State of Affairs – *How is technology reshaping the economy?*

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Which new technologies are having – and will have – the biggest impacts on the economy and the workplace? Has the pace of economic change really picked up – if so, why is productivity growth so low? What can policymakers do to accelerate the commercialization of Queensland and Australian technologies and the diffusion of global technologies while ensuring all Australians benefit? In the first of Grattan Institute's 2017 State of Affairs events, Productivity Growth Director Jim Minifie was joined on a panel by Joanna Batstone, Dr Charles Day and Martie-Louise Verreynne to explore technology and the economy.

Moderator: Jim Minifie, Director of Productivity Growth Program, Grattan Institute

Speakers: Joanna Batstone PhD, Vice-President and Lab Director, IBM Research Australasia
Dr Charles Day, CEO, Office of Innovation and Science Australia (OISA)
Martie-Louise Verreynne, Associate Professor of Innovation, University of Queensland Business School

JIM MINIFIE: Good evening everybody, thank you so much for joining me for tonight's Grattan Institute and State Library of Queensland event. My name's Jim Minifie, I run the Productivity Growth Program at the Grattan Institute and it's a great pleasure to take part in what for me is the first of our partnership series with the State Library, which has been running for some time now. It's a great privilege really to be part of the Library's events program and it's great to see so many of you here. I'd like to also acknowledge the traditional owners of the land, ancestors, and elders past, present and future. My understanding is that the site of the State Library was an important meeting ground for the Indigenous peoples of this area and in many respects what the State Library does with their events continues that deep tradition. Our ambition for this evening is to draw on what to me is a really extraordinary depth and diversity of expertise represented here in the panel. Let me introduce the panellists. Joanna Batstone has had a long career at IBM, first as a hard-core researcher and then, increasingly over the years, as a research leader. Joanna leads IBM's research capability here in Australia and she was up in Queensland today as part of IBM's outreach participation in the World Festival of Science talking about quantum computing, one of the very fascinating technologies that's coming down the pipeline. Joanna, thank you so much for joining us.

JOANNA BATSTONE: It's great to be here.

JIM MINIFIE: Thank you. Next is Martie-Louise Verreynne, who is associate Professor of Innovation at the University of Queensland (UQ) Business School. I've known Martie-Louise for many years and she has published dozens of papers in top international journals on both research commercialisation

from the university environment and also really looking deeply at how private sector firms operate, innovate, respond to change, and what differentiates those that are successful in responding to a changing environment from other firms. And finally, Charlie Day - I've known Charlie for many years, thank you for joining us. Charlie is the CEO of the Office of Innovation and Science Australia, it's a role that he took up in December last year, and prior to that he spent many years at the University of Melbourne launching a fascinating new venture called Carlton Connect, which aims to bring together the big end of town, start-ups and researchers into an innovation precinct at the University of Melbourne. The reason why to me it was so exciting to bring the three of you together is that between us I think we'll be able to tell a story about what technology is and how it's developing, how that interfaces with economies in general, with the Australian economy and with firms and workplaces in the Australian economy, and then we'll move onto some of the policy challenges that face Australian policymakers. My ambition for the evening is that we're going to run through that very narrow set of issues and then we'll have about half an hour for rich interaction with all of you, so I look forward to your questions. We're lucky enough to have questions that some of you posed to us when you signed up prior to the event, so I'll run through some of those as well. Broadly speaking, I thought we'd go through those three question areas and then open it up.

Let me start with a conjecture about what technology is and how it develops. At a deep level, technologies are the exploitations of phenomena. There's some characteristic of the natural world that human beings notice, characterise and learn to exploit. A simple and ubiquitous example of that would be the laws of electromagnetism, that were pretty much setup 200 years ago and with spinning magnets and coiled wires and so forth, which formed the basis of the technology in our electricity utility system to this day, although it's obviously shifting towards a different generation basis as we speak. You see each of these modules of technology being concatenated together and grouped up into functional products that all of us use and at any given point in time there are some early technologies that are now really mature and well-developed across the economy, and then there are emerging technologies that are still in the earlier phases of development and have got a long development pathway ahead of them. My question to you Joanna, as a technologist, as somebody in an organisation that has been responsible for fundamental research over the decades and also for commercialising all the way through to end users, where do you see a range of technologies – and you might want to select a few – that are mature but still not fully commercialised and less mature with a lot of promise, how do you see those playing out today?

JOANNA BATSTONE: I think if you look back over history you see these different eras of technology adoption and technology change. So if you think back over the last hundred years, in the days of the Industrial Revolution we took different types of technology to change the way that we work. The first phase of the Industrial Revolution was all about big equipment, big machinery taking over work that had prior to that been manual. We then moved into what we would call a tabulating era, we started building devices that enabled us to count and measure things. Once we started counting and measuring we wanted to be able to do that more efficiently and we ended up with tabulating machines that could add. In the 1940s/1950s we started to move into the programming era, because we could now start to build the transistors and circuitry that launched the computer revolution and the whole programmable era. We're in this phase now where we've got existing technology in place and we continue to rapidly transform the technologies we've been used to using today - laptops, mobile

phones and computers - but we're now looking into what is that next generation of compute technology?

So if I'm looking at it from a computing perspective, we actually like to define this next era of where we are with computing, including the world of artificial intelligence (AI), as the Cognitive Era, that we're building systems that behave and interact with humans in a much more natural interactive style than a system that you program, so that's one element. From a computer science perspective we're moving into this world of the Cognitive Era that in the future could also be the Quantum Era with compute technology that's coming out of the labs, so that's more from a computational perspective. Another area that I would pick, and you touched on it as well, is the world of medicine. As you start to be able to think about computing in a fundamentally different way it also changes the way that you think about the design of new drugs, potentially the treatment of individuals, based on the information that is now enabled by the fact that you can access massive amounts of data and that our technology is now advanced enough that we can sequence the human genome and then take that information and start to design a much more personalised medicine from a treatment perspective. So I'm seeing this massive explosion in our ability to access information that changes the way we can innovate and bring new product to the market.

