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JOHN MOLSON
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Professors Carlos Cordon, Professor of Strategy and Supply Chain Management, and Benoit Leleux, Stephan Schmidheiny Professor of Entrepreneurship and Finance, and Researcher Marc Chauvet prepared this case as a basis for class discussion rather than to illustrate either effective or ineffective handling of a business situation.

Celonis: Building a Lean Digital Ecosystem

GERMANY, APRIL 2021. Martin Klenk was getting ready to climb on the main stage of the 2021 Celosphere conference. Like its predecessor a year earlier, the conference was organized virtually because of COVID-19 travel and meeting restrictions. This year, however, the stakes were much higher as Zoom fatigue had set in and audiences' patience with videoconferencing technical glitches had all but disappeared. Everything would have to run smoothly. After all, smooth, seamless processes were exactly what Celonis claimed to enable …

When the team of founders incorporated Celonis in 2011, they certainly did not foresee the latest turn of events, particularly that one day they would stand on a large, custom-built stage with a wall of cameras focused on them and thousands of virtual onlookers. It would soon be time to share with the audience the latest steps in the formidable journey that took them from a minuscule Munich student apartment to one of Europe's most celebrated and valuable unicorns. Their early process mining algorithms had evolved into a collection of

some of the most powerful software for rapidly identifying process discrepanciesand optimizing complex corporate IT systems.

To maintain its position as the category leader in process mining and execution management, Celonis now needed to be able to facilitate – or even automate – corrective measures on these processes to edge closer to process mining nirvana, i.e. a fully automated, intelligent and real-time execution management system (EMS). But to reach that holy grail, Celonis still had to determine the right balance between features that were best developed in-house and those that could rely on its growing ecosystem of partners. Opening up the platformto third-party suppliers unleashed a new wave of creativity that could prove difficult to contain and channel. Would the team be able to control that explosive growth? Was the EMS the end of the road, or just another step in a longer journey to unleash the full power of big data in large organizations? Celonis had created tools to bring the Lean philosophy into the digital age, but would the new ecosystem be enough to launch it into orbit?

From the corner of his eye, Klenk noticed the stage manager approaching. Muting the microphone with her hand, she whispered it was time to get on stageand show the attendees the new product architecture that Klenk's teams had been working on for several years and the ecosystem they had built around it!

Celonis and the inception of process mining

Celonis was founded in 2011 in Munich (Germany) by Martin Klenk, Bastian Nominacher and Alex Rinke a few months before their graduation from TUM, the Munich Technical University[1] (*see* ***Exhibit1***). The trio had just finished a consulting project for Bavaria's public broadcasting service Bayerischer Rundfunk (BR) focused on improving BR's IT service team's response times. Whereas the industry average was about two days, BR often needed five days to deal with issues. As they completed this engagement, the three students were baffled that the traditional, albeit best-in-class, optimization methodologies they had used – running interviews, tracking a few samples in the workflow, interpreting macro-level key performance indicators (KPIs) – were extremely inefficient, time-consuming, imprecise and, thus, not that useful. How could companies with broad IT system landscapes, which meticulously tracked events and generated troves of data, not consider using that data to generate more useful insights? BR rated its project a complete success and recommended that the trio consider commercializing their concept.Confident they could deliver on this idea, the three agreed to decline the corporate job offers they had already secured and, instead, embark on an entrepreneurship path to show the world how process mining could be done better.

[1] https://www.tum.de/en/innovation/entrepreneurship/news-events/entrepreneurship-news/short/36721

After graduation, the trio started developing their first "process mining" software solution: By compiling the log-files generated by most enterprise resource planning (ERPs) (e.g. SAP, Oracle, Microsoft), customer relationship management (CRMs) (e.g. Salesforce) or similar enterprise-level IT solutions, their tool automatically represented the organization's actual workflows, pinpointing bottlenecks, delays, sources of sub-quality products and divergences from the expected workflow. With this finer, data-based, real-time understanding of their process dynamics and performance, companies could shift their efforts from documenting and auditing performance to actually improving it. This concept of "process mining" had already been developed by academics, who were running demos with a few thousand events,[2] but until then, it had never been applied to real-world situations commonly facing tens if not hundreds of millions of events.[3]

