On the Power of Modelling

Interview by Karen Christensen

In addition to teaching Operations Management at the Rotman School, you recently co-founded a start-up called SiMLQ, which, according to your website, is "Revolutionizing process management." How are you going about this?

We believe transforming process management is an important strategic direction to take at this moment in time. Our vision is to become the tool of choice for the analysis of business processes using a 'digital twin.' Digital twins replicate physical objects, processes or systems using real-time data to simulate and mirror their real-life counterpart.

Many organizational systems today are both highly complex and highly congested. In the past, managers could build simplified models of all the activity going on within a system and then take steps to impact its efficiency. Today, mountains of data are being generated that can be paired with machine learning and AI—which means that we can now create *highly realistic models* of organizational systems.

We believe these realistic models will be transformative, because they mean we can analyze and improve complex operational contexts by looking at causality and the impact of distinct actions on overall performance. Specifically, the processes we are focusing on are called 'queuing network processes.' In Operations Management, a *queuing network* is a system where customers, patients or 'jobs' move through multiple interconnected queues and servers, forming 'waiting lines' throughout the system. Queuing Theory analyzes how things like the rate of customer arrivals, service speed and network configurations affect performance measures like queue length and response times. Operations managers have long studied queuing to optimize resource allocation and improve efficiency.

In daily life, we observe queuing all around us. When you go to a hospital's Emergency Department (ED), you have to follow specific steps: You sign in, then see a triage nurse, then check in at a registration desk. Eventually, you will see a doctor or nurse practitioner, and you might then be sent to other doctors. We can think of each step as a part of the queuing network for this ED.

Queuing also happens when you phone a telecom contact centre. First, you get an automated response, which you progress through, depending on your inputs; and if you're lucky, eventually you will get to a human agent who can solve your issue. The majority of manufacturing also involves queuing: jobs move from one station to another as a product is pieced together. And cloud computing farms are also complex queueing networks. As indicated, we now have so much amazing data that we can make all of these systems much more efficient.

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Why did you decide to initially focus on healthcare for your business?

For a few reasons. As a business professor, I know that making money is important to people. But I also know that the quality of life that can be attained via good healthcare is much more critical. Worldwide—and certainly in Canada—we are seeing issues of very long wait times, a severe lack of family physicians and delays in elective surgeries. I myself have been served in emergency departments in four different countries, so I know it's not just a Canadian problem. And we have an aging population, which complicates everything. By addressing different parts of the problem, we hope to impact the greater system. In the end, our aim is to impact peoples' quality of life for the better.

The second reason we chose to start out in healthcare is that my Rotman colleague and co-founder **Dmitry Krass** and I have been working on healthcare research for over 15 years now, so we have many great connections in the industry. It made sense for us to focus there first.

Can you give us an example of how SiMLQ adds value in a typical emergency department?

Let me first explain why we are called SiMLQ—which is pronounced Sim-L-Q. The 'Q' at the end stands for Queuing theory; 'ML' stands for Machine Learning and 'Si' stands for Simulation. When you are working with a complex system, it is not easy to analyze it. The best way to do so entails using some kind of simulation that captures the causation of how things work. The results of the simulation should provide a good understanding of what the impact will be of different possible interventions.

For example, most ERs have a rapid-assessment zone and a non-rapid assessment zone. There are people arriving constantly, and they all have to be triaged. The nurses examine each individual and there is a choice to be made: 'Where should I send this patient?' This choice then impacts the flow time for both acute patients—truly acute patients—because sometimes people exaggerate their symptoms—and also non-acute patients. And that is just one decision amid everything else going on in an ER.

Another example is, you might see a doctor, as I did after a ski accident on my last visit to an ER, and they say, 'You need some blood tests and medical imaging.' But where will they send you first? If they have direct access to the current queuing situation at each location, they can decide to send you to one place over another. This is what we call a 'routing action.'

Our work can also touch on practical strategic decisions. Say there are 200 hospitals in the province of Ontario, but the province only has funding for 10 new MRI machines. Which hospitals should they go to? This decision will impact waiting times for thousands of people, and there is also the important issue of equal access to services in rural versus urban areas. There may be more people in an urban area, but the service there is already pretty solid compared to rural areas, where there are much longer delays. By choosing a rural hospital, you may not see the same optimization, but equity must also be considered. These are just a few examples of the issues we're aiming to address with SiMLQ.

You've been teaching Operations Management at Rotman for over 20 years. Are there key principles or mindsets that have stood the test of time?

