earlier, one of the biggest challenges to increased urbanization is transportation and infrastructure. The transport sector, including consumer vehicles, is responsible for a large portion of greenhouse gas emissions. Over-crowded transport infrastructure leads to lost productivity and leisure time, decreased economic activity, and contributes to an overall lowering of quality of life.

One of the areas that technology will play a large role in changing is the car. The entire infrastructure around cars, their use, and the systems that support them in cities are very likely to undergo a radical shift in the next 2 or 3 decades, based both on urban planning and environmental needs, as well as the technological developments that are already being implemented in designing the cars of tomorrow.

ACES

One of the key concepts around the developments in transportation is defined by the acronym ACES, which we'll explore a bit more in this section.

The "A" in ACES stands for autonomous. Self-driving cars are on the horizon, and there's no question about it. The technology is at a point where this is viable, especially with the kind of wholesale infrastructure change and investment that we need to combat climate

change. Babies born today may very well grow up in a world where they never learn to drive a car - if not them, then those born in the next ten years, certainly. This is a hard concept for many adults today to understand, and many are hesitant to trust this new technology, but this conversion is happening, and very likely will be a fact of life sooner rather than later. Many people may not be convinced until they actually experience self-driving cars for themselves, but it will happen. As much as we like to be in control of our own vehicles, in control of our own lives – basic logic bears out the fact that computers are far more reliable than humans at complex tasks like driving. Future generations may very well look back on the last century of the automobile as truly crazy – much as we now look back on the era of folk medicine, miracle tonics, cocaine-laced cough syrup, etc. as crazy.

For this change to occur, however, technology needs to be coupled with intelligent debate and wise planning of our infrastructure. Arguments abound as to where money should be allocated – repairing existing infrastructure, expanding public transit, allowing natural changes with the rise of companies like Uber and the gig economy to take their course and see how that impacts transportation, and the like. The reality of the situation is it's not a binary choice – you can utilize self-driving vehicles no matter which "bucket" you wish to fund. Self-driving public transport, self-driving individual cars, self-driving ride services – the underlying technology is autonomous, computer-driven vehicles. Couple that with new infrastructure and support systems, clean energy driving the vehicles, and more automation – you get cleaner vehicles, safer vehicles, and a great deal of networked traffic control that allows for speeds and flows that are impossible when humans are behind the wheel.

The "C" in ACES stands for connected. That's

the next key way in which technology will influence the transportation system of the future. Self-driving is cool, but the real benefits in efficiency, speed, and infrastructure come from connectivity. Cars being able to talk to one another, to traffic signals and road "rules," for lack of a better term, as well as sensing obstacles, pedestrians, and similar will make for safer, more efficient transportation. When you remove human reaction time and decision-making, or turn most of it over to a computer system, at any rate, you can enable greater speeds, more vehicles in the same space, greater throughput on existing infrastructure, and similar benefits.

Auto manufacturers today are already moving in this direction. By 2020, it is expected that 80-90% of vehicles being produced will, at a minimum, be connected in some way – able to analyze information about the world around them to make adjustments to its operations, provide suggestions, added safety margins and responses, and more. This is already happening in many newer cars – integrated navigation and feedback, re-routing and detours, intelligent systems diagnostics, auto-application of brakes to prevent collisions, and so much more are already facts of life for new car models, and that's only the start. Again, this can be thought of in parallel to a lot of the technology developments we've seen with the internet of things. 10-15 years ago, people would have thought you mad if you said your home was going to have lights, cameras, climate controls, door locks, and other features that could all be controlled remotely via a smart phone, even from halfway around the world. But that's a reality now, and that connectivity has enabled these otherwise mundane or somewhat limited



improvements in constituent parts to become more – the whole is greater than the sum of its parts. The same holds true with the future of connected vehicles and roadway infrastructure systems.

The “E” in ACES stands for electric. Fully electric cars are going to become the standard in the near future. This will dramatically reduce carbon emissions, and more so if we convert our electrical generation to sustainable methods, though that’s really the focus of the next section. Even as it stands today, electricity produced in a power plant is far, far more efficient (in terms of energy output per unit of fossil fuel burned or pollution output) than in individual car engines. So, yes, if everyone today had an all-electric vehicle, we’d see an uptick in power plant pollution, but a much more significant decrease in auto pollution that would more than outweigh the uptick.

