

STRUCTO: A START-UP IN 3D PRINTING FOR THE DENTAL INDUSTRY

Because the purpose of business is to create a customer, the business enterprise has two and only two basic functions: marketing and innovation.

- Peter F. Drucker¹

In February 2018, Huub van Esbroeck, CEO and co-founder of Structo, a start-up company in Singapore, proudly launched the company's latest product - Structo Velox, a revolutionary desktop 3D printer. Velox had been built specifically for dental practices, with built-in integrated post-processing features—traditionally a manual process to convert a designed appliance seamlessly into a final printed part. Structo had gradually shifted its target customer base from 3D printing service bureaus to dental labs that often had bulk orders for its printers. However, converting its invention into a plausible business and identifying a specific customer base had been a daunting task for Structo. The company had eventually overcome this challenge through continuous testing of its business model and several product iterations.

In 2012, van Esbroeck, along with some of his classmates, had embarked on designing a 3D printer as a classroom project at the National University of Singapore (NUS). Three years later, the project had evolved to become a full-fledged product-based company in Singapore, producing state-of-the-art industrial scale 3D printing machines. The Velox, along with Structo's range of other industrial-scale dental 3D printing solutions, had helped Structo build a portfolio of products targeted towards the dental industry. Structo's 3D printers had helped several dental clinics cut the cost of clear aligners (an alternative to metal braces) by 50 per cent per patient, as well as halved the time for executing the procedure of producing models for the aligners. Whilst Structo still received orders from individual dental practitioners; the company's main consumers were dental labs that often put in bulk orders for the printers.

Van Esbroeck and the other co-founders of Structo wanted to scale up the company rapidly. However, at the same time, they wanted to maintain the company's innovative integrity by continually improving upon the product features. What could be the best strategy for Structo to quickly scale its business?

¹ Peter F. Drucker, About, <https://www.drucker.institute/about-peter-f-drucker/>, accessed February 2018.

This case was written by Professor Reddi Rayalu Kotha and Lipika Bhattacharya at the Singapore Management University. The case was prepared solely to provide material for class discussion. The authors do not intend to illustrate either effective or ineffective handling of a managerial situation. The authors may have disguised certain names and other identifying information to protect confidentiality.

Conception of Structo

Early Days

Structo's journey had started when seven undergraduates studying mechanical engineering at NUS were working on designing a hydrogen-powered eco-friendly car for the Formula 1 circuit. While building and designing the hydrogen vehicle, the team serendipitously stumbled upon the 3D printer technology, got interested in the concept, and built a 3D printer instead. The initial prototype – built out of discarded shipping cartons – could print four times faster and with higher throughput than the regular 3D printers available in the market. The group used a 'masking' technology for their printer, a new concept that had a far better efficiency than existing 3D printer models in the market.

After graduation, while his other teammates applied for full-time jobs, van Esbroeck decided to pursue a master's degree. However, the team continued to work further on refining their product prototype and realised its business potential after analysing the demand for high-speed 3D printing machines in Singapore and worldwide.

A year or so down the line, van Esbroeck and his teammates finally decided to turn what was then a prototype into a full-fledged business. Though the original group comprised seven students, only three people from the team, along with van Esbroeck, were keen to pursue the business actively. They found Structo in 2014 and soon after began meeting with seed investors.

Seed Funding

Van Esbroeck and his team at NUS had received a prototyping grant of US\$ 7280 in 2012 from the University Innovation Fund Programme sponsored by Singapore National Research Foundation (NRF). This grant had allowed the team to toss in their ideas, build a prototype product, and file for a patent while they were still students at the university.² However, when they approached investors and venture capitalists with the prototype, they faced several challenges.

Structo required funding to set up a manufacturing plant with machines and product development tools and a laboratory for testing their end product before they could approach the market to sell their product. The Singapore government had placed a lot of emphasis on promoting start-ups like Structo that focused in manufacturing and high-tech development. However, despite the government support, companies like Structo faced difficulties in attracting investors as they were typically more capital intensive and required larger investments than software, e-commerce or fintech startups.

Wavemaker, a seed-stage venture capital (VC) firm, had two headquarters: one in Singapore and another in Los Angeles. Paul Santos and Dennis Goh headed the Singapore branch. Santos had always believed that investing at the early stage was more about the people, the opportunities in the market they were pursuing, and the vision they were trying to realise as a venture capitalist. He liked to spot an opportunity, and he believed opportunity 'was driven by change'. As he explained, "The bigger the change, the more pain the change caused. One had to think of the value that an entrepreneur has created. Interestingly as a business grows, another opportunity can evolve, and hence the business becomes more valuable".