JIM MINIFIE: So those are two arenas, the IT space, with huge potential for further development, and the medical space. Charlie, do you see other domains that are undergoing rapid change?

CHARLES DAY: Yes, certainly, and one of the things, as Joanna's pointed out, the changes in IT capability are pervasive across lots and lots of industry, so it's not just in the IT domain but IT applied to a whole bunch of things is changing things really fast. One of the areas that we're very interested in is education and how advances in IT, networking, communication and so forth will change the way education as an industry works. The other one that I think is particularly interesting and very apposite right now is in the energy space and I think from the point of view of innovation one of the things to really watch for is where cost curves change really rapidly. What we've seen in the last decade or so is the cost of renewable energy has come down way faster than anyone predicted that it would and the capability of energy storage has improved way faster than anyone predicted that it would for a given price, so that's driving some massive changes. That, in turn, weaves into some of the IT capabilities around smart grids and smart networks that can then support the integration of that. So as I look around there's just wave upon wave of transformation coming through, a lot of it powered by IT.

JIM MINIFIE: Is it a fool's errand to try to predict the pace or the range? Let me give you an example, some of us are concerned that AI is going to take all of our jobs or that AI could result in a superintelligence that might have very different values to human values. Are these things that you can really analyse or is it more that we're in a realm of discovery and we just need to wait and see and prepare on a scenario basis, rather than a predictive basis?

JOANNA BATSTONE: I think we are in this realm of discovery, but let me give you a couple of examples from an AI perspective. One of the real applications in AI is around understanding information, so what we're starting to see is it's changing the nature of how we work. We've got a very interesting engagement with an energy company over on the West Coast of Australia where we're looking at how do we tap into 50 years' worth of field engineer reports that would then help that company think through how do you optimise the management and operation of a plant? So just think

about that, 50 years' worth of employee information and insight all stored in our heads or in large stacks of paper, but with AI techniques you can teach computers how to learn that stuff and then automate it and then the style of work with a human expert becomes very different. So a lot of these AI systems are clinician assistant, engineer assistant opportunities because they're not decision-making systems, but they are very much augmented intelligence systems where the algorithms can learn and interpret information, then you and I get the opportunity to be the expert looking at the information now presented to us.

JIM MINIFIE: So potentially a complementarity between human skills and computing?

JOANNA BATSTONE: Exactly.

JIM MINIFIE: So we've spoken about IT, we haven't spoken much yet about the transformation that can occur in the economy. Martie-Louise, do you see technology as fundamentally shifting, possibly in the recent past and looking ahead to the future, how our economy operates?

MARTIE-LOUISE VERREYNNE: It's really interesting because I think for organisations that are doing research, technology is shifting very fast and there's a lot of development, but for organisations that have to make this work there's a long tail of businesses that are very slow to adopt new technologies and they're still using a lot of the old style technologies that are still at this stage with a feeling that they have to have a website for their business. So you've got this huge range of businesses that are moving very, very fast, working with universities and technology companies and doing incredible things, and quite often they're small businesses but because they're so engaged with the community they look much larger and far more professional as a result of that. Then you've got this long tail of other businesses that are really just struggling to see how they're going to survive in the face of all these new technologies that may actually make them irrelevant into the future. So the answer is a little bit more nuanced than just a yes or a no.

JIM MINIFIE: In the UK and the US there's evidence that the spread between the leaders and the mass of firms has risen over the last 10 or 15 years. Is there evidence of that type in Australia as well?

MARTIE-LOUISE VERREYNNE: Yes, we're seeing the same thing in Australia. We're seeing this huge spread where 10, 15 years ago you probably would've seen businesses had access to similar types of information, they had quite similar understanding of what was important in their industry, what kinds of technologies they needed to know, and that is changing. Charlie talked about the education system and I think the education system has a really big role to re-think how we educate people to be successful for the next era of technology because at the moment we're teaching technology skills to STEM scientists and we're teaching some skills that are personal and interpersonal skills to social scientists, but I think there should be far broader skill bases that overlap for those types of scientists. I think STEM scientists should be able to understand how they're going to actually interpret the data that's coming from AI and social scientists should be able to talk and understand science and understand much faster how they can bring it into their organisations and make use of it.

JIM MINIFIE: It seems to me that technology is what drives productivity growth and productivity growth is what drives income increases. If you go back to pre-Industrial Revolution, living standards,

depending on how you measure, might have been a 15th or a 25th of today's levels and it looks like most people have benefited over the very long run. Is there any reason to think that has shifted more recently and that the rising tide has benefited people to a less widespread extent?

CHARLES DAY: I think one of the great unanswered questions in contemporary economics is the advances of technology appear to be showing up everywhere in our lives, except in the productivity statistics. In Australia we've seen a plateauing of productivity growth over the last few years, but that's common across the Western world. There are many theories for why this might be. I'll confess, I just don't know what the right answer is, it's a lively debate, but I think that intuitively you've got to feel that the power and the capability that we're putting in the hands of people is transformation. So I think there's got to be something that's not there in the statistics. I don't trust those.