We’re standing at the beginning of the end for the internal combustion engine. Major car manufacturers have already announced that they are phasing out the combustion engine. By mid century, many countries will make it

illegal to sell combustion engines. While sooner is better in terms of the environment, the exact timetables matter less than the migration of our transportation sector to electric vehicles, and the death of the internal combustion engine.

The “S” in ACES stands for shared. As much as many of us like our cars, take pride in them, the model(s) we’ve chosen or been able to afford, and view them as a status symbol, those days, too, are numbered. It may take a few decades still, and adoption is likely to be staggered and uneven, but with reliable, autonomous vehicles and public transport, there simply won’t be a need to “own” a car that sits unused the majority of its life. Right now, our transportation isn’t there. Gig-style ride-sharing services are still in their infancy, and costs remain high. Removing human drivers drives down costs, at a much greater rate than the increases costs in technology to enable driver less cars and driver less infrastructure.

Put another way, if the price, reliability,

and availability of driverless vehicles were low enough, you wouldn't need a car. Commuting, traveling, running errands, etc. – if vehicles were always available and at a cost where, over the same period of time as you would own a car, ride fees are less than or no more than what you would spend on a car in purchase price and maintenance, then there's no good reason to own a car in the first place. Removing the burden of fuel or charging, insurance, licensing and registration, DMV visits, maintenance and repairs, all of that from people – if the economics are right, the conversion will take care of itself. Again, this will take time, but is the likely future of transportation in the 2030s or 2040s.

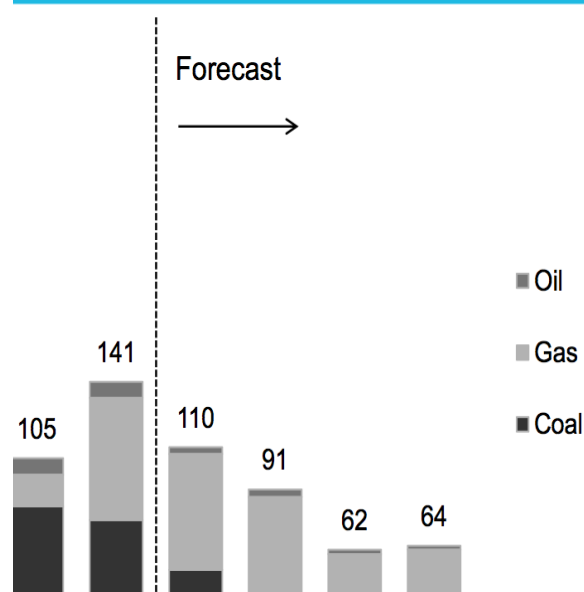
Economic Changes

Adoption of automated technology for transportation may actually happen faster in the non-consumer sector. This includes trucking, small-scale transit networks at universities or business parks, and similar. The simple economics will largely dictate the conversion here, whereas consumers at large will need to be convinced. When it comes to trucking, though

– once the technology is proven, there's no reason driverless vehicles wouldn't be preferred – they don't require salaries, benefits, or have mandatory sleep periods. The overall cost of moving goods and services will go down, and the trucking companies themselves will be large drivers of this move in the trucking industry. Closed systems, like public transport, will likely follow suit or convert concurrently, and consumers will be among the last groups to be sold on autonomous vehicles on a widespread scale.

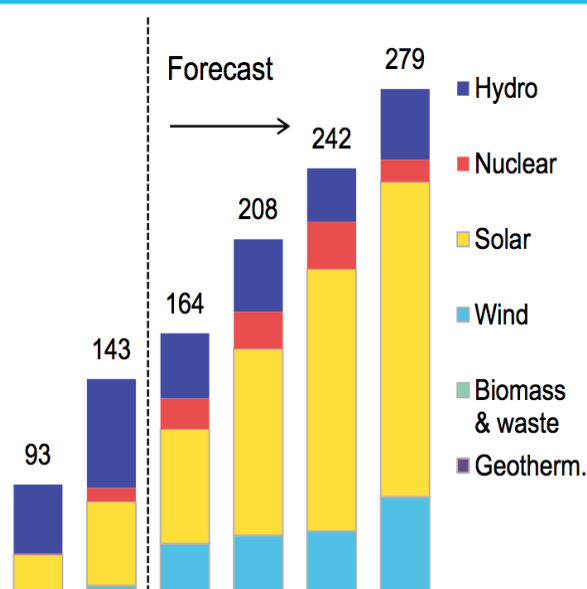
Not many people are aware, but by category, the second-largest employment sector in the US is trucking (the first being the government). The 7 million or so professional truckers will likely be put out of a job, within this current generation. Much like the shuttering of manufacturing plants due to outsourcing, this will doubtless have some negative effects in the short term. A cascade of 20, 30, or 40 million people will be affected, as the industries that support trucking and transport largely cater to the humans involved – truck stops, hotels, restaurants, etc.