Structo received joint funding of US\$ 0.73 million from Wavemaker and SPRING Singapore as part of a series A round funding in 2016. Standards, Productivity and Innovation Board (SPRING),

² US\$1 = SGD 1.37, conversion rate as at 19 November 2018.

Singapore was a statutory board under the Ministry of Trade and Industry of Singapore which focused on enterprise development in the country. The investment from Wavemaker and SPRING helped fund Structo's hardware and software development, material formulations marketing efforts for the launch of its 3D printer over the next 18 months.

Another challenge faced by Structo was securing talent. In the early days, Structo needed to hire a few people across different disciplines in order to grow. The team at Structo resolved this challenge by hunting social networking sites like LinkedIn for requisite talent and also tried to increase their visibility on these sites to attract experienced individuals to join their company. Wavemaker's support to Structo extended to areas beyond funding, including advice on legal issues, human resources and business development. The VC helped coach the founding team of engineers at Structo and introduced them to potential customers, advisers and mentors.

Targeting an Unknown Market

Search for Consumers

Van Esbroeck and his co-founders sought advice from Wavemaker and decided to set up their venture as a business-to-business (B2B) company. He explained,

Back in 2013-2014, the conventional thinking was that if you have built a 3D printing machine, you can go on Kickstarter [an American public-benefit corporation which maintained a global crowdfunding platform] and sell the machine directly to individual consumers. However, consumers often try to substitute material (provided by the manufacturer) with cheaper options after purchase - but when the machine breaks down, they will want the manufacturer to provide the required service still, and the product to continue to perform as earlier, despite being subjected to substandard material usage. In the beginning, we were ready to deal with such issues, as we had no idea who could be our customer base. However, we also knew that our technology was fundamentally different and would benefit from a B2B model, which is a lot easier to scale. We had heard about service bureaus, and so we started making a list of Bureaus that we could approach market our products.

The team's initial idea of approaching service bureaus came from the understanding that anyone who wanted to outsource 3D printing jobs across industries approached service bureaus for their requirements. A service bureau conventionally was a company that provided business services for a fee. Service Bureaus in the 3D printing industry allowed organisations to outsource production. 3D printers were used by service bureaus extensively and hence could benefit from high-speed 3D printing solutions.

The Structo founders visited several 3D printing service bureaus in Germany, Belgium and the United States (US) to understand their business. They realised that while the demand for 3D printing machines from service bureaus was high, the diversity of the requirements was also huge as they serviced a variety of printing needs ranging from shoe parts to parts for an aircraft — printers required by such bureaus needed to be customisable as per the individual product need. Producing 3D printers with high customisation features required a much larger capacity, scale and maturity on the part of the manufacturer and Structo, having just started, needed to build significant resources to cater to these requirements.

For a few months, the founders of Structo were directionless as to who could be their potential customer, and then they finally got a breakthrough. They received a phone call from a Singapore-

based dentist who was looking for a highly efficient 3D printer with high throughput. He became their first client, and this first sale provided van Esbroeck and his partners a clue about targeting a niche segment within the 3D printing market. Van Esbroeck elaborated,

We never identified 3D printers as a business; we started from a technology perspective. When we established the start-up, we spent the first few months building and maturing our technology, hardware, material and software. Then in 2015, we visited probably eight to 10 service bureaus across Germany, Belgium and the US. But they all had such diverse needs, so our initial response was that we wanted to build all those capabilities. But the call from our first customer changed everything. We learnt from him what he was doing, and realised there were thousands of dentists who would have the same requirements. The printer geometry shape and requirements were pretty much the same for most dentists.

With further research, van Esbroeck and his team came to understand that dentists around the world were increasingly prescribing clear aligners (made of clear plastic that was almost invisible) to their clients because of their ease of use and aesthetic advantage over traditional braces (refer to **Exhibit 1** for clear aligners). The process of providing customised clear aligners to patients involved a 3D scan, followed by a 3D design and printing of the model, which was then subjected to vacuum forming to create the transparent aligner. This had created a massive demand for 3D printing in the dental industry.³

But the team at Structo did not as yet have a clear picture of who clients would be. They realised after a few transactions that most dentists, unlike their first customer, did not order directly from the manufacturers but instead sent their models to dental labs for printing. The demand for 3D printing machines from dental labs was significantly high, and unlike service bureaus, they all needed the same type of printer with more or less the same features. This was a more feasible requirement for a start-up like Structo to fulfil.