JIM MINIFIE: My understanding that advanced economies have in common is they've experienced relatively slow productivity growth since the end of the first internet boom, so over the last 15 years. In turn, that was a relatively short blip that was a pickup after quite an extended period since the mid-1970s of slow productivity growth and, going back even further, you had the post-war boom that was unusually fast compared to what had gone before. So it's not out of the historical record to imagine that we might have a period of slow productivity growth but, like you, I find it hard to square with the fact that it looks like on a number of dimensions technology has become relatively low marginal cost for very, very large expansion, so put you a cell phone in the hand of everybody in the world or you essentially apply software to whole industries at very low marginal cost. It looks to me as if the secret, Martie-Louise, might be in the area that you've brought up, which is that not all firms are availing themselves of those opportunities. The puzzle to me is how come they haven't gone bust? If it's really so great to be at the frontier, then how come these firms are still in business at all? What's special about those firms? Are they in protected sectors or are they going to shrink into irrelevance, so the fact that you've got some relatively slow firms doesn't matter for the aggregate? Or in some sense are they a symptom of a non-dynamic economy, an economy that's not taking advantage of these big opportunities?

MARTIE-LOUISE VERREYNNE: It's a very good question and I think you really need to answer it from a sectoral perspective, because I do think different sectors act quite differently. I think there's such a big growth in demand for services that a lot of service businesses are protected against the things that you're talking about, so they're still getting away with poor practices because there's demand for services and the businesses cannot deal with all of that demand. I don't think that's going to last forever because as AI and things like that are starting to help the businesses that are performing well and that's at the forefront, it's going to change the demand for the services of those that are lagging behind. So I think it's really just a timing effect, rather than something that's going to into the future remain the way that it is.

JOANNA BATSTONE: I think there's another dimension here. You asked what happened to these companies and why do they survive or why don't they fail? For the companies that survive, I think it's this constant re-evaluation and retesting of both the business model and set of products. I know for us as a 100+ year company we've constantly reinvented the portfolio that we sell in the marketplace. Many of the large Australian companies that have been in business for over a hundred years have done the same thing. You look at a company like Amazon, that you think of initially as a company that was online books, now just announcing that they're going to become Amazon.go, a grocery shopping

organisation. The innovations in technology drive also an innovation in new business models, new go-to market, that often pull technology. So sometimes it's a technology push that opens up and enables a new market but as Amazon exploded into the world of online book-buying they then ended up becoming a transportation company, a shipping company, a data centre company, an energy company to support the initial business, it transforms the business.

I think if you look at companies here in Australia, particularly in the financial services industry, you're seeing some of that transformation occurring today. The traditional players are disrupting themselves to bring new services to market and then there's a whole cottage industry of small start-up companies that emerge, the FinTech industry, who are taking pieces of the pie in an industry and as you get that ecosystem building it's driving rapid innovation because the incumbents have to innovate in order to stay relevant.

JIM MINIFIE: So it's not a small business or a large business phenomenon, Martie-Louise, do you see laggards at both ends of the spectrum?

MARTIE-LOUISE VERREYNNE: No. The statistics tell us that the large businesses are better at reinventing themselves, they're better at reinventing their business models and they're better at coming up with and introducing innovation. There is overwhelming evidence for that. It's much harder for small businesses to do it, but small businesses are very good at copying what others are doing. That's always been a real benefit to them because if large businesses are reinventing the business model or they're coming up with new ways of doing it there's always small businesses that follow in that. Reinventing what others are doing or copying what others are doing is not a bad thing, it's actually a good thing.

JIM MINIFIE: It struck us that the emergence of cloud computing and other platforms which can be accessed essentially on a pay-as-you-go model make it much easier to be a small firm, you can get bite-size chunks of industrial scale financial advice or logistics services or what have you, so that would tend to tell you that, at least for some of the activities, it's actually much easier to be a small firm and easier to be an innovator. Let me turn to you Charlie, when you draw on your experience from Carlton Connect do you see it essentially being easier to be an innovative start-up now than in the past? Is that leading to a genuine explosion or is it just hype essentially, that it's easier to have a website but you're not really a firm?

CHARLES DAY: I certainly think it's easier for a team of innovators to establish a business, establish a global presence and sell globally from Australia, easier than it ever was before because you can virtualise everything, you buy everything on an "as you need" basis. The challenge is that it's also easier for everyone else as well, so from a competitive position you haven't necessarily gained a lot, Your barriers to entry in terms of needing capital to buy lots of equipment and all this kind of stuff have gone down, but the competitive intensity is as great if not greater than it was in the past. So the need for really solid execution, good business model design, all those kinds of things, becomes that much more important because if you do want to build a global business today you are competing with other people all around the world. So the competition, the competitive intensity is that much greater.

JIM MINIFIE: Stepping back, there's a lot of creative destruction and entrepreneurs are betting their houses and corporates are making big bets. But if I'm a citizen I care about my job and I care about

the price and the quality of the services that I consume, so how do all of these changes that we're talking about play out on those dimensions? It seems like they might be different because on the one hand I've got greater diversity, improved quality, but on the other hand I worry a lot more about my labour income than I did before. Are you seeing that in the data or is that just a popular narrative?

CHARLES DAY: I think that we're certainly seeing improvements in the quality and the cheapness of goods and services. You can buy much nicer stuff for much less money than you used to be able to, so in product markets things are getting a lot better. Services markets are a little bit different; they don't see the same cost benefits. On the employment side of the ledger, we continue to see, as has been true for a long time, every month jobs being destroyed, but for the last five years more jobs have been created than have been destroyed. In fact, that's been true for quite some time, so this cycle of destruction of jobs and creation of jobs is ongoing. The question and I think the thing that no-one can really know without a good crystal ball is whether the relative rates of destruction and creation are going to structurally shift into the future. There's a lot of apocalyptic stuff out there about the rate at which jobs will be destroyed but there are a lot of people refusing to estimate at what rate jobs will be created, and unless you're prepared to forecast both of those numbers you can't really say what the net effect is going to be for people in the economy.

