The founder of the Creative Destruction Lab
describes its moonshot mission
to create a Canadian AI ecosystem.

Thought Leader Interview:

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by Karen Christensen

Describe what happens at the Creative Destruction Lab (CDL).
The CDL is a seed-stage program for massively scalable science-based companies. Some start-ups come from the University of Toronto community, but we now also receive applications from Europe, the U.S. (including Silicon Valley), Israel and Asia.

We launched the program in September 2012, and each autumn since, we've admitted a new cohort of start-ups into the program. Most companies that we admit have developed a working prototype or proof of concept. The most common type of founder is a recently graduated PhD in Engineering or Computer Science who has spent several years working on a problem and has invented something at the frontier of their field.

The program does not guarantee financing, but the majority of companies that succeed raise capital from the CDL's Fellows and Associates — a carefully- selected group of individuals who themselves are serial entrepreneurs and early-stage investors. Throughout the year, our MBA students work with the start-up founders as part of a second-year elective course, helping them develop financial models, evaluate potential markets, and fine-tune their scaling strategies.

To date, more than 100 start-ups have come through the Lab. When we launched, we set a goal of generating $50 million in equity value created in terms of the aggregate value created by companies that went through the Lab. When we finished our fifth year in June 2017, we had exceeded $1.4 billion in equity value created.

What exactly does the Lab provide to entrepreneurs?
Start-up founders benefit from a structured, objectives-oriented process that increases their probability of success. The process is orchestrated by the CDL team, while CDL Fellows and Associates generate the objectives. Objective-setting is a cornerstone of the process. Every eight weeks the Fellows and Associates set three objectives for the start-ups to achieve, at the exclusion of everything else. In other words, they define clear goals for an eight week 'sprint'. Objectives can be business, technnology or HR-oriented. Our Fellows and Associates—all volunteers—are critical to the CDL's success.

Tell us more about the CDL Fellows and Associates.
We have designed a marketplace — a community that functions under a set of rules and norms — that facilitates efficient transactions between first-time founders and experienced entrepreneurs, many of whom are also investors. Often, the two sides don't know each other until the rookie founder seeks out the experienced entrepreneur/investor when raising capital. Knowing very little about the entrepreneur, the investor usually says no,

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but occasionally says yes, at which point they are very committed. By the time we hit the end of the academic year, the Fellows and Associates have met with the ventures many times, and they've gotten to know each other. Furthermore, the entrepreneurs have demonstrated their ability (or inability) to deliver against an aggressive set of objectives through several cycles. We don't require Fellows and Associates to invest, but they can — and many do.

When you're founding a company, you're faced with a thousand different things you could be working on. The question is, what should you focus on? People who have done this before are able to triage those thousand things and prioritize the two or three most important things to focus on right now to increase value and de-risk the venture as quickly as possible. Every eight weeks, this group meets with the founders and sets objectives; then the founders carry on building their ventures.

The CDL does not charge fees or take equity. The currency for participation is performance. There were seven Fellows in our first year, so the bi-monthly sessions were named after that Group of Seven Fellows, or 'G7'. At the end of each G7 session, we ask the Fellows and Associates to raise their hand for any companies for which they are willing to commit their most precious resource: time. We ask them to commit to meeting with the company for an hour every other week until the next session.

Any companies that don't inspire at least one raised hand are dropped from future meetings — although they are still part of the CDL family and attend other events. The rule is that at least one company must be dropped from the G7 sessions at each meeting. In the rare case that hands go up for all companies, we raise the price in terms of the amount of time required to commit. As we proceed throughout the nine-month program, this allows us to focus more and more resources on ventures that are showing the most progress.

Three years ago, CDL made a huge bet on artificial intelligence (AI) and machine learning. What prompted that?
In our first year of operation, one of the start-ups that came to us was Chematria, now called **Atomwise**. Its founder, **Abe Heifets** — a U of T PhD in Computer Science and Biology — was applying a new AI technique to drug discovery. What Abe was doing represented not just a marginal improvement, but a potentially transformative change to the way drugs are discovered — which represents a multibillion-dollar problem for the pharmaceutical industry.

While we were working with Abe, a team of graduate students from U of T Computer Science won a high-profile competition at Stanford called ImageNet. It's basically an image-

recognition competition, whereby a computer is given a bunch of pictures and has to identify the image, whether it's a ball, a horse or a wheelbarrow. This team from Toronto participated, and not only did they win — using a machine learning technique called deep learning, largely developed at U of T — but they won by such a margin that the following year, all of the finalist teams were using their technique.