One of the first dental labs the Structo team worked with was Glidewell, where they were able to replace a hundred of their existing machines with 25 Structo 3D printers. With 25 machines handling the work of 100 printers and still having extra capacity, they proved to the client the efficiency of Structo printers.

Working with dental labs for Structo was a ‘whole different ballgame in contrast to working with individual dentists’, shared van Esbroeck. It consisted of mostly bulk orders, the processing of the order was smoother, and the sales cycle was much faster. Van Esbroeck explained,

In the dental industry, the main application that has a very high volume of demand for 3D printing is clear aligners. They are very expensive; the cost to a patient here in Singapore for a typical case, is about US\$5000 to 8000, but the dentist pays a substantial part of that cost to the dental lab. The actual cost of manufacturing the aligner is typically about US\$300, and that cost can potentially be reduced tenfold with economies of scale, but no one is doing it yet in the market. In Asia Pacific, 3% of patients prefer clear aligners as opposed to 97% opting for metal or wire aligners, and we believe that this consumer choice is mainly because of the high price of clear aligners.

Focus on Product

Structo’s industrial-grade additive manufacturing 3D printers had a unique patented technology and

³ Invisalign, “Invisalign Braces”, <https://www.invisalign.com.sg/>, accessed February 2018.

were able to achieve faster speeds with large build volumes at a lower cost compared to existing stereolithography (SLA) printers in the market.

Technology

Based on its patented mask stereolithography (MSLA) technology, Structo's printers were of higher speed than existing SLA and digital light processing (DLP) printers, and also provided higher throughput and thus lower costs for customers without compromising on print quality. MSLA technology utilised a panel light source array and a digital mask to control which regions in the printing plane were illuminated by the light source below (refer to **Exhibit 2** for MSLA technology)⁴.

The key selling point of the printers that Structo produced was that they printed about 8-10 times faster than printers in the same price category available in the market. Regarding price, a Structo 3D printer standard model starting price was US\$30,000, while most 3D printers in the market had a price range between US\$5,000 to US\$500,000. The speed of the Structo printers allowed for the printing of up to 10 orthodontic models in 30 minutes (refer to **Exhibit 3** for a picture of the Structo DentaForm Printer).

Focus on Material

Structo had also developed its innovative polymer materials for a range of printing applications, which worked with its unique MSLA technology, with precise morphological curing control and formulated according to the various needs in dentistry.⁵ Van Esbroeck explained,

Material is critical to the success of any 3D printing business. We are testing our material to see if it works on other printers. If we can establish a separate materials business, we can potentially double our margins. Moreover, unlike 3D printers, the material does not require support services and the demand is recurring. However, while the quality of the material is a critical factor in a 3D printing workflow, patenting material is difficult as it is a very opaque product - more so because it is almost impossible to police patenting of materials.

3D printing machines are in demand now, but they will eventually commoditise. A machine that is ten times faster, three times more accurate and three times cheaper is easy to replicate. Therefore, that is a significant threat to our business, so we have to keep innovating our product offerings, and also focus on materials.

Selling to Dental Labs

Marketing Strategy

Van Esbroeck and his team used a simple and direct marketing strategy to get dental lab customers on board. The US was the company's biggest market. He elaborated,

We have a sales and technical support person in the US. Internally, we use 'guerrilla marketing' strategies wherein we print physical samples of aligner models and stick them in an envelope with a letter and a brochure and send them to lab owners. This has proved to be quite effective so far. Sharing a physical sample with your probable customers sends a strong message, as it sits on their desk as a reminder rather than a pamphlet that goes into the bin. For our first marketing

⁴ MSLA, Structo, <https://www.structo3d.com/technology/>, accessed February 2018.

⁵ Structo 3D, "Materials", <https://www.structo3d.com/materials/>, accessed February 2018.

campaign, we sent 300 of these samples to different labs. The cost of that marketing was about US\$3000, and we sold two machines from that campaign. So the revenue we earned was US\$60,000. It is a very direct sell approach, but we also try to sell through other channels like trade shows and publications. We do not use social media much as a sales channel because of the nature of our product.

Industry Statistics

3D printing technology promised to make dentistry affordable, customised and convenient for patients.⁶ This meant that there was potentially a growing market for such solutions. The 3D printing market for dentistry was estimated to become a whopping US\$9.5 billion industry by 2027.⁷ The sale of 3D printing machines to dental labs was also expected to double from US\$240 million to US\$480 million by 2020, and was expected to provide more than 60% of all dental production needs by 2025 (refer to **Exhibit 4** for Projected dental 3D printing revenue opportunities).⁸ Van Esbroeck shared,

For our printers, 70% of the revenue currently comes from the US market. This is because of the cost to the customer for clear aligners. The market for clear aligners is primarily drawn by consumer spending power, and so currently, the primary markets are the US, Europe and Australia, where customers can afford these products.