The route to unicorn status

Companies rapidly welcomed Celonis' software, and the startup grew significantly over the following years. In 2012, Celonis partnered with SAP, the leading ERP software provider; this partnership allowed Celonis to expand its sales footprint with SAP's 12,000-strong global salesforce and seamlessly

[2] An event is characterized by a set of attributes such as, a case ID, timestamp, cost, resource, and others. A set of events creates an event log – a table with events listed in its rows.

[3] A deep dive into the creation and scaling up of Celonis can be found in Leleux, Benoit & Marc Chauvet. *Celonis: The Process Mining Unicorn*. IMD case no. IMD-7-2161, 2021.

integrate into SAP's pre-existing corporate accounts. Because of the reliability and impact that the partnership unlocked, many early, small-scale projects within German industrial behemoths were expanded into full-fledged deployments. The team agreed that it was time to expand into North America, the largest market for enterprise software, and that the best way to ensure the success of this endeavor would be for Rinke to relocate there. At the time, the triumvirate each held the co-CEO title. Such an egalitarian setting was commonplace in Germany,[4] but several clients and advisors commented that for large North American corporations, it undermined the perception of Rinke's ability to decide because he would always require the agreement of at least one of his co-CEOs. Over the first decade of Celonis' existence, the allocation of responsibilities had progressively converged with Nominacher focusing on the European and international operations, as well as back-office activities, Rinke running the Americas operations and front office activities, and Klenk focusing on the engineering and development of Celonis' offering. As a result, the trio decided to appoint Martin Klenk as CTO, leaving Nominacher and Rinke as co- CEOs. This clarification of the co-founders' titles coincided with Celonis' Series B funding round in June 2018, when the company's valuation surpassed $1 billion for the first time, graduating it into the four-strong German unicorn club.

Celonis' international expansion was boosted by the publicity that accompanied its unicorn status, as well as introductions made by the new investors and fresh funds. The small Tokyo office grew into a much larger entity in a country already

[4] Including in large German corporations such as Zalando, METRO, Deutsche Bank, Goldman Sachs Germany … and even SAP briefly in 2019–2020.

convinced of the value of ERPs and processes. To complement the North American headquarters in New York, new offices were opened in San Francisco, Chicago and Raleigh. In November 2019, just as the company was entering its ninth year, a Series C round raised the company's valuation above $2.5 billion.

But the realization also brought with it a load of tricky strategic questions. Oneof them was whether it made sense to focus on specific industry verticals. Although the technology was extremely versatile and thus not a constraint, many scale-ups had previously failed due to a lack of focus. Would it make sense forthe company to forego the revenues of some industries, or should it consider new forms of collaborations to capture these verticals through partners?

Digitalizing Lean

The principles of Lean long predated the digital wave. Originally focused on manufacturing, the concept emerged from Toyota's operating model in the 1930s and was refined in the following decades. At its core, this production- focused set of principles aimed to deliver continuous improvement of output products while respecting employees by focusing on the three types of deviations from the optimal resource allocation required to produce a given product – wastefulness, non-uniformity and overburden – which were often referred to by their Japanese names: Muda, Mura and Muri, respectively (*see* ***Exhibit 2***).

In the 1980s, North American car manufacturers realized the "Toyota Production System" had allowed their Japanese competitors to outperform them in terms of sales. Gone were the days when Toyota relied on cheap labor

to produce mediocre vehicles. Instead, Toyota and its peers outperformed US manufacturers in terms of quality, cost and lead time,[5] prompting them to follow the same path:

- Asking what clients value.
- Mapping how this value should "flow" across the production process.
- Ensuring that the actual flow adhered to the plan.
- Establishing a "pull" dynamic by only producing when a client placed an order.