Those are just two examples of events that inspired us to bet on machine intelligence. Overall, we saw mounting evidence that AI was a general-purpose technology that could be applied to a wide range of problems across a vast array of industries, and that's what prompted us to dedicate a new stream of the Lab's activity to AI.

At first, you faced resistance; why?
People said we were being too narrow, that there weren't enough startups to fill an AI stream and that there wasn't enough interest from investors. At the same time, we had believers. One such believer who herself had written a highly influential blog post describing the 'landscape' of companies emerging in the machine learning world was **Shivon Zilis** — a Canadian based in San Francisco and a partner at the venture investing firm **Bloomberg Beta**, where she led the firm's investments in machine intelligence. I invited her to the Rotman School to present her insightful analysis to our MBA students, and the CDL team — quickly realizing she is a star — recruited her to join forces on our AI initiatives. (**Elon Musk** subsequently saw the same potential and recruited her to help him build his empire.)

So, we moved forward with the new stream, but to address these concerns, in 2015 we also launched an annual conference — with Shivon as co-chair — called Machine Learning and the Market for Intelligence. The goal was to educate the Canadian business community about the importance of this emerging field. Leaders in the field — from organizations like **Google**, **Uber**, **Apple**, Stanford, Carnegie Mellon and MIT — came to Rotman to discuss and debate how AI is and will impact a variety of fields, from life sciences to manufacturing to retail. We held our third annual conference in October 2017.

Talk a bit about the CDL's results to date.
The launch of our AI stream transformed the Lab from a Canadian enterprise into a global one. In our first year, our start-ups were all from Ontario, but they now come from around the world. Similarly, in our first year, our Fellows were all from Canada, and that, too, changed when we launched the AI stream. Our ML7 (Machine Learning Seven) includes **William**

Tunstall-Pedoe, who flies in from Cambridge, England, every eight weeks. He has a PhD in Machine Learning and founded Evi, which was acquired by **Amazon** in 2012. Evi's technology powers the AI engine in Amazon's Alexa, which, to my knowledge, is still the top-selling consumer AI hardware product in the world.

The ML7 also includes **Barney Pell**, who flies in every eight weeks from San Francisco. Barney also has a PhD in Machine Learning and led an 85-person team at **NASA** that flew the first AI into deep space. He then built an AI company called **Powerset** that was acquired by **Microsoft**, and now he's the cofounder of **Moon Express**, which is essentially building a **Federal Express**-type service to the moon, because Barney believes the moon is going to be an important gateway for commercial space travel.

So far, the results have surpassed our expectations. Back in 2012, we accepted 25 companies into our general high-tech stream. Last year, we doubled that by adding the second cohort focused on AI, so we had 50 start-ups. This year, we doubled our intake again by accepting 100 AI-focused start-ups and adding a new stream: The world's first program focused on launching startups predicated on quantum machine learning (QML). To our knowledge, the CDL is home to the greatest concentration of AI-based companies of any program on Earth.

Among CDL's 'graduating' companies to date, which best personifies your vision?

We are proud of all of them, and different companies reflect different aspects of our vision. For example, Atomwise personifies our focus on the application of science that can have a transformative effect on society. As indicated earlier, it brought in a very early application of a new branch of Computer Science (deep learning) and applied it to a commercial focus (drug discovery).

Thalmic Labs captures the scale and ambition of our mission. They raised their seed financing largely from our G7 Fellows. About a year ago, they raised $160 million in Series B financing (US$120 million), which was one of the largest Series B financings in Canadian history.

UDIO, founded by **Katya Kudashkina** (Rotman MBA '15), captures the CDL's entrepreneurial spirit: She immigrated to Canada without a penny to her name and really hustled to get into the top business school in the country while studying English at night. When she graduated, she was recruited into a nice, secure job at the **Canadian Pension Plan Investment Board**. She left that job to found a start-up, which she brought to the Lab, raising a few hundred thousand dollars in investment capital.

Early on, UDIO was focused on building robotic bees for artificial pollination in the agricultural industry. But the G7 advised Katya that it was going to take too long to get to revenue with that business model, and that she needed to be closer to her customers. So, she packed up her life and moved to California — essentially living on someone's couch so she could focus on almond farmers in Northern California and learn their business from the ground up.

Ultimately, Katya ran out of capital before she could get to revenue and the company folded; but she wouldn't give up and launched another start-up. She learned a lot from her first company and maintained great relations with her investors. I wouldn't be surprised if they invest in her again, because she is so driven, trustworthy and willing to learn. She is a prime example of the persistence required of entrepreneurs.