The only thing I would say, going back to what Martie-Louise said, is being educated and staying current with your education I think is going to be the one thing that we're all going to have to get better at going forward. So the idea that the set of skills that you might develop early in life will see you through the rest of what is becoming a longer and longer working life is not going to hold true into the future.

JIM MINIFIE: One aspect of technology that seems to have hit other developed economies really hard is that improvements in ICT have made it possible for advanced economy firms to locate part of their production process in China, India or other low labour cost environments, and essentially break what you could have thought in the past as a kind of linkage between your status as a citizen, a worker in an advanced economy and the technology that's being generated by the corporations that are domiciled there. That seems to have split to some extent, so if you're a manufacturing worker or a manufacturing manager in the US your experience has been quite negative over the last 10 or 15 years. Australia's been protected from that because we've been on the "sell" side of the China resources boom, which in a sense is the other side of this equation, but a lot of concern that I have is that as technologies make services more tradeable you end up looking at potentially the same transformation occurring here. My question to the panel is do we have some vulnerabilities that potentially haven't yet really raised their heads to the interaction of technology and globalisation potentially changing that social contract between workers and technology owners?

JOANNA BATSTONE: It's an interesting question. As a global multinational we do business in over 170 countries around the world and so it changes the dynamic of work, but it also changes the way you think about how do you take advantage of the environment that you're in to take advantage of the workforce and the skillset within region to get smarter at where you do the work? We do have what we call Global Delivery Centres that support all of our clients in China, in Japan, in Australia, we've got a Global Delivery Centre in Victoria, we've got one in here, we've got one in Sydney, but this multinational view is not about offshoring jobs; it's about being smart about where you want to do the work. And 15, 20 years or so ago, when we opened other research labs around the world, when we

opened our China lab, our Tokyo lab, and five years ago when we opened our lab here in Australia, it was about looking at where can you optimise the work, where is the skillset and the talent base in order to do the work? So it's much more of a distribution of work and work effort. Certainly that's a large multinational perspective. You want to take advantage of the local economy of scale, of talent to be able to do the right work in the right place.

JIM MINIFIE: Are you seeing similar trends, Martie-Louise, for other firms?

MARTIE-LOUISE VERREYNNE: I think you're right in that work is changing. AI and other things are replacing certain jobs and those jobs are not just blue collar jobs; they're sometimes white collar jobs as well. We've been protected in that we've had the mining boom, for example, that's helped with that but that's coming to an end and that's going to change what it means for people in their work. What I am seeing is we're visiting manufacturing firms in Brisbane and they're doing absolutely amazing things. They're doing specialised manufacturing of customised products, they've worked out how to do this really well and it means that there are still manufacturing jobs but they're far more interesting than they used to be for the person working in them. I think this is the kind of thing that if somehow that can grow and be encouraged would actually be positive for the trend that you're talking about.

JIM MINIFIE: I often get the sense that the declines are really visible because they're often brand names and firms that you know very well, whereas the growth areas are less visible because you haven't heard of them. So I would see some expansions of similar manufacturing but often with a design and an innovation focus rather than a process focus, in Melbourne as well.

MARTIE-LOUISE VERREYNNE: You're right, yes.

JIM MINIFIE: What's quite striking to me is that automation interacts in a fascinating way with the labour cost, because the labour cost component becomes much less important and you can bring back significant components of the manufacturing value chain, but they're often the more exciting, the more engrossing and the more scalable forms of those things. I presume the same is true in services as well?

MARTIE-LOUISE VERREYNNE: Yes.

CHARLES DAY: We've seen a bit of that already in Victoria where Ford closed down their vehicle assembly operations. In December last year they increased their investment in design and R&D in Victoria, so the parts of the value chain where people are getting engaged is shifting and it's less familiar. People associate with the car industry with these big, cavernous factories with moving production lines, but increasingly they slice the value chain and the bit of design in the car is done in a design studio and it could be in Melbourne, could be in Silicon Valley, could be in Israel; it could be anywhere.

JOANNA BATSTONE: I think we've seen the same phenomenon in South Australia as well with the car industry declining. What has sprung up there is this very fascinating ecosystem with advanced medical technologies. Those advanced engineering skills that in the past might have been automotive skills now become medical device manufacturing skill, and so the work changes and it shifts into new opportunities for innovation.

JIM MINIFIE: If we switch now to the policy agenda, there's a set of challenges that policymakers face and, as we were talking beforehand, to me the intriguing thing about innovation is the very thing that makes it an incredible engine for growth, which is that ideas are very low cost to replicate. So somebody's got a better idea that economises on the use of resources, it doesn't hurt you for me to use that as well, and so you can have this essentially non-rival benefit across all users through exploiting aggressive leading edge technology. But what makes that a challenge for policymakers is that individual innovators know they're going to be copied and so they're going to undersupply the innovative effort potentially because they recognise that they can't capture the full benefits of their innovations. Then policymakers have to think about intellectual property protection, they need to think about public good provision of research that's going to be basic and freely available, and then they've also got to think about which part of this complex global innovation network can we host locally? You could be overambitious and try to capture too much.

Charlie, can I start with you? You've been in the role now for a number of months. Do you see government grappling with these dilemmas? How do you see an economy like Australia which, depending on how you look at it, is a small economy, a remote economy, a resource-heavy economy, making those trade-offs?