To me, the key principle in my research, my teaching and my business has been the ability to model things. You can experiment with a model much more cheaply than playing with reality. Doing live testing is very expensive. So, before you go ahead and change a procedure, if you can replicate it on a model and get a sense of the result—that is a critical step in the process.

When I first started at Rotman, I worked with Dean **Roger Martin**. One of the first things he said to me was that the difference between good managers and excellent managers is their ability to model. That always stuck with me. Models allow us to focus on the things we can control and to understand how various elements interact and will be impacted by change.

Today, the challenge for young managers is that models are much more complex than ever before. It's not as simple as, 'demand is decreasing with price.' Today you have to be able to look at different scenarios and how different ages and genders impact things in a way that you couldn't do before, because you didn't have the data.

What are the steps involved in taking complex data and turning it into an actionable insight?

Figure One shows our framework for moving from data to decisions. We call it the 'Digital Twin Process.' The process starts with existing data in a current IT system. Out of these data, you create an 'event log' with three main components: Which jobs are being tracked (items in a workflow? Patients? Computer tasks?); what processes/steps did these jobs need to undergo?; and when did these activities happen? You can note that by putting a time stamp on it. Once you have these three things, you can add to them many other static and dynamic features—like the size of the order, patient ages or genders and so on.

The analytical team then transforms these data into an event log that enables the creation of process maps and dashboards. Then it trains a simulation model that can be used to support 'what if?' analysis. Business experts can then compare the effectiveness of different actions and select actions to be implemented. This selection can also be made using a decision support tool or can be automated using modern optimization capabilities. The action then changes the system, leading to new data being collected in the system, updating the model—and so on. The magic is that with tools like SimLQ, the digital twin process can be completed in real time.

When the digital twin process works, you end up with a really good predictive model, but what's most important is that it captures the *causal structure* of the process. This allows you to do 'comparative analytics,' such as calculating counter factuals. You can ask, 'What would happen if we added capacity?' or, 'What would happen if we changed this doctor's shift?'

In the past, going from data to a simulation model would have taken one person about a year—but now you can do all of these things in seconds. You can capture what would happen, select an option and update the model immediately. And using reinforcement learning, we can further improve the automation of decision-making. If it was a good decision, the next time we will know that, and act accordingly. You basically create a feedback system because as the system changes, the digital brain essentially changes with it. It's a kind of real-time feedback where decisions of the digital brain are implemented, change the data, and the data changes the digital brain. That is the essence of our approach.

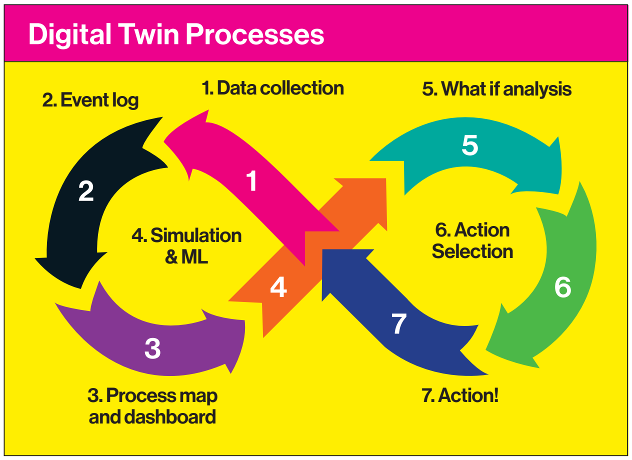

FIGURE ONE

What's next for SiMLQ?

First off, I'd like to give a plug to the **Creative Destruction Lab**, because we went through its AI Stream in 2025, and it was amazing. We learned a lot. It really helped us to focus and change the way we work. The mentorship we received really shaped how we do things, how we push things and how we prioritize things, which is extremely critical for our staff. We are very grateful to the CDL team.

As to where we're going next, we're currently piloting our product in several hospitals and have sold it to a couple of others. The next goal is to reach about 100 customers. We'd like to scale up the usage of SiMLQ more broadly in Canada and south of the border—and then go to other places. The long-term vision is not to focus only on healthcare, but to move into other applications. Over time, we wish to see SiMLQ as the tool of choice for creation, analysis and optimization of business processes using digital twins in the service, manufacturing, logistics and communication industries.

Right now, we're a small company with 12 people, so we don't want to bite off more than we can chew. But one day we might look at manufacturing systems, court systems and more. After all, our goal is to revolutionize how process management is conducted, period. ***RM***

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