Surfing the digital wave

At the time, Lean methodologies were predominantly implemented on paper. But in the following decades, the broad adoption of computer systems, digital technologies and ERP systems resulted in the gradual digitalization of processes. However, the anticipated benefits of expensive ERP system deployments oftenfell short of expectations because they were not accompanied by a parallel transformation in how the businesses operated. Armies of consultants were still recruited to tweak antiquated pre-digital systems and make sense of the gigabytes of data these new systems generated and accumulated.

New Celonis employees were often reminded by Klenk that their company's success relied on bridging this gap by empowering their clients to make senseof the data. More recently, Klenk had updated his pitch to new employees after reflecting on the typical customer journey when using the Celonis software

[5] The time between the initiation and the completion of a production process.

suite, stating that a typical project had three steps: feeding real-time data, identifying execution gaps and driving actions to mitigate these gaps.

Feeding real-time data

Klenk's teams worked hard to ensure as seamless an integration as possible with most ERP and CRM systems, even in large multinational companies. The CTO had lost count of the number of times clients had been baffled that the Celonis deployment was operational within a few days. The system could analyze terabytes[6] of data and track hundreds of millions of events in real time. But Klenk was all too aware that ERPs and CRMs did not track every piece of information generated in a company. E-mails and documents in shared folders possibly also contained valuable pieces of information that could help assess how processes were running in the field. If the ultimate goal was to enable companies to capitalize on all of the digital information available, these "blind spots" were a problem, so Klenk's team developed a desktop recorder technology dubbed "task-mining." Another known weakness of the approach was its tendency to focus on the richest data flows, a statistical fluke inherited from the tendency to focus on sigma, the standard deviation of distributions. Leading experts in Lean implementation had grown convinced that significant savings could be realized by targeting not the mean but the "long tail" of the distributions, or the rare events that occurred with very low probability. Despite occurring infrequently, they could contain a wealth of information and provide clues as to how to manage or avoid them.

[6] A terabyte is 1,000 gigabytes.

Identifying execution gaps

When pitching its solutions, it was critical that Celonis demonstrated a clear return on investment (ROI) for its customers. Celonis invested heavily in documenting use cases, showing the new insights gained and highlighting inefficiencies from optimal processes. The business case was of course easiestto build in sales, procurement and vendor sourcing, which were often the first areas where Celonis' solutions were used. Many large companies had invested millions of dollars in completely digitizing these functions, requiring traceability and comparability of both vendors and internal processes. Klenk assessed thatclose to 80% of customers used the suite's features to manage orders and accounts payable.

This 80% figure highlighted the benefit of staying industry-agnostic. The three founders had considered whether to develop industry-specific features several times, but elected to continue addressing the market as broadly as possible forthe time being.[7] In their view, they were creating an entirely new software category, and as such, they should remain open to all verticals. Nonetheless, clients like Dell and BMW – who had become Celonis advocates after seeing significant improvements in their operations – were regularly nudging Celonis to focus more on their industries and develop even finer tools for their

[7] Celonis had already built a marketplace with hundreds of apps with industry-specific content, such as Fuel Order Management for airlines or Patient Management for hospitals. This experience fueled the questioning around whether Celonis should be the sole (or at least main) creator of these apps or whether these apps should be opened topartners with domain/industry expertise.

purchasing functions. Klenk occasionally wondered if Celonis was missing out on some opportunities. Yet, he had recently been privy to a conversation with the CFO of a large automotive supplier about how the company had improved its annual cash flow performance by around €20 million by focusing solely on accounts receivables, which alleviated his concerns. There was still a plenty of low-hanging fruit to be had with a generic solution.

Driving actions

For a long time, end users were responsible for acting on identified business discrepancies and bottlenecks, based on their company-specific knowledge. This was seen as a corollary of the founders' decision to remain industry-agnostic. It was further reinforced by the discovery that large, successful Celonis deployments often relied on the establishment of process excellence centers, which brought together data engineers, analysts, trainers and evangelists to ensure that insights were acted upon. For instance, in 2018, after two years of exploring and evaluating Celonis, BMW decided to set up a "process mining team."