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CLEAN ENERGY



The safety of driverless vehicles means fewer accidents, and will likely save hundreds of thousands of lives a year. This is a very good thing – right now, worldwide, about 1.4 million people die in each year in car accidents, to say nothing of the millions more injured, some permanently. Insurance companies, doctors, hospitals, etc. are all going to be hit economically by a move to autonomous vehicles.

However, at the same time, new, good quality, technology-based jobs will be created. In the long-term, the infrastructure and support ecosystem that will need to be developed from this shift to driverless vehicles will likely create more jobs than are lost – but that’s small comfort to the trucker or waitress or hotel maid who gets laid off. So change will likely happen gradually over the next few decades, and not all at once.

It’s hard to say exactly what new job opportunities might be created. In order to predict the future, we analyze events from the past. One good example of how unexpected but positive new economic opportunities come into play with new technology can be found in the iPhone. When the iPhone debuted, there was no App Store – just the basic programs supplied by Apple, and some limited content from Apple-designated partners. The utility of the product itself was limited as a result. Once the idea and push for an App Store was brought to fruition, it opened up a whole new sector of the market. Now, millions of apps exist, and most of us interact with at least some of them on a daily basis. That wasn’t part of the planned or predicted march of technology advancement with the iPhone, but it organically developed as a necessary ecosystem because of the adoption of the technology. The same will likely hold true with a move towards autonomous vehicles.

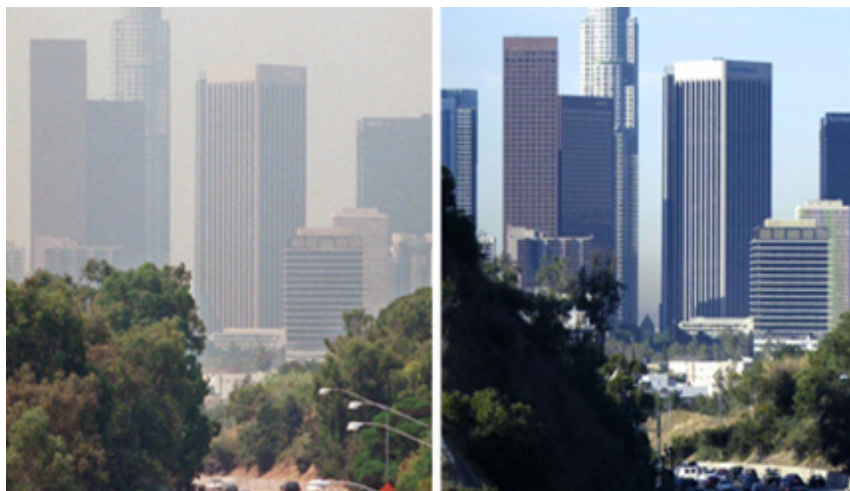
Infrastructure Changes

The change to autonomous, connected, smart vehicles has many other benefits as well. One key

benefit is the traffic efficiency that can be achieved. No longer do you need stoplights at intersections. No longer do you need to have cities designed around cars and trucks. Essentially, that is how all our modern cities have been designed – not based on the needs of people, but the needs of transportation via cars and trucks. Changes to how those vehicles operate may very well allow the cities of the future to reclaim some focus on humans, and build out cities that are more environmentally friendly, more people-friendly, and more like the cities of old.

An example of this can be seen in New York City. Times Square had several main transportation arteries going through it, with significant daily traffic and congestion. But the city wanted to grow Times Square as a tourist destination. They tried a pilot program of blocking the streets, forcing traffic to be rerouted, and setting up pop-up shops and restaurants in place of the roads. There was a tremendous outcry in advance of this experiment, but the city did it anyway. And amazingly, what they found was that traffic improved. It forced more efficient use of other intersections and pathways and shuttering these major arteries actually resulted in traffic improvement in the surrounding areas. They made the change permanent as a result.