As indicated, CDL features collaboration with both current MBA students and highly successful entrepreneurs. Can you give an example of a firm that benefited from both?

One example is **Validere**. One of the co-founders just finished his PhD at Harvard, where he developed a technique called Optical Liquid Fingerprinting, which identifies the properties of a liquid. Normally if you want to find out a liquid's properties, you take a sample, send it to a lab, and wait for the results. This start-up developed a process whereby they can essentially determine the properties of a liquid in real time. They came to the CDL wanting to sell this service to the luxury perfume industry, to help detect counterfeit perfumes.

After reviewing their business, the Fellows told the founders that they *loved* the technology but *hated* the business idea. So, the G7 turned to our MBA students and asked them to do a market analysis to find out where this technology would have the most value. The MBAs returned with a recommendation to move from one of the sexiest of all industries — luxury perfume — to one of the least sexy: oil and gas. And that is what they ended up doing.

One of our Fellows is Dr. **Chen Fong**, former head of Radiology at the University of Calgary and active investor in medical technologies as well as the energy industry. After learning about Validere's technology and the recommendation to focus on oil and gas, Chen flew the founders out to Calgary and drove them (himself!) around the city to meet with a number of oil and gas executives to solicit feedback on their product.

Soon, the business was transformed: They attracted some significant customers and went from being unable to raise capital to being over-subscribed, with more investor interest than

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they could accommodate. Our MBA students learned a tremendous amount — a very different but complementary type of education than they get from reading about historical case studies. This example epitomizes CDL's vision: A science-based innovation that will enhance society; created by appreciative, persistent, and coachable founders; national connections, insightful advice and mentoring from our G7 Fellows; and an incredible hands-on learning experience for our MBA students.

The Lab is one of the most popular second-year MBA courses at the Rotman School. Why does it resonate so much with students?

For two reasons: First, it combines the traditional mode of learning from lectures with learning-by-doing; and second, it links academic work with a sense of ownership.

The traditional approach to learning at CDL is led by our Chief Economist, Professor **Joshua Gans**, who developed a structure for teaching entrepreneurial strategy along with MIT's **Scott Stern**. This provides students with an academic framework and context for what they're going to experience next. Then comes the learning-by-doing part. Normally, business schools use Harvard Business School cases to provide examples in the classroom. As indicated, we replace those with real companies. Working with founders, Fellows and Associates provides students with an opportunity to roll up their sleeves. Instead of reading a 30-page case that comes with a fact set, they have to find the facts themselves and figure out — of the infinite information out there, which bits are the most valuable for their needs? They experience the messiness of the real world and the reality of having to make decisions without having full information.

The second piece is *ownership*. When our students work with these start-ups, *every decision matters*, so they have a real sense of ownership. It's a powerful learning experience to feel ownership over the results because the consequences are so tangible.

Universities rarely adopt programs developed elsewhere. What motivated the University of British Columbia, New York University, the University of Calgary, Université de Montreal and Dalhousie University to adopt the Creative Destruction Lab program?

Every university has a program or course on entrepreneurship and start-ups, but I think the CDL stands out due to its significant results. The calibre of investors from the business community who have rallied around the CDL is unprecedented. Naturally,

other universities would love for that to happen at their own business schools.

When UBC indicated interest in adopting the program, the big question was, 'Is this replicable?' But a very competent team, under the direction of Professor **Paul Cubbon**, was able to reproduce it. When CDL-West completed its first year, the results on all dimensions were impressive, and we had evidence that, yes, this program is replicable. We have since launched CDL at the University of Calgary, Dalhousie University and Université de Montreal, and in October, we announced a partnership with New York University's Stern School of Business.

CDL Toronto's competition is not Vancouver, Calgary, Montreal, New York or Atlantic Canada: it's Silicon Valley. Each of the CDLs has attracted some of the top business people from its region. Our challenge now is to cross-pollinate, so that the Montreal Fellows are connecting with companies in the Toronto program and the Toronto Fellows are connecting with companies at CDL Atlantic, and so on. One of the things that makes the Bay Area so effective is that everything moves so fast. If we can accelerate the velocity of business development here, we will have raised Canada's game as a whole.

You mentioned earlier that CDL launched the world's first program focused on quantum machine learning (QML). What is your vision for this initiative?

It's a bold one: By 2022, the QML Initiative will have produced more well-capitalized, revenue-generating quantum machine learning-based software companies than the rest of the world combined, with the majority based in Canada.

