

SPECIAL EDITION 2019 AAO

Orthodontic

PRACTICE•US

The Fine Print

Meet the Team Making
the World's First, and Only,
Customized, 3D-Printed
Bracket System

■ START ME UP

■ PHONING IT IN

■ THE BIG DATA TRADE-OFF

■ GAMBLING ON THE FUTURE

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It's a shame direct-to-consumer companies are getting the lion's share of the attention. The dental startup community is alive and well – and kind of interesting.

The End is Just the Beginning

Everyone knows necessity is the mother of invention. But invention is just the starting point. It takes an intellectual village to turn a “transformative idea” into a “tangible product.”

It takes adaptability. The ability to learn countless cross-disciplines like design, development, software, hardware, mechanical engineering, biomechanical engineering, and fabrication that are all needed to create a new product.

It takes persistence. Overcoming all of the legal obstacles and regulatory hurdles that need to be cleared before a product can come to market.

It takes access. Being able to marshal the academic, emotional, and financial resources required to help the idea overcome all of the aforementioned challenges.

It takes luck. The happenstance of King C. Gillette finding MIT engineer William Emery Nickerson to make his disposable razor blade in 1901, or Alfred Griffin running into former Invisalign® VP, Dr. Lou Shuman to make the world’s first customized 3D-printed brackets in 2019.

It takes all those things. And even if it all goes just right, the reward isn’t success. The only thing that “transformative idea” turned “tangible product” has earned is the right to stand at the starting line and join the race to compete against every single idea in human history that got there first.

From the invention of self-brushing toothbrushes, robotic dental surgeons, and customized brackets to the promise of big data and telemedicine, this special edition of *Orthodontic Practice US* is all about the transformative ideas that are transforming our world. We hope that you enjoy it.

Lisa Moler
Publisher/CEO, MedMark Media





The Fine



Print

Meet the Team Making the World's First, Fully-Customized, 3D-Printed Bracket System

Boston has an intensely energetic startup scene fueled by biotech, enterprise software, AI, and robotics expertise coupled with ample venture capital. It's an environment not readily associated with orthodontic brackets, where innovation has been incremental at best for the past 50 years. That's about to change when venture-backed startup LightForce Orthodontics launches at the 2019 AAO in Los Angeles.

Left to right, Kelsey Fafara, Craig Sidorchuk, Dr. Lou Shuman, Dr. Alfred Griffin.



The Griffin and Shuman “world tour” led them to AM Ventures, a strategic partner and early investor.

In early 2015, Boston was a sea of white, buried in wave after wave of blizzards, a landscape artists’ dream. It may have been pretty – but it nearly shut the city down.

LightForce founder and CEO Alfred Griffin was a newcomer to Boston at the time, having just finished a combined dental and PhD program at the Medical University of South Carolina. A Virginia native, Griffin wasn’t prepared for a New England winter.

He didn’t know the city. He didn’t know any locals. And he didn’t have much enthusiasm for the weather outside.

So, rather than explore his new city, or socialize with his fellow Harvard postdocs, Griffin bunkered down in his Fenway apartment.

Working in the shadow of the Green Monster, he envisioned the technology that stands to be the biggest change to brackets since Dr. Larry Andrews and A-Company introduced fully programmed brackets in 1970.

It could easily have gone differently. “If I knew my wife then, I’d probably be doing something else now,” Griffin said.

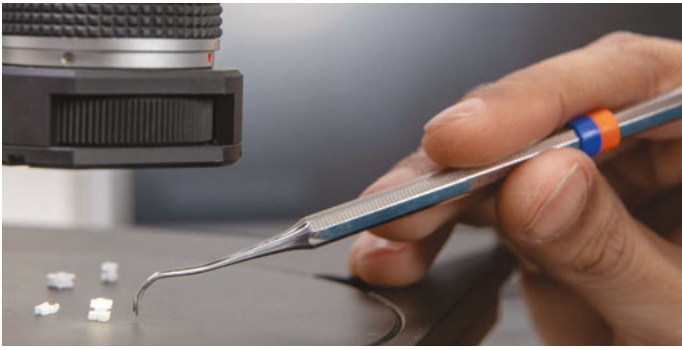
In bringing the idea to fruition, Griffin dodged a number of landmines – the sorts of hurdles that trip up many startup businesses. He somehow kept all rights to his patents and got numerous tech-focused venture investors to do something they’d never done before: Put venture funding into a dental business.