It was a victory for reclaiming space, and perhaps a foreshadowing of the changes to come, as we get back to building our cities around people and their needs, rather than the needs of vehicles. These kinds of changes make cities and urban areas more approachable and desirable – places you want to go and spend time in. Many Asian cities and older European cities are already like this, simply because their older areas have never been modernized around



vehicles, but preserved in their largely pedestrian-based origins. It provides different energy and experience to city living and one that is generally seen as far healthier and engaging than many of our American cities.

This is just one example of the kinds of changes that can be made as we move into a more and more autonomous world. Technology and tech experts are going to be the keys to implementing these more utopian visions of the future. But it is entirely possible that we can reclaim our cities, reclaim our spaces, and make the cities of the future far greater than the cities of today.

Opportunities and Solutions - Energy

Energy is the other key area that can really shape a better future for life in cities and the world in general. Growing populations, especially in developing countries, will demand more and more energy to function. Newly developed populations will want TV and internet and computers and air conditioning, all the luxuries we currently enjoy, and rightly so. But that will require a massive increase in the world's energy production. Fossil fuels won't last forever,

and that's to say nothing of their horrible impact on the planet and the climate crisis. The good news is, alternative, environmentally-friendly sustainable power is becoming more and more affordable, and more and more widespread.

One of the most promising technologies for sustainable energy production is solar. While battery technology needs to be further developed by the enterprising engineers and technologists working on that problem today, overall solar technology has become more and more affordable, thanks to advancements in manufacturing techniques and availability and price of materials. As more cities and individuals utilize solar power, the production costs decrease due to economies of scale. Flexible controllers and smart power grids, with technologies and code written by the tech experts of today, will shape the power grid and energy production capabilities of tomorrow.

The trends on solar costs made it clear that this is a winning strategy to meet our increasingly-urbanized and developed population's energy needs. The Earth receives enough energy from 1 hour of sunlight to meet our current demands for an entire

year. We just need more widespread adoption of technology to harvest, store, and distribute that energy efficiently.

Data projections on planned upcoming power plants globally support that solar is currently the main direction in which the planet is moving. Despite developing economies with large natural resources in fossil fuels still bringing more fossil fuel plants online, the overall trend is overwhelmingly a move to sustainable power, largely in the form of solar energy. By 2030, the ratio of clean energy to carbon energy is estimated to be greater than 3:1, with around half of that clean energy being solar.

The technology has become far more affordable than in the past, and continued work by manufacturing and technology experts will likely continue to bring the cost of solar components down still further. In many places, political will remains a problem, though, in time, those barriers too will fall. The simple economics of solar energy dictate this to be true. In 1977, 1 watt of solar energy production cost \$77 fully loaded, with amortized equipment and everything else. As of last year, the average is around \$0.30. This is well below the loaded costs of most fossil fuel and nuclear power generation. And cities that are building for the future are well aware of this. The cheapest solar power currently is produced in Dubai – a city built on the riches of oil. They, perhaps more than anyone, are aware of the limited future in fossil fuels and are building for a more sustainable world.

Technology's Role in the Solutions

From the previous two sections, it should be apparent how large a role technology is playing or will play, in the implementation of solutions to meet the needs of our future cities. Once again, we can draw on inspiration from the past to show technology's role in finding solutions

that work, and also how technology alone cannot solve all the problems – it takes political will and economic and social demands from citizens, too.

In the 1980s, smog was a persistent problem in Los Angeles. But through the fusion of political will, pressure from citizens, and technological innovation, change was made, and today the right side of the image is the predominate state of air in LA. It was no single silver bullet, but a combination of regulation, technologies like catalytic converters, unleaded fuel, public transport, tighter controls on emissions and factory emissions, and similar that turned this bleak situation around.

Even within existing infrastructure, in today's cities, there are huge potential technology applications that can start making an impact on environmental, energy, transportation, waste management, and other challenges. Utilization of the Internet of Things (IoT) can provide low-cost ways to start moving the needle on planning, policy, and culture. Monitoring instruments, cameras, and smart devices can augment existing, non-networked features of city life and generate benefits for many of the challenges discussed in this paper. Some examples from the pilot programs in Palo Alto include:

- Low-cost and ubiquitous wireless access can be achieved through relatively low-cost 2G and 3G access points mounted to streetlights or utility poles. This essentially provides network coverage throughout a city for any kind of governmental applications – from police cameras to monitor crime, to smart devices, to instruments and monitoring equipment, and much more.