CHARLES DAY: These are live issues in Canberra right now and they're also live issues in all of the state capitals, because a lot of these issues are local issues as well. I think there is a sense that some of the assumptions that we've had about the past and the way the economy worked in the past are changing. What we've seen in some areas, for example, in the sharing economy with things like Airbnb and Uber, is the states have now responded to that virtually across the board, but in other areas, like the other big platforms, the social media platforms and so forth, the government's been remarkably absent in the conversation. The question going forward, as more and more things move to zero marginal cost, is what should the role, what could the role of government be? I think there are some opportunities for government to be quite creative in how it partners with the private sector in some of these areas, but that's again going to challenge some of our traditional notions of how we manage the risk and so forth of those things. So it's a really interesting time for government and for policymakers more generally. I think that the pace at which the private sector is moving these things forward is putting everyone on their toes. What are the right answers? I don't think it's easy to be clear across the board, but certainly a level of nimbleness in policymaking is essential.

JIM MINIFIE: Martie-Louise, Australians are said to be great fundamental researchers and Australian firms in general, with the provisos of some of your earlier comments, are said to be pretty good adopters of technology, but there's also said to be a commercialisation gap in Australia. Is that true and if it's true, why is that true and is it a problem?

MARTIE-LOUISE VERREYNNE: Yes, it is a problem and yes, it is true. I do think that we are not very good at taking things that are invented in universities, research institutes and places like that and getting it into the market. Typically when we think about the policy we think that we need to do something about the university researchers to get them to be better at talking to industry and bringing things to market, and that's true. I think some of the initiatives of the government around that at the moment with the ON program, for example, that's run through CSIRO and which we are very involved in, is actually a really good one because it's teaching scientists to think about their research from a business model perspective from day one, rather than to wait until they've spent 15 years or

something on a piece of research and then realise it's never going to make it to the market. So I think some of those things are really good and it's helping scientists to get better, but we also need to think about how we can get business more involved in what universities are doing and how we can get business to talk more to universities and provide opportunities for that to happen. I think it's a two-way street. It's not typically how we think of it as a one-way street in that universities need to get better; I think we all need to get better.

JIM MINIFIE: It comes back to the push versus pull you were talking about before Joanna?

JOANNA BATSTONE: Yes. Well, it's very interesting, we have research and development labs here in Australia and here in Queensland we have our security labs in the Gold Coast. When you think about invention, the idea could come from a research scientist in a university, but if that research scientist has the brilliant idea how do you take that to market?

If you look across Australia there are relatively few companies that have research and development in Australia. There's a large and healthy university sector, but on the R&D side there's a smaller footprint here in Australia compared to other major market economies. That's really one of the questions is when you think about innovation it's not just about the university scientist, there needs to be this whole opportunity to take it through productisation, commercialisation. I think the focus on accelerator programs that we're seeing spring up over the last five years is a way to try to tackle some of that gap, but if you can host a Melbourne accelerator program, a Stone & Chalk accelerator program and you bring in researchers, industry people and businesspeople together it's a way to try to accelerate that technology transfer from the idea of the faculty or postdoc or PhD scientist into something that has potential for commercial value. That's what traditionally large companies would do in their R&D labs, but the world is changing and that shift I think is also looking at can we leverage the small and medium sized business community to do rapid acceleration of technology transfer?

JIM MINIFIE: So when you put yourself in the position of an IBM or another global firm looking at where to locate R&D facilities, why do you think it is that Australia appears to be punching below its weight, appears to be less successful than perhaps other peers?

JOANNA BATSTONE: I think there are some dimensions, it's not completely obvious. We've been here 5+ years now and one of the reasons we opened a lab here was you look at the ecosystem around you and if you're going to open a business here, so transplant into Australia, what you look for is there a talent base, can I hire people to join my new company or to join my new lab? So you want to look at that ecosystem of technical talent around you so that you have an employee base in the future and clearly Australia has that, we've got very talented universities that produce very talented graduates. I think the question is more around sustainably of the model. If I look at many large industries, we were just talking about Ford, they've left. Why is that? There are many different reasons that a company makes a decision to stay or to leave, but I think it is fair to say that we're punching below our weight here in Australia from that R&D perspective and it's not obvious to me why, I haven't been here long enough yet to have figured it out. But it is interesting, if you look at the major companies here, we have one or two companies, but why don't the pharmaceutical companies have more of an R&D effort here? It's a great place to attract technical talent.

CHARLES DAY: I think certainly historically we have punched below our weight and Australia shares with the UK an odd distinction of having the majority of its researchers in the university sector, rather than in business. Most other advanced economies have the majority of their research community in the business sector and I think that creates a dynamic and a culture within the research community which is not as applied and as focused on the application of technology as you see in some other communities. So I think that Joanna's exactly right, we don't have that vibrant commercial research base. I don't have a lot of data on this, but going around the country and talking to some corporates about their attitudes I sense there is a shift underway, albeit a gradual shift. Johnson & Johnson have a presence here in Brisbane that they're growing, obviously IBM are in Melbourne, Lockheed Martin have just located their first lab outside the US in Melbourne, so we are I think starting to see a trend where people are starting to locate here. It's got a long way to go before I could say we're punching above our weight though.

JIM MINIFIE: We've done something of a whistle-stop tour, I want to now open it up to questions and let me start with a couple people have lodged prior to coming this event. There are a couple of questions around the environmental angles. We know as economists that if you've got a public good that's not properly being protected, private provision is going to get the wrong answer and if you add technology you can make things worse not better. The question is how do you maximise technology policy so that it factors in those environmental and social elements? Is this a technology question first and foremost, or do you need to get the institutions right?