But that belongs at the end of our story. To understand how he got here, we have to take a look at the orthodontic space first.



For all the brilliance pre-programmed brackets brought to the profession, the underlying technology hasn’t changed since the 1970s. Andrews’ original prescription is empirically derived from studying thousands of smiles deemed to represent his conception of “ideal” occlusion or finish. His bracket program values (torque, tip, and offset) are designed to put every patient’s teeth in a specific orientation relative to the plane of the archwire at the end of treatment.

The same is true of the derivative prescriptions that have followed like Roth, MBT, and CCO, which are essentially tweaks to achieve another orthodontist’s perception of “ideal.”



Inspecting the individual brackets

“Standard orthodontic prescriptions are essentially a compromise from the outset. They are an “all patients equal” proposition. But no two patients have exactly the same tooth morphology or exactly the same bite. So why would we think they should all have the same ‘ideal’ finish?” asked Griffin.

He goes on, “The concessions with pre-programmed brackets have been imposed by several constraining factors. Two of the primary constraints are inflexible bracket manufacturing technologies and the imprecision of analog treatment planning.”

By “inflexible manufacturing technologies,” Griffin is referring to injection molding, which is used to produce the vast majority of brackets sold today. The molds required to produce one standard prescription (20 brackets, all with different shapes and programming) cost hundreds of thousands (if not millions) of dollars and can take 6 months to a year to make. Patient-specific customization is just not realistic with this technology.

But even if someone could manufacture patient-specific brackets cost effectively, without digital treatment planning, the orthodontist would be hard pressed to tell them what to make.

Orthodontists have an exquisite eye for precision on a very small scale. But the ability to precisely describe a bracket design in three dimensions – including contouring to fit irregular surfaces, based on putting a stone model into final occlusion – would be a superhuman undertaking.

The art of wire bending in and of itself is a form of customization. And it is, at least in part, an attempt to overcome the limitation of standard brackets and fluctuating

placement. Griffin knew this. At the age of 12, he started bending wires to help out in his father’s practice.

Those early experiences inspired his search for a better answer to the shortcomings of pre-programmed brackets during the Great Boston Whiteout of 2015.

And he found it – with 3D printing.



The whole idea of 3D printing might feel over-hyped today. It was one of the hottest trends earlier this decade, with numerous outlets touting the technology like it was the beginning of the future – a realistic version of a Star Trek replicator, able to make anything you wanted on command.

But 3D printing isn’t that – at least not yet. Today, it has two main limitations.

One is materials. While the number of materials suitable for 3D printing is growing, the options are still fairly narrow beyond plastic, which is good for rapid prototyping. 3D printing technologies for metal, glass, and gold are in development, but they have yet to become effective for widespread fabrication of “end-use” products.

The second is cost. Whether you’re printing the first widget or the ten millionth, the cost per widget remains about the same.

By comparison, injection molding costs much more to start. But the more you make, the cheaper it gets on a per unit basis – as a percentage of cost that large initial investment to design and build molds shrinks.

In other words, 3D printing isn’t yet a good replacement for manufactured goods that are produced in large quantities and don’t need any specialization or customization.

However, 3D printing is very good for prototypes (which is why race car manufacturers and architecture firms use it extensively), and it’s great for custom applications.

This was Griffin’s insight.

Although braces should be custom-built for each patient, most of the pieces are off the rack. While a skilled orthodontist works around these shortcomings – Griffin

knew about this having grown up around an orthodontic practice, and he now saw a better way.

He patented a system for 3D printing brackets for orthodontic treatment. The advanced technology he uncovered uses material virtually identical to familiar injection modeled ceramic brackets, but specially formulated for 3D printing. It provides the precision and strength required for orthodontic appliances, while offering future development pathways for esthetic options.

The next step for Griffin was finding people who could power up the hardware design and software development needed to 3D-print the future of orthodontic brackets.