However, 3D printing was expected to catch on in Asia-Pacific in the coming years, and it was already big in China. The Asia-Pacific market for healthcare 3D printing was expected to reach US\$3.34 billion by 2021, growing at a projected CAGR of 24.6% during 2016-2021.⁹ Commenting on the scope of 3D printers in the dental industry in Asia, van Esbroeck explained,

China is hugely advanced in 3D printing, and so is India. It is only the ASEAN region that is lagging in this sector. China is home to the second largest orthodontic printing company in the world, in Shanghai. They print 20,000 unique orthodontic parts in one day, and that is quite a feat. Our three major competitors are Stratasys, 3D Systems and EnvisionTEC. However, all of them build solutions for sectors ranging from aviation and aerospace to jewellery and prototyping, and none of them specialises exclusively in dental like Structo.

Interestingly, the key restraint for the global dental 3D printing market was the high cost of dental 3D printers due to the usage of cutting-edge technologies. Moreover, patenting these technologies often requires high capital investment for registration and getting regulatory approvals. Also, the growth of the market was a challenge due to the lack of skilled labour with knowledge of the usage of 3D printing technology.¹⁰

Further Avenues

⁶ Stratasys, "4 Reasons to Use a 3D Printing Service Bureau", <https://www.stratasysdirect.com/manufacturing-services/3d-printing/3d-printing-service-bureau-reasons-to-use-one>, accessed February 2018.

⁷ Laura Griffiths, Dental 3D printing market to reach \$9.5 billion by 2027, 10 January 2018, <https://www.tctmagazine.com/3d-printing-news/dental-3d-printing-market-grow-9-5-billion-10-years/>, accessed February 2018.

⁸ Evanson DDS, "How 3D Printing Is Revolutionizing Dentistry", <http://www.evansondds.com/how-3d-printing-is-revolutionizing-dentistry/>, accessed February 2018.

⁹ Mordor Intelligence, "Asia-Pacific Healthcare 3D Printing Market - Segmented by Application, Technology, Raw Material and By Geography - Growth, Trends and Forecasts (2018 - 2023)", November 2016, <https://www.mordorintelligence.com/industry-reports/asia-pacific-healthcare-3d-printing-market-industry>, accessed February 2018.

¹⁰ PRNewswire, "3D Dental Printing Market to be Worth US\$3,427.1 Million by 2025: Increasing Focus on Aesthetics Ups Demand for 3D Printing in Dental Healthcare", June 06, 2017, <https://www.prnewswire.com/news-releases/3d-dental-printing-market-to-be-worth-us34271-million-by-2025-increasing-focus-on-aesthetics-ups-demand-for-3d-printing-in-dental-healthcare-626705971.html>, accessed February 2018.

By the end of 2017, Structo had grown from a college start-up to a growing established company. Its printer software could be upgraded even after purchase, thus continuing to improve efficiency. Structo's custom-formulated material, produced in its in-house manufacturing unit in Singapore, further ensured that its printers were unique and had a market advantage over similarly priced 3D printers in the market.

Manufacturing its materials in its materials division in Singapore had opened another business avenue for Structo, allowing the company a significant advantage over competitors in the market. Structo sold directly to the US market and through distributors in other markets. The company had trained its distributors in supporting customers in their respective markets. Commenting on further expansion plans, van Esbroeck explained,

As business is expanding, we intend to grow organically in mainly two ways, one deeper into dental, and two, eventually broader into non-dental.

Structo's business was expanding gradually, and it wanted to expand and scale further in the dental market. At the same time, it also wanted to continue to assess and gradually grow its market base in the service bureau industry. The firm also had the opportunity to expand in the materials industry and sell materials to other 3D printing machine manufacturers. However, its medium-term focus was to grow in the dental market.