JOANNA BATSTONE: Let me take it from an energy perspective as well. Any large corporation, and obviously I represent a large corporation, tackles these questions as well. We all pay an electricity bill, we all pay a utility bill, and whether you're a private citizen or running a large fabrication facility, the impact that you have on the environment impacts the experience that you have as a corporation as well. What I think we're seeing at the moment is a big shift towards a focus on sustainability if you're a large corporation. We're all used to now going into hotel rooms and seeing the sign in the hotel room that says "as a responsible citizen please think about re-using your towels" as opposed to throwing them on the floor, because then you don't have to wash them as much, you don't have to use as much energy, and it's good for the environment. So I think there's a corporate sense and a personal sense in responsibility as it relates to sustainability for the environment and that actually also translates into business value as well, because it comes back to the bottom line of zero carbon footprint, energy-neutral kinds of innovation. And that focus on sustainability and environmental conscience plays out in a number of different industries. I was booking a flight just a few days ago, obviously I've flown here, and you can opt to pay more to have in essence a carbon-neutral experience on that aeroplane because it reduces the amount of offset taxes.

So I think there's this dynamic of personal responsibility with environment and sustainability that actually is also seen within the corporations of the world because, again, from a sustainability perspective, we need to protect the resources that we have, and as we protect them it's also good business. So it's an interesting equation there around environment pros and cons and how do we protect the environment, as well as looking at novel new ways to innovate.

CHARLES DAY: Constraints are a great stimulus to innovation. So when you're thinking about sustainability, trying to express those constraints in a way that can drive innovation can be a really powerful way to do that. You can do that through a price mechanism, you can do that through a

regulatory mechanism, there are a few different tools at your disposal to do that, but putting those constraints in place can be a huge stimulus to innovation. The classic example is California's regulations around fuel economy standards for vehicles which have really affected global fuel economy figures around the world because of that regulatory lead that they took. So I think that as we think about moving forward around sustainability we'll always be looking for those regulatory levers, the price levers, whatever, to help drive that kind of innovation. But I think that the power of the innovation community to respond to those is really quite significant.

JIM MINIFIE: As you said earlier Charlie, the speed with which photovoltaic in particular has dropped in price has been one of the few bright spots in otherwise a very concerning climate arena, from my point of view anyway.

MARTIE-LOUISE VERREYNNE: I can add a bit of a policy angle to that. We did a piece of research a couple of years ago where we looked at how external stimuli affect innovation in businesses, and what we saw was that the green tape was actually very good for stimulating innovation whereas red tape wasn't. The reason was that green tape gives you the outcome that must be reached and it leaves it to the business how to reach that outcome, whereas red tape tells you what to do. So I think that's a very small but really important distinction in terms of when you want to stimulate innovation.

JIM MINIFIE: That's a very neoclassical perspective, Milton Friedman would be proud, specify the end goal not how to get there. There's another set of questions and I'm going to try to group them together into "work". You see the rise of peer-to-peer work appearing to shift the balance between relational full-time or part-time work and more spot market work, and there's also a concern about whether the volume of work is going to be there. If you find significant components of work really being removed, whether it's automated or offshored, what do policymakers need to do to respond to those changes?

CHARLES DAY: I'm not so concerned that huge swathes of work are going to disappear because I'm always amazed a humans' capacity to come up with new things that they can keep themselves occupied with. But I do think the nature of work and how it relates to our lives is going to change and that's going to change a lot about the fundamental basis of how our society works, because work gives people meaning and position and value in society in a lot of ways. I think that a conversation that we are increasingly going to need to have is how does work factor into our own view of ourselves and the way our society is structured? I know last week the Greens' leader at the Press Club started that conversation and had some interesting reactions. I think that's a conversation that we are going to have to have at some point and there are a whole lot of dimensions that then flow from that around other forms of supporting people in different phases of work.

JIM MINIFIE: Let's open it up to the audience. We'll take two questions at a time and we can group the questions.

AUDIENCE: I hope I'm going to attribute this quote correctly, I think it was Danny Kahneman, the behavioural economist, who said something like, "I'm not so interested in artificial intelligence as I am in natural ignorance or stupidity". In terms of AI, it seems that a lot of large companies are seeking incremental improvement rather than looking for large step change and I see some large industries at the moment that could be seeking somewhat easily, I would've thought, that step change. If you're looking for an experience recently I'd say the iron ore industry has absolutely decimated its costs by

thinking outside of the square. What role does AI or other forms of innovation go towards conquering that sort of question?

AUDIENCE: Charlie, you were talking about the importance of government being nimble in response to technology changes, anyone would jump quickly to say governments are very nimble organisations generally. You see it in things like you mentioned the Uber example and governments responding to that, rather than being a head of the game, and being reactive, rather than proactive. Can you unpack what it means to be nimble for government and for policymakers in that context?

JIM MINIFIE: Two great questions. So where are the big applications for AI and do you think we're being aggressive enough? I think that's a question for you Joanna, firstly.

JOANNA BATSTONE: I think you're seeing a lot of energy going into the world of AI right now or, as I said, augmented intelligence, perhaps not natural ignorance, but I think it's fair to question is it incremental to start and then where is the big a-ha moment? The interesting thing about AI and the techniques that you use to build systems to take advantage of it is you have to teach them first. So the explosion that we're seeing with AI techniques today is around teaching algorithms the language of finance, teaching algorithms the language of medicine, teaching algorithms the language of industrial plant manufacturing and robotics. So I really view that we're at the cusp of transformation as a result of the enablement that we've been doing over the last five years. AI as a technique has been around for decades and decades, but the energy in the marketplace for adoption of some of these new techniques is really now because we've gone beyond designing and algorithm to play chess or to play backgammon or to play Go and we're now seeing real business applications that we can take advantage of.