- Cameras and software can help monitor parking availability in parking lots, and coupled with a networked API, can be linked to the web, Google Maps, GPS/traffic apps, or custom parking apps to make finding parking spots easier, faster, and less hassle. Less time spent searching for spots means more time for productivity and leisure, and less time cars are running unnecessarily, which in turn means less gas use, less pollution, and less traffic congestion.

- Simple devices can be used to count cars in and cars out of a parking garage structure, letting motorists know whether or not there are free spaces. This is an even lower-tech (though still tech) way to achieve the same kinds of things that the cameras and software mentioned above

These are just some of the present-day applications for technology as part of the solution to city living, and part of the solution to our greater challenges. From a purely economic standpoint, there's a great deal of opportunity for money to be made in developing technology solutions to all of these problems.

Despite great strides in awareness, innovation, and implementation of major changes to our ways of life, especially in cities, are not moving fast enough. Technology experts, through innovation and development, can help drive that future forward at a faster pace.

Conclusion

Urbanization, industrialization, climate change, and population growth present many challenges to our current way of life. Technology holds the key to meeting these challenges with solutions. We can build or convert our existing cities into smart cities, with autonomous transportation, networked infrastructure, and a people-centric approach to design and planning. We can ensure everyone has access to clean water, good waste management, reliable and renewable energy, and so much more. And there are opportunities here, not just to make things better, but for tech companies and tech experts to make a good living, with good jobs, working on solving

these big problems of today, and creating the bit solutions of tomorrow.

Major tech companies are being consulted to develop solutions for converting or building smart cities around the world – from Ecuador to India and beyond. Ten cities in Saudi Arabia planned for the next few years are intended to be built as smart cities. Likewise, 125 cities in India are slated to be converted into smart cities in the next few years. Countries far and wide are beginning to see that these changes are the future, and are not just a luxury, but rather a necessity.

Tech experts can help develop and drive these changes. With a major crises like climate change looming, we need everyone with good

ideas, working together, to find technology based solutions to our largely urban problems. The added benefit to all of this is that solving these problems may help us live happier, healthier lives in cities, as we reclaim space, focus more on our environment, and find ways to make life easier. Fusing technology with political and social will is ultimately what will make or break our move into an exciting and uncertain future. Will we meet the challenges of today with the technology and bold dreams of tomorrow? **The future is in your hands.**



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The Information Management Forum was founded by five CIO's who envisioned peer-to-peer learning in a strictly **vendor-free** environment. Though vendor-sponsored networks and research companies have expanded and saturated the IT landscape over time, IMF's goal since its beginning in **1975** has been to be the best source of shared information in IT for a select group of members while remaining strictly **vendor-free**. The diverse base of members utilizes IMF as an extension of their staff to achieve their goals. For **over thirty-five years** one constant remains the same: IMF's only motive is its members' success.

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West Palm Beach, Florida

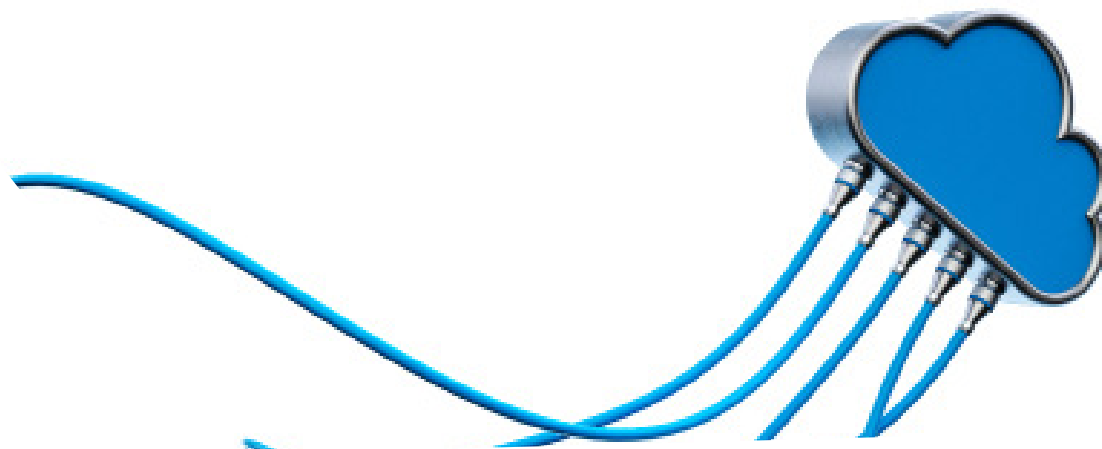
09.27-28

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