However, since the mid-2010s, the emergence of artificial intelligence (AI) and robotic process automation (RPA) [8] had once again raised the question of industry focus among the three founders and their investors. With that in mind,

[8] Robotic process automation is the reliance on software components that automate the interactions with existing IT applications, including those originally intended to be only used by humans. These software components are often referred to as "robots," as they replace humans and do tasks faster and more efficiently.

task automation features had recently been added to facilitate and ensure consistency in the gap-mitigation actions taken by customers.

COVID-19

By the end of 2019, Celonis had hired its 1,000th employee and moved both its Munich and New York headquarters into larger offices. The executive team had enlisted seasoned SaaS-industry experts to help the company achieve its goal of creating a completely new software product category. The revamped team was just starting its brainstorming on the organizational changes that would be required to triple the headcount in the coming years when the COVID-19 pandemic hit the world, putting these aspirations on hold.

In the wake of the first lockdowns, all Celonis offices, including both new headquarters, were left vacant. The work culture across the 15 different offices worldwide combined the German support for work-life balance with the digital savviness of any SaaS vendor, allowing the business to run nearly as seamlessly as before. But many companies had to halt most, if not all, of their operations, making cash management the top priority. The remaining manufacturing plants that were still operating had to adapt their workplaces in real time to limit the risk of cross-employee contamination causing even more disruption to operations, which was compounded by higher absenteeism due to sick leave and preventive quarantines. Disruptions in supply shipments and deliveries to customers became common, especially when they crossed international borders.

In response, Klenk's team worked around the clock to release three "COVID-19 Customer Care" apps to help businesses preserve cash by better monitoring accounts payable and receivable and identifying the biggest supply chain disruptions. These applications could plug into existing Celonis installations and were delivered free of charge, not only to all existing customers but also beyond the customer base, through a cloud-based solution that allowed any company to simply upload its datasets and have them assessed. Many new companies reached out to Celonis' sales teams after trying the apps and discovering the many areas where they could extract direly needed cash.

COVID-19 Customer Care Program Announcement

At the same time, Celonis' teams decided to run a full-page ad campaign in a number of prominent newspapers, including the *Wall Street Journal*, pledging Celonis could find $10 million trapped in readers' businesses, or it would donate $100,000 to the reader's chosen non-profit organization (*see* ***Exhibit 4***).

Meanwhile, a handful of Celonis customers faced the opposite problem: COVID-19 vaccine manufacturer Johnson & Johnson, diagnostics instruments and reagents manufacturer Sysmex and hygiene products supplier Kimberly-Clark experienced tremendous peaks in demand. Kimberly-Clark faced a tenfold increase in orders, which it chose to address by operating an online "war room" where teams would hold 24/7 shifts during which they would use the Celonis platform to make sense of the situation in real time and ensure their supermarket clients remained stocked.

Building an ecosystem

Onboarding consulting firms

From Celonis' inception, Klenk had made it a priority to ensure the software solution remained as simple to integrate and use as possible. These were key differentiators in the product's early years, but they made consulting firms highly reluctant to use the tool because it could cannibalize highly profitable projects. The company counted large, industrial accounts such as Siemens, Deutsche Telekom and Kellogg's among its customers. Seven of the world's tenlargest telco companies used Celonis, as did six out of the ten largest oil and gas companies and some of the largest bottling companies, such AB InBev and Coca-Cola. The founders were all too conscious that their success had been partly made possible thanks to the original partnership they had signed with SAP, giving them access to its key accounts. Growing an ever-more heterogeneous client base and reaching smaller accounts while remaining agile could only be accomplished by involving consulting and professional services firms, which would then deliver value to their clients through a variety of means, including specializing in the client's specific industry or function, focusing on Lean or similar operations expertise, being included in broader strategic consulting projects or even just having the ability to staff process mining experts on short notice.