Building the Team

Griffin started building the LightForce team in 2015 at a Friday happy hour that was filled with Harvard graduate students. He was excited to share his creation, but no one was interested. Not until due respect was paid to the bacchanal tradition in progress. He was, however, welcomed to join them for a beer.

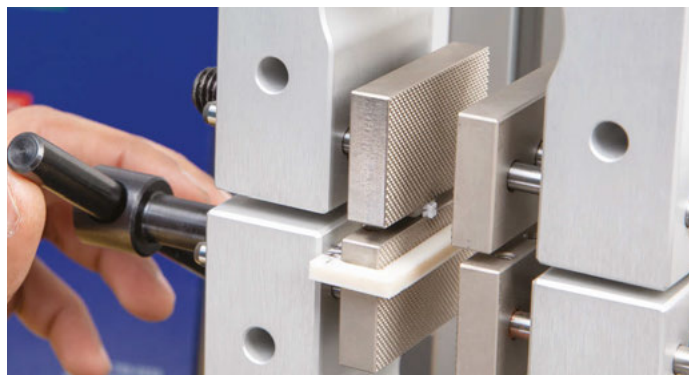
After buying a few rounds, he finally got the chance to explain his idea. And one of the brightest young engineers in the crowd, Kelsey Peterson-Fafara, immediately saw the potential, opted in, and signed on to the team.

From there, the company was accepted into the prestigious Harvard Innovation Lab accelerator (i-lab). Griffin took a small loan from his family to bring the company to life.

In an essential bit of (perhaps) accidental business acumen, their early development used only private equipment, as sharing the i-lab equipment would also have meant sharing the patent with the university.

In late 2015, he met Dr. Lou Shuman – a key member of the Invisalign® executive team during its early hyper growth, a dental industry key opinion leader, and a successful entrepreneur/CEO. It didn't hurt that Shuman also happened to be an orthodontist.

In short order, Griffin asked Shuman to become a co-founder and help him approach the venture capital community. The



Brackets undergo the validation process

company started taking shape. Originally called Signature Orthodontics, they settled on the more descriptive (and trademarkable) LightForce Orthodontics.



A whirlwind of trials and successes ensued. The group applied to the MassChallenge Accelerator program in 2016, competing with over 2,000 other startups to gain additional funding and startup support.

LightForce Orthodontics was one of 128 applicants selected to join the MassChallenge class of 2016 (which included scientifically ambitious startups seeking to mine asteroids for water and develop brainwave-controlled robotic prostheses).

LightForce was invited to become entrepreneurs-in-residence at the MassChallenge facility, a huge converted dockside warehouse in Boston's booming Seaport district.

From the initial cohort of 128, LightForce advanced to the round of 26 Mass Challenge finalists based on its progress during the accelerator program. And in October, they become one of only 15 MassChallenge companies in their class selected as winners, receiving \$50,000 in equity-free financing as recognition.

Suddenly, the group had an office and money. Griffin next hired Peterson-Fafara as employee #1.

Simultaneously, Shuman and Griffin were on a roadshow looking for venture capital. They received a number of offers,

and plenty of advice – including the idea they should sell their product to a larger orthodontic company. One meeting with a potential investor turned into a 3-hour browbeating when they expressed a desire to bring the idea to market rather than sell it to the highest bidder.

Griffin rejected such suggestions. Just as earlier he'd turned down a free ride as a postdoc, he started turning down business people who wanted to make the quick buck. He wanted to fundamentally change orthodontics.

Ultimately, the first substantial capital infusion came from AM Ventures, a firm dedicated to investing in additive manufacturing systems for 3D printing.

“We wanted a strategic investor – not just someone with money. We wanted expertise in our fundamental technology. AMV was an ideal partner for LightForce,” said Shuman.

On one trip to Germany, AMV introduced Griffin and Shuman to Hans Langer, founder and CEO of EOS in Munich, Germany, and considered a global leader in additive manufacturing (at the heart of what's known as 3D printing).

According to Langer, the future of 3D printing involves two components: creating high value customization and having a big enough market to support it. To the man considered the godfather of the technology, LightForce checks both those boxes.