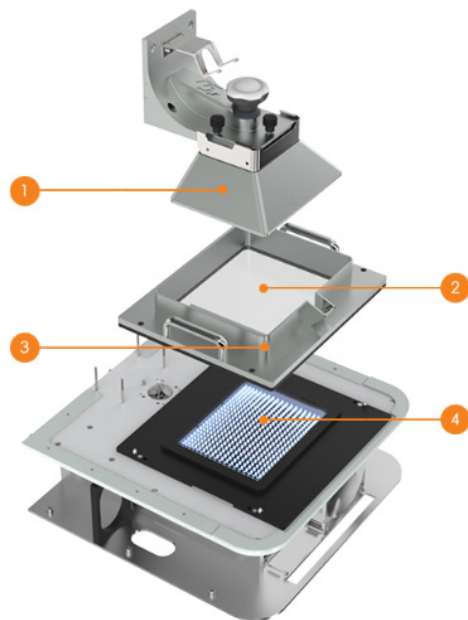
Van Esbroeck and his partners had learned a lot about the 3D printing market over the last few years. They had extensive knowledge about printing technology and its application to dental technology, the materials most suited for the dental imprint products, and how to develop them. Van Esbroeck wondered if this was sufficient in helping them quickly scale up their business. Was focussing on the dental industry the right strategy for Structo?

EXHIBIT 1: CLEAR ALIGNER



Source: Structo3D, Blog, Part 2: 5 Things You Need to Start a Clear Aligner Business, July 25, 2017, <http://blog.structo3d.com/part-2-5-things-you-need-to-start-a-clear-aligner-business>, accessed February 2018.

EXHIBIT 2: MSLA TECHNOLOGY



Mask Stereolithography (MSLA)

Proprietary, Patented, Perfected

Structo, the pioneers of MSLA, has reinvented stereolithography with a fundamentally different approach.

MSLA technology utilizes a panel light source array⁴ and a digital mask² to control which regions in the printing plane are illuminated by the light source below.



- 1 BUILD PLATFORM
- 2 DIGITAL MASK
- 3 RESIN TANK
- 4 ARRAY LIGHTSOURCE

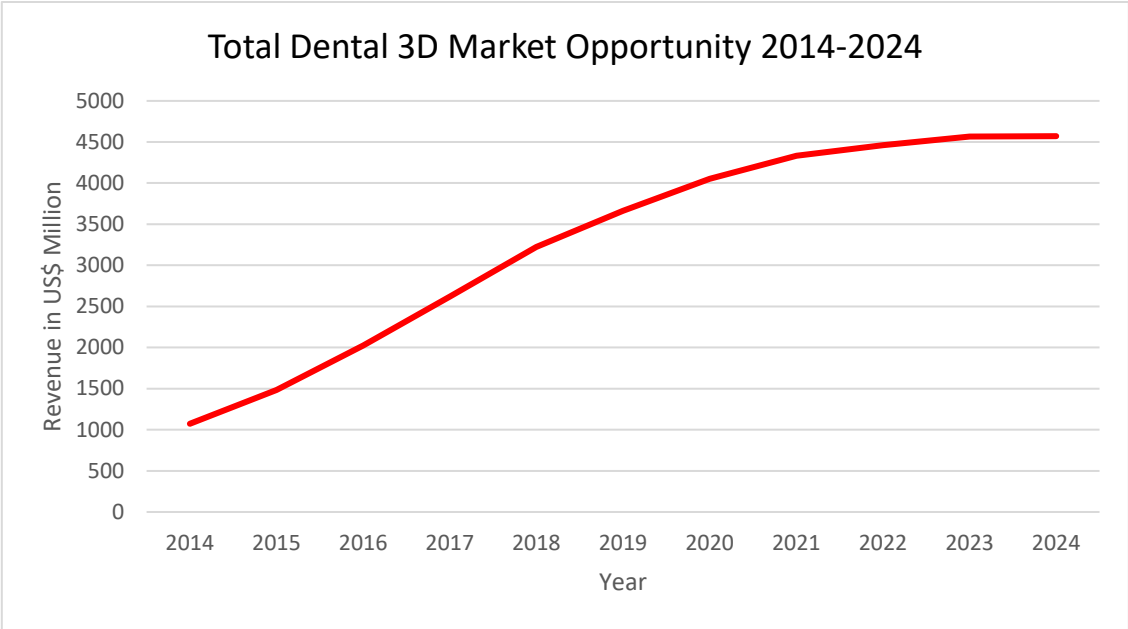
Source: Company Data

EXHIBIT 3: STRUCTO ORTHOFORM 3D PRINTER



Source: Company Data

EXHIBIT 4: PROJECTED DENTAL 3D PRINTING REVENUE OPPORTUNITIES (2014-2024)



Source: SmarTech Publishing 3D Printing in Dentistry 2018, <https://www.smartechpublishing.com/blog/state-dental-3d-printing-2018/>, accessed February 2018.