Successful sales required not only seamless deployment on the technical side but also the adaptation of work practices, corporate cultures and change management. For these activities, consultants and their rich industry-specific experience were clearly beneficial. To support the onboarding of these partner

consulting firms, a "Digital Consulting" department was created and began partnering with KPMG, PwC and Deloitte. The department would support these consultants in specific client engagements. Thanks to project-related licenses that often lasted for a short period of time, these firms began using the software to quickly do the tedious tasks of data extraction and processing, allowing their consultants to focus on the more profitable part, i.e. generating process insights and optimization recommendations. Later on, several energy-industry-specific firms started relying on Celonis for its consulting services, which again scaled up the company's commercial reach. To accompany this trend, in 2021, Celonislaunched its "Celonis for Consulting+" program, which allowed all consulting firms to use its solutions for free up to a certain threshold (*see* ***Exhibit 5***).

A new software category: Execution management system (EMS)

As the pool of users grew in number, geography and profile, Klenk saw users doing more and more with the system and demanding additional technological features. Now that they could easily see their problems through Celonis' "X- ray" diagnosis, users' appetite grew for a solution that would automatically fix the gaps. To top it off, the requests were becoming more use-case-specific.

Attuned to the needs of Celonis users, Klenk recognized that this evolution was here to stay. He asked his team to rework the software from the core, transforming it into a platform that could accommodate many new data sources beyond traditional ERP and CRM systems and run as many software applications as possible. As a result, the Celonis Execution Management System (EMS) wasborn.

EMS was much more than just a deep rewrite of the source code. By allowing vetted external software providers to complement its own tools and engines and by leveraging new data sources,[9] Celonis hoped to strengthen its ability to solve business problems in real time. Early customer feedback appeared to confirm the new platform's benefits to customers (*see* ***Box***).

EMS in a fragrance manufacturer

Supported by a prominent consulting firm, a renowned fragrance manufacturer deployed the EMS in a few weeks across four plants to audit its production processes. The EMS identified that sales representatives were accepting post-order changes without consultation, resulting in production freezes and sub-optimal sized shipments.

In these four plants alone, 40 full-time equivalents (FTE) were lost each year to these late order changes, and $15 million worth of additional transportation costs were not charged to clients. For the manufacturer, the project was a real breakthrough, especially considering it operated over 300 such factories worldwide.

With the consultants' help, a specific add-on was developed for this manufacturer's EMS that could intercept post-order changes and alert sales representatives to suggest delaying the change or charging a portion of the costs incurred.

[9] In addition to data originating from ERP systems and software-as-a-service-based CRM tools, the EMS could now gain access – through "connectors" – to data from data warehouses, productivity tools (Microsoft Teams, Google Drive, Microsoft 365), captures of user interaction data, and even paper documents via optical character recognition. Custom developments could further expand the range of data collected into Celonis' platform.

This opening to third-party developers relieved some of the pressure on Klenk's team, which was continuously developing new features for clients. Over the years, significant efforts had been deployed by the development teams to regularly assess which features truly needed to be added to the core software, making the latter more cumbersome, unruly and difficult to maintain. With the new approach, the development of industry-specific EMS content could be left to the Celonis ecosystem consisting of hundreds of service, tech and academic partners.

Klenk was adamant that RPA features had to be integrated into the core engine itself to support the ability to automatically execute corrections to company processes because it was so fundamental to industrial clients. Leaving this to partners would jeopardize Celonis' ability to control the pace and direction of these changes. The area had witnessed a growing interest, prompting Celonis in 2019 to launch a series of business intelligence and interconnectivity applications called "Action Flows" to address these needs. To maintain its edge, Celonis acquired Czech startup Integromat for a reported $100+ million in early 2020. The startup provided an enterprise-level platform that automated tasks, making it a natural complement to Celonis' EMS.

But these developments also highlighted some of this strategy's challenges: To address new business needs beyond the standard use cases – "order to cash" and "procure to pay" – custom development was often needed considering Celonis' growing customer base with more than 1,000 companies from 20+ industries, bringing back the need for highly paid consultants. This called into question its relevance for smaller clients. Also, without such dedicated developments, Lean-inspired approaches, such as asking "why" five times,

could reach the system's limits once diving into a company's idiosyncratic processes.