So on one hand I would agree with you that it's incremental to get to a point at which you've crossed a significant threshold and now you can start to transform the industry, and it has to be two pieces of the puzzle coming together. You've got to have the fundamental computer science capability but you've also got to have a problem environment that demands that you innovate in as algorithm, and I think that's where we are with the massive explosion of data that we're having to handle today. If you look at the world's data generation capacity, about 90% of the data that we have in the world today was created in about the last two years, so it's all those YouTube videos, all those Netflix videos, all of that Instagram data, social media data, in addition to the commercial data. So we're at the point where we've crossed a threshold, there's no way we can drive insight from that vast volume of data without innovating in the way that we build the algorithm. We're really at that tipping point at the moment, so yes, one could argue the advance in a machine learning algorithm is incremental, but we're at the tipping point of a threshold of transformation and it's transformation in a different way in the way we think about data transforming industries enabled by AI technologies.

JIM MINIFIE: So watch this space or participate in this space.

CHARLES DAY: There was a report from Data61, part of CSIRO, recently which talked about the second half of the chessboard and this notion that exponential chain things really start to get interesting when you get to the second half of the chessboard. That's a reference to an old story about the person I think in Ancient Persia who offered to solve the king's problem and said he would have one grain of wheat on the first square of the chessboard, two grains on the second square and

four on the third until the chessboard was full and the king thought that wasn't very much, until he got to the second half of the chessboard and realised that that was the entire grain supply.

JIM MINIFIE: Well 2 to the 64 is a big number.

CHARLES DAY: Yes. So these exponential changes can accelerate rapidly when they do take off, the question is when you hit that inflection point. Coming back to the second question, which was around what does it mean to be a nimble government? The interesting thing is that government interacts with the economy and the innovation in a number of ways, and to be a nimble government I think is to be a government that is a demanding and a creative customer. The government buys a lot of stuff in the economy and the way that the government buys that stuff, the processes it goes through, the parameters it wraps around that can have a really significant impact on the way the economy works and the way in which government interacts with the provider community can be really, really important. Where we see governments doing that well, they can drive rapid innovation across the economy, particularly in the private sector providing them. So I think to be a nimble government is to be a smart customer.

I think the other thing is to be an innovative regulator and one of the good examples we've got at the moment is that ASIC's created a sandbox for FinTech. They've created a special regulatory environment for FinTech firms to try out new things outside of the traditional structures of financial regulation. Those kinds of approaches can enable the emergence of new technologies, new ideas much faster than if we had to change the entire regulatory apparatus. We see that in other areas, there are opportunities to do similar things like that as we move, for example, from mass medicine in terms of medical devices where you design a medical device and get approval and sell it by the thousands, to personalised medical devices where you design a medical device for a particular patient. How do you deal with that from a regulatory perspective? Well, I think it's going to be one of the challenges for government to be nimble in how they respond to that.

AUDIENCE: My first question is about the increasing role that automation plays in life over the next five, ten years and, as we hit that exponential sweet spot, humans will obviously rely more on technology to make decisions. Does the increasing reliance on technology to make these decisions and a decreasing reliance on our own brains to make decisions worry you in terms of the overall intelligence of humans going forward? My second question is with regards to jobs being potentially replaced by technology. Do you see what you could call unskilled labour being pushed more towards social welfare or do you see the cost of job protection insurance premiums increasing?

AUDIENCE: I'm interested in whether when Joanna and her colleagues look around the world for where to locate new facilities and they decide on Australia, how do they then decide on where in Australia they might locate and also, at the other end of the spectrum, where might emerging companies consider their locations? And in both cases, is there an overwhelming imperative to locate in the CBDs of our state capitals or is it's plausible for IBM or a small start-up to locate successfully in a smaller regional centre, so long as it's got an NBN connection and something better than 56k dialup?

JIM MINIFIE: Great questions. The first one, which I'll pose to everybody on the panel, are you worried that human intelligence is declining as machine intelligence is increasing?

MARTIE-LOUISE VERREYNNE: I'll put on my educational hat in answering that. I think you could easily think that, but I think at the same time we can now calculate what we usually would've added up in our heads on our mobile phones or things like that, we can also play Words with Friends and other things that stimulate our brains. On a more serious note, I think that the skills and the things that are going to be expected of humans in the future are actually going to be higher level thinking skills than what it is now, because it will be about problem solving, about interpreting results. So instead of just calculating things and those more low level skills, we'll be expected to do the more high level thinking skills. So I'm not really concerned about that.

JIM MINIFIE: Other thoughts?

CHARLES DAY: I've got to say the question reminds me of the old adage that science fiction doesn't tell us about our hopes, it tells us about our fears and one of my favourite movies is WALL-E where the people end up going around in these sleds, completely flabby, tuned into media all day. Is that really where we're going to go? I'm a bit with Martie-Louise, I'm fairly optimistic that what we are offloading are some of the lower value cognitive tasks and humans have the capacity to rise to and use higher level skills. So I'm not pessimistic.

JIM MINIFIE: The second question was around whether people who predominantly have made their living with a manual skill are going to find it more difficult to do that in the future. Before I open it up can I just have a go at that? One of the maxims I've got in my mind is that over the last five or ten years software has been progressively transforming industries. The inventor of the first web browsers, Mark Andreessen, famously said "software is eating the world" but what's less well-known is the proviso to that, which is that the end result of software eating the world is artisan production, by which I mean that the relative cost of the things machines can do drops towards zero and that increases our willingness to pay for human, customised, real world, emotional, caring work. So if the system works well we'll find whole new realms of activities that machines cannot do coming into demand. Whether that dovetails perfectly with the people who are on the downside of the machine remains to be seen, but in principle you've got quite some upside. Do others have things they want to add to that?