Why QML? First, we can leverage the leadership that CDL currently has in the commercial application of machine learning. Second, we can leverage Canada's leadership in quantum computing at places like the **Perimeter Institute** and the **Institute for Quantum Computing** in Waterloo, Université de Sherbrooke in Quebec, and **D-Wave** in Vancouver, among others. Third, we can leverage the network of investors, entrepreneurs, scientists, and corporations that have rallied around the CDL and our mission of commercializing science for the benefit of humankind. [**Editor's Note:** For details on the QML program, visit creativedestructionlab.com/locations/Toronto/quantum.]

Clearly, the CDL is leading the way in this arena.

I believe so. Three years ago, it felt like we were moving early on AI, but we realize now that — if we could turn back the clock — we actually should have started even sooner and moved faster. We were roughly a year ahead of everyone else, but now a number of

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programs in other countries are focused on AI startups — so we're running fast just to keep our position.

In terms of QML, so far we're the only ones doing it, and that's because the technology is so embryonic. We might go for two or three years without a significant success, because we might be too early. The point is, once there's a hit, places like MIT, Stanford and Silicon Valley will all double down in this field. Our approach is to get ahead, make the investments now, and attract all the elements of the ecosystem to Canada.

We want to do in Toronto with QML what Silicon Valley did with semiconductors in the 1960s. There's nothing inherently magical about Silicon Valley. The semiconductor industry happened to start there due to the pioneering efforts of a handful of people, and once that community grew big enough, it became very hard for other regions to compete. Our view is, if we can seed it here and if the industry takes off five years from now, by that time, Canada will have such a critical mass that it will be hard for the whole community to move somewhere else. We're trying to plant the seeds now.

Already, three top Silicon Valley venture capitalists are sufficiently optimistic about this program that they offered to invest in every one of the companies that gets into it — *sight unseen*. Most of these companies won't make it — and they know that — but they want to be involved because along the way, they will get an education in QML, and there is some positive probability that one or two of these companies will figure out a commercial application.

Globally, what has been the reception to AI?
Earlier this year, the Canadian government made a series of financial commitments to attempt to maintain its position as a leader in AI research. In July, China announced a long-term AI plan that dwarfs Canada's investment and specifies a timeline through 2030 during which China aims to become the world leader in AI. Over the Labour Day weekend, Russian President **Vladimir Putin** foreshadowed significant investments when he stated: "AI is the future, not only for Russia, but for all humankind. Whoever becomes the leader in this sphere will become the ruler of the world."

There has also been caution: **Tesla** CEO Elon Musk has made pleas for governments to take AI safety seriously and to set up regulatory bodies to manage it. His **Twitter** response to Putin's remarks was: "It begins...," which he followed with: "China, Russia, soon all countries w strong computer science. Competition for AI superiority at national level most likely cause of WW3 imo." Musk is concerned that AI is developing more rapidly than

we realize and that there is significant risk to human civilization. He feels it needs to be regulated, not unlike communications, air traffic, financial services, healthcare and aerospace.

Will AI change the way decisions are made in organizations?
Yes. Every disruptive technology lowers the cost of something, and in the case of AI, that something is *prediction*. By prediction, I mean using data that you have to generate data that you don't have. Economic theory tells us that as the cost of machine prediction falls, we will use more of it. Prediction is an input to decision-making under uncertainty. When faced with uncertainty, we need to predict the likelihood of different outcomes when we make a decision. As machine prediction becomes cheaper, we'll increasingly substitute human prediction for machine prediction in the decision-making process.

However, prediction is not the only ingredient for decision-making. Judgment — the assignment of value or payoffs to possible outcomes — is also important. Machines do prediction, but only humans have judgment. I anticipate that organizations will engage in much more decision-making because a key ingredient is now much cheaper, and the value of human judgment will increase, as we demand more of it. We can only speculate on the aspects of judgment that will be most valuable, but things like ethical judgment, emotional intelligence and artistic ability are likely suspects. ***RM***

Ajay Agrawal is the Peter Munk Professor of Entrepreneurship, Professor of Strategic Management, and founder of the Creative Destruction Lab at the Rotman School of Management. He is also cofounder of Next Canada, which includes Next AI, a not-for-profit program to inspire young entrepreneurs and technologists to explore commercial opportunities that are a direct result of advances in AI. Along with Rotman Professors **Joshua Gans** and **Avi Goldfarb**, he is co-author of *Prediction Machines: The Simple Economics of Artificial Intelligence* (forthcoming, Harvard Business School Press, April 2018). For more on the book visit predictionmachines.ai