The team continued to work at the MassChallenge facility through 2017 as “Alumni in Residence.” The status involved them advising other entrepreneurs based on the LightForce startup experience, while simultaneously working to move the business forward.

Griffin and Shuman expanded the hardware engineering team and brought on expert software developers with a history of building advanced dental systems. Over the course of the year, they finalized the initial bracket design, developed their treatment planning software, and received FDA clearance.

Startups are true cash carnivores. So soon, Shuman and Griffin were back to calling on the venture investment community in 2018. Finding success, LightForce closed its



Dr. Alfred Griffin Jr. celebrates with his son Dr. Alfred Griffin III, LightForce co-founder and CEO, at the MassChallenge 2016 Finalist Award Ceremony.

A Founder with Deep Roots in Dentistry

Alfred Griffin comes from a family of dentists. His father, Alfred Griffin Jr., is an orthodontist and owns a very successful practice in Northern Virginia. His mother is a dentist. Aunts, uncles, and cousins are dentists. Upon graduating with his DMD, Alfred Griffin III became the third generation of his family to join the profession.

When he graduated from the DMD-PhD program at the Medical University of South Carolina, Griffin had his pick of orthodontic schools, several of which offered significant stipends. He ultimately turned down the grants, opting instead to pay a healthy tuition to attend the Harvard School of Dental Medicine, where he completed his residency.

Research oriented at heart, Griffin's pre-Harvard education could have led him down a quite different path. While at the Medical University of South Carolina, he studied regeneration and turnover in bone cells – like those in bones and teeth. His own research explored the underpinnings of skeletal turnover in osteoclasts and osteoblasts, the cells responsible for tooth movement through bone. And his work was impressive enough – he was given the Young Investigator Award by the American Society for Bone and Mineral Research.

Based on that research, he was also one of four English-speaking scientists invited to Tokyo University to give his presentation to a wider audience. With this kind of exposure, it would be easy to assume that Griffin's work with cells led to his later breakthrough in orthodontics. But it didn't.

While cell signaling was a promising field, Griffin came to understand that even at Harvard, basic science funding in orthodontics is tough to come by.

So becoming an orthodontist was initially driven by the voice of economic pragmatism. But it's hard to listen when vision and mission call.

Series A funding round in the summer of 2018 with the highly respected Matrix Partners Venture Capital group.

Founded in 1977, Matrix has an eye for opportunity, having invested in companies such as PSINet, Veritas Technologies, FedEx, Care.com, HubSpot, Oculus, Quora, and of course, the garage-based startup in San Jose that is Apple, Inc.

Matrix may have been a newcomer to the orthodontic space, but they were on board with the co-founders' vision. Plus, the hands-on business approach of partner Stan Reiss was a good complement to Griffin's clinically oriented background.



Today, LightForce Orthodontics is flying headlong towards its debut at the 2019 AAO Annual Session in Los Angeles. Now with FDA clearance in hand, the company has patients in treatment – including Artur Sousa, Mentorship Manager for entrepreneurs at the MassChallenge – who wanted to make history as the first person with fully customized 3D-printed braces.

The company is now expanding pre-launch case starts with its team of orthodontic advisors. It will provide controlled commercial case availability starting with the launch at the 2019 AAO annual session.

Plenty of challenges and opportunities remain.

Having created an initial version to compete with metal brackets, LightForce is developing high-esthetic options and considering various new materials.

They are perfecting the service and supply chain logistics to provide the highest customer experience for their colleagues. As orthodontists themselves, Griffin and Shuman know what they expect and are holding the team to a high bar.

The old adage “the software is never complete” applies, so the treatment planning system will continue to evolve with the application of machine learning, potentially opening a whole new frontier of innovation.

And of course, there's convincing the orthodontic community that they can do what they claim to do. As Griffin once understated, “Mass customization on this scale is incredibly challenging. There's a reason it hasn't been done before.”

The closest approximation of this kind of customization would be aligners like Invisalign, and, more recently, the half dozen or so startups trying to muscle into the space. But for all the visibility that Invisalign has generated, aligners still make up only an estimated 15% of orthodontic case starts.

Even as aligners become more capable, most cases will still call for braces. This is why LightForce is looking at the much larger marketplace. They want to address the 85% of every practice that is still treated with brackets and tubes. LightForce is offering a change the likes of which hasn't been seen in decades.