CHARLES DAY: I think you put that really well.

MARTIE-LOUISE VERREYNNE: Yes.

JIM MINIFIE: The other question was around the regional component, the geography which I think really concerns us. Here we are at "the arse end of the world" to quote Paul Keating back in the day, and there are some towns that are even further in that direction, let me put it that way.

JOANNA BATSTONE: Part of the question was do you have to be in the CBD or can you be more remote? Let me give you a perspective from an IBM Research perspective with 12 labs around the world. Some of those labs are in a CBD, some of them are not, but I think it's fair to say for all 12 of our labs when we've started the lab it's been in close relationship and partnership with an academic partner.

When we first started IBM Research in 1945 in New York on the campus of Columbia University in New York City it was a lab on a university campus that subsequently, once it got its legs and became

established enough, moved to the suburbs of Westchester County about 60 miles north of New York City and is basically in a woodland field. The T J Watson Research Center, if any of you have ever visited, looks a bit like a Starship Enterprise rising up out of the field, but it's in the middle of the woods. Our labs in California and our Almaden Research Center are at the top of a hill in Almaden, but they are close to the hotbed of innovation around Silicon Valley and the South Bay area. So proximity is important and you don't have to be in a CBD, but what is important is wherever you choose to locate the people that you want to have can get to work. So you have to be able to think through where is my workforce, it comes back to where is my workforce? Unless you're truly virtual and you're not in an environment where your people go into the office every day, and there are companies like that who are 10% in the office and 90% virtual, but for a company that does have a physical presence you can be remote but you have to be not so far remote that people can't get to work.

As we've looked at our newer labs, we've opened four labs in the last eight years or so, Australia, Ireland, two locations in Africa, and Brazil, in each one of those it's been this decision-making around where is the talent base, where are the universities, where is the ecosystem of business, and then where's the right place to put my facility? The right place to put my facility question also then involves state and local government, because if you're going to build something you need somewhere to put it which could be a big empty field and you're building literally greenfield, or it could be you're going to start by leveraging the community that you find. In our decision to locate research recently in Victoria the magic circle was around landing in Parkville, the science medical precinct, because it ticked many of those boxes of ecosystem. But we have other development labs across Australia and if you look at where we have development labs in Australia they are in the major metropolitan areas: we've got our Security Development in the Gold Coast, we've got our Linux Technology Centre in Canberra, and we've got a lot of our mainframe investment research in Perth. So we're not literally in the middle of nowhere, but we do build outside of major metropolitan cities for a variety of reasons.

Our recent new development labs in the United States for our cognitive technologies, back to AI, and our Watson platform of technologies, in addition to our research labs in Almaden and Westchester County we've now opened new centres right in the middle of New York City, Astor Place, and right in the middle of San Francisco. So as you're experimenting with how to drive innovation you also experiment with the model of where do I put my physical locations and it's an interesting debate, particularly in Australia, back to the manufacturing industry and the automotive industry, as you close down a plant it becomes potentially prime real estate to do something really cool and interesting, but different.

AUDIENCE: My question is about creativity and AI. Last year a French company analysed social media posts to the point where they could predict how to do a marketing campaign around alcohol consumption. How valuable do you think creativity will continue to be and will we get to a point with AI where data analysis will enable us to actually unearth some sort of algorithm to make completely original new things that human beings haven't in the creative sphere?

JIM MINIFIE: Intriguing. Joanna, in the first instance?

JOANNA BATSTONE: Coming back to this data question again, social media data is causing us to invent new ways of analysing information. Some of you may have been tweeting about the event

tonight and some of you may have been tweeting about the World Science Festival here in Brisbane all week. Twitter is really interesting because it changed the dynamic of conversation away from sentences into 140 characters, so the patterns that you then can analyse and the way that you think about language structure fundamentally changed from teaching an algorithm to interpret the sentences that Jim wrote on a piece of paper to now looking for insight into a 140 character tweet. It turns out that, as you mentioned, you can do a huge amount of analytics on those 140 characters.

We've done a piece of work that shows you can do personality analytics on those 140 characters and do inference around somebody's personality profile and whether they're an extrovert or an introvert or whether in fact the character in how they're tweeting has changed because perhaps their behaviour has changed by the way that you analyse the information in the tweet, so it's driving a fundamentally different way of thinking about how we use data. Another example from a Twitter social media perspective is you can leverage the information that people put in their tweets to infer things about outbreak of infectious disease or about a food poisoning associated with a restaurant in a particular neighbourhood because you can see patterns in those datasets aggregated. So the information that we now have requires us to develop these algorithms to treat information in fundamentally different ways, and that's where I think you see the innovation. I mean, who would've thought you can do personality analytics on 140 characters? It's really driving a new way of thinking about data.

JIM MINIFIE: I'm already regretting some of my tweets!

JOANNA BATSTONE: It's actually really interesting because you can do this analysis that says are they my tweets or is it my speechwriter's tweets? So it becomes really interesting and it has all kinds of applications. Language analytics is a really valuable area for AI, the whole meaning of language, the meaning of conversation, the ability to translate text to speech or speech to text is a massive opportunity for all of these AI techniques.

JIM MINIFIE: Thank you so much Joanna, Martie-Louise and Charlie. I've found it fascinating. I know we've only just scratched the surface of an enormous arena, there's a huge amount of work out there and I hope that the audience also has felt that we've touched on some fascinating areas. Thank you for your insightful questions. Thanks to the State Library of Queensland for hosting this event and I look forward to seeing some of you at a future event. On behalf of Grattan Institute, thank you so much for participating in what, from my point of view, has been fascinating.

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