The low awareness of the newly created execution management software category could prove to be challenging in this context. The entire category was new, and there was still work to be done in terms of evangelizing its benefits. Celonis' ecosystem partners were expected to be instrumental in this task, as the 2,500 Celonis employees could not push this agenda at the scale the company desired. The gradual entry of other vendors in the EMS category was boosting awareness, yet it meant tougher competition was to be expected. Celonis had started hiring in-house consultants, representing close to 10% of all the company's job openings by early 2022. This surge in hires would strengthen the EMS's notoriety, but some wondered whether this would not antagonize the ecosystem of partners the company had worked diligently to build over the years.

Unlocking value everywhere

For more than a decade, "unlocking trapped value" had been Klenk and his co-founders' guiding star. Gone were the days when projects lasted months, cost millions of dollars and required a pack of consultants to conduct interviews, gather observations and prepare reports. The aspiration behind EMS was that value could be unlocked in a matter of weeks, if not days, as long asstandardized methodologies were in place. In such cases, clients raved about the lower cost of identifying and solving discrepancies, which allowed them to focus on the "long tail" (i.e. low probability events) of minor glitches.

Klenk could not help smiling. With process data more readily available, habits and attitudes would have to be adapted, and a revolution was now underway. This revolution had been a core element of his own personal journey at Celonis, from a focus solely on technical matters to becoming the harbinger of a fundamental mindset change. Now, the genie was out of the bottle, and it was still unclear how far the new tools could go. In particular, the consequences of opening up the platform to third-party developers unleashed a new wave of creativity that could prove difficult to contain if not properly managed.

How would the co-founders navigate the growth ahead of them? Would the EMS be the last, or just the latest, innovation from Celonis in the journey to unleash the full power of data? All were questions at the top of Klenk's and his co- founders' minds.

Celonis had created a cloud platform that allowed the Lean philosophy to move to the digital age, and the new ecosystem provided the fuel to keep it in orbit. There was no going back, but conversely there was no clear route forward. Uncharted territory awaited.

Exhibit 1: Celonis co-founders Bastian Nominacher, Alex Rinke and Martin Klenk

Source: Deutscher Zukunftspreis, courtesy of Celonis

Exhibit 2: Sources of deviations according to the Toyota Production System

	**Muda** 無駄	Wastefulness occurs when activities done by the process do not add value to the product. Some of these activities are nonetheless necessary, such as **inspection and safety testing** and are referred to as Type 1 Muda. Type 2 Muda covers all non-necessary wasteful activities which should be eliminated, such as **undue transport or movement between machines or defects.**
	**Mura** 斑	Non-uniformity includes any instance of divergence between the optimal flow of value in the production process and its real-world implementation. This includes **overproduction and excess inventory**.
	**Muri** 無理	Overburden occurs when machines or human operators are **utilized in an unsustainable way (e.g. above 100% capacity)**, and leads to operator absenteeism and illness, and machine breakdowns. It is often the result of excessive removal of Muda (wastefulness).

Source: Adapted from TheLeanWay.net

Exhibit 3: Screenshots of Celonis' software solution

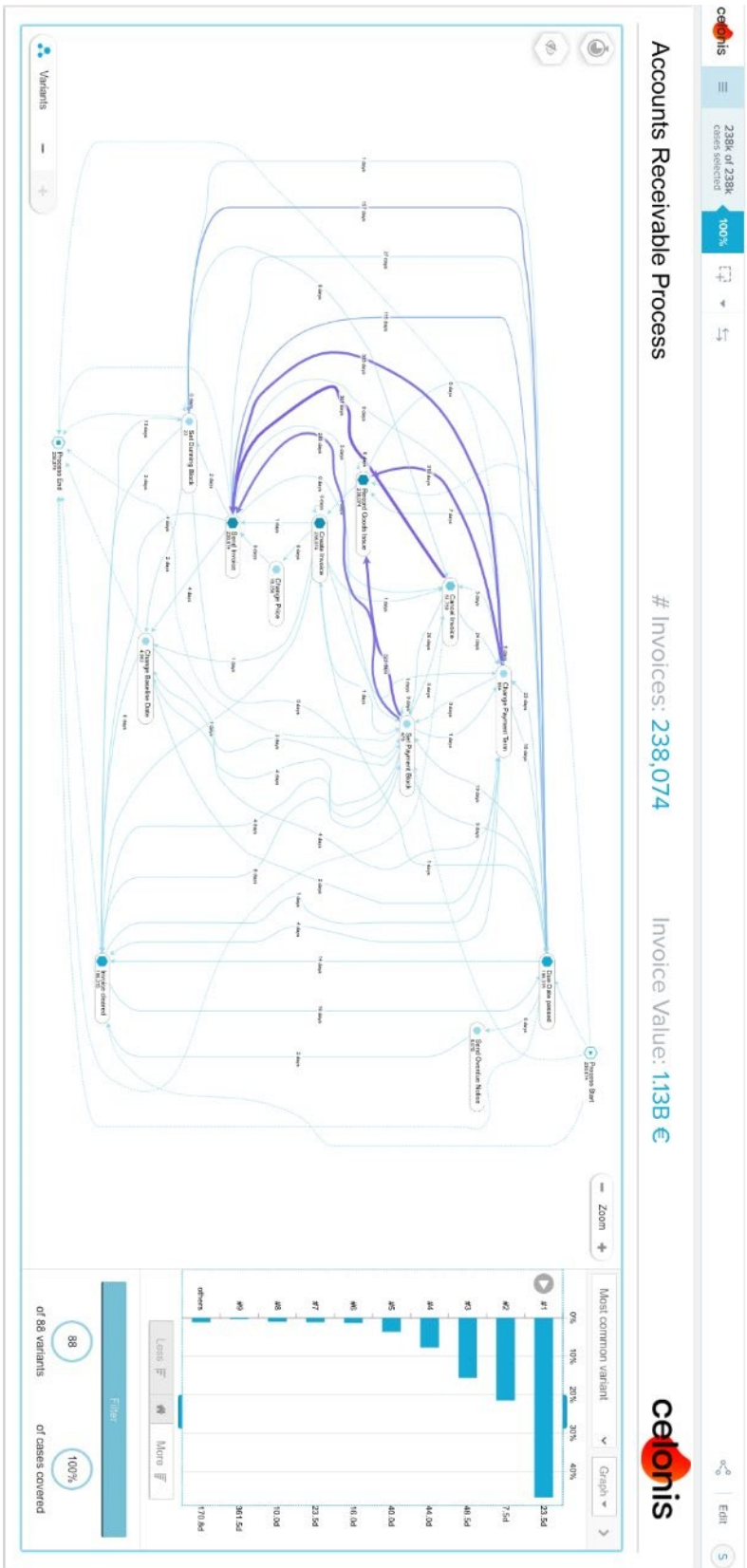
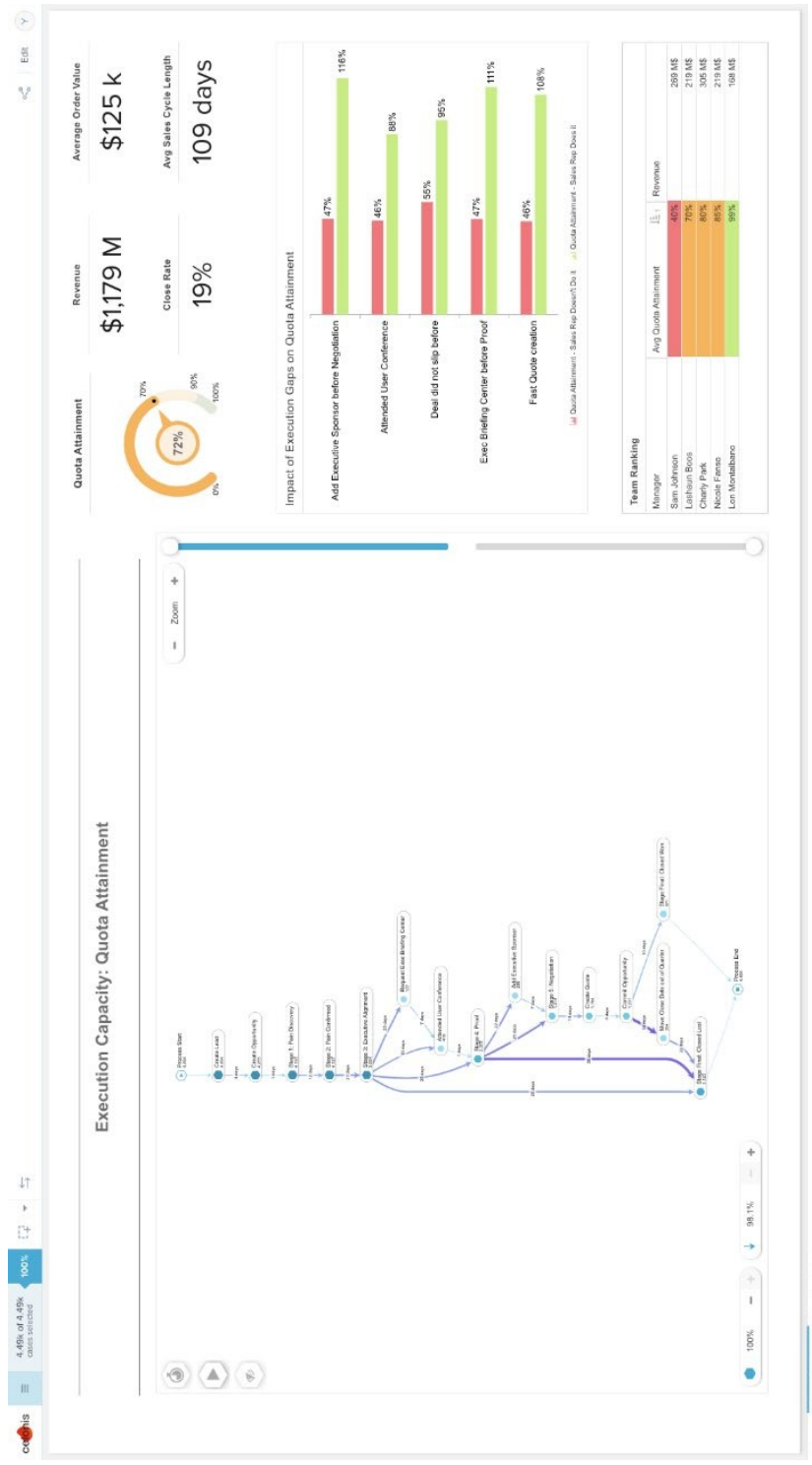


Exhibit 3 (continued)



Source: Celonis

Exhibit 4: $10 million execution capacity challenge

Celonis' $10 million Challenge (30 second TV spot)

Celonis' $10 million Challenge (2-minute TV spot)

Co-founder and co-CEO Alexander Rinke holding Celonis' full-page advertisement in the *Wall Street Journal*

Source: Celonis and https://www.celonis.com/blog/the-ultimate-business-challenge/

Exhibit 5: Deep and rich ecosystem of partners

250+ Service Partners	Including IBM, Accenture, PwC, Capgemini, Tech Mahindra, Genpact, Deloitte, KPMG, EY, Cognizant, Tata Consultancy Services, Wipro, Infosys…
40+ Technology & ISV Partners	Including IBM, Microsoft, Salesforce, Amazon Web Services, Connexiom, Appian, Snowflake, Coupa, FireStart, Cyberark, Acsis, Oracle, Splunk, Pelico, Aptivio, Winshuttle …
700+ Academic Partners	King's College London, HEC Paris, IMD, University of Amsterdam, University of Arkansas, Heriot Watt, University of Leeds, IE, Universidad de Costa Rica, Harvard University, Copenhagen University …
1,500+ Consulting & Services firms on Celonis for Consulting	
15,000+ Celonis trained professionals	

Source: Company information