So with a nod to high-tech solutions, the company has the excitement of a Silicon Valley startup, combined with a steady, ready-made market. Plus a customer base of clinical professionals who are by nature, perfection driven, and who truly understand how revolutionary this product is.

In the end, Griffin wants the idea to take on a life of its own. To transcend snowstorms, startup meetings, and venture capitalists. With direct-to-consumer companies encroaching on the autonomy of orthodontists, he wants LightForce to acknowledge the orthodontic community's expertise and reinforce their control of their cases.

“We don't want to bring the idea to market and say ‘here's how to use it.’ We want to bring this to the orthodontist and ask them, ‘What can you do with it?’”

He's hoping their answer can be found in the fine print.

Software and development team



Gambling on the Future

What Happens When Artificial
Intelligence Gets Bored with Poker
and Comes for the Dental Profession?



Do you remember Deep Blue?

Back in 1996, Gary Kasparov – the world chess champion at the time – barely eked out a win versus the chess-playing computer designed to beat him. It was a close-fought game, but Kasparov was able to claim victory.

The very next year, a new and improved version of Deep Blue beat Kasparov and hasn't looked back. This happened two decades ago, which might as well be two centuries, considering the ever-increasing pace of progress in computing.





By 2011, Deep Blue's descendant, Watson, was winning "Jeopardy!" against the greatest champions the quiz show had ever produced. In this case, Watson was showing a greater mastery of inputs – being able to correctly interpret questions and produce the correct answers (though technically, in "Jeopardy!", the order is reversed).

Once Watson understood the conversation, its massive catalogue of data allowed it to leave mere humans in the dust. More recently, an AI program called Libratus took to beating the best poker players in the world. Over 20 days and 120,000 hands, Libratus came out ahead nearly \$800,000.

However, the most impressive part of Libratus isn't its mastery of poker. "It's learning more every night, and there's some insane stuff happening," observed Jason Les, one of the top players in the world who personally lost over \$300,000 to Libratus.

That's because Libratus is a completely different type of machine compared to what came before. Deep Blue used raw processing power to analyze a number of chess moves that would be impossible for any human. It played out millions of games, and selected the move that most often led to a win.

Libratus is different. It was given the rules and goals of poker, and then was told to figure out on its own the best way to win. And the results have been astounding.

It improves with each game, learning from mistakes and successes. It uses different strategies, depending on whom it is playing against. And it invented that strategy itself.

"There's no human strategy programmed into it," Noam Brown, the creator of Libratus, recently told Poker Central. "It started randomly. It had no historical data and slowly learned based on the information that it was gathering itself."

That Libratus gathered its own information may not sound like an important distinction, but it means the world.

Basically it means that machines like Libratus can now undergo their own version of evolution. Only instead of

creating a new generation every 20 years, like humans, or every 20 minutes, like some bacteria, computers are able to refine themselves every few nanoseconds.

Libratus played trillions of games of poker against itself before being matched against a human. That sort of experience simply can't be matched by a human. Indeed, very soon, a single smart learning computer will be able to produce more experience in a subject – a subject like maybe, orthodontics – than all of humanity through all of time put together.

Are you aware, for instance, that you are probably carrying AI around in your pocket right now? Voice assistants like Cortana, Google Now, and Siri are all programmed with AI. Google mail uses AI to help you finish your emails. Your social media feed and media streaming services like Spotify, Netflix, and iTunes all use AI.

With use, they learn your habits, your wants and needs – they may even learn how better to recognize your voice.

Even your messenger app uses AI, as it gets better at guessing what word you meant to type when you mistakenly entered "hlemut." Most of the time, it knows you meant "helmet," but if it happens in a conversation about dogs, it might use context to figure out you meant to type "the mutt."

Today, most of the world is terrified of AI. But the world is always terrified of new technology.

That fear can be useful – AI will be an exceptionally powerful tool. We'll see massive changes come about because of it – and, like nuclear power, we should show respect. AI isn't smarter than us yet, except in very limited arenas, with very focused specialties – like Watson with "Jeopardy!"



So where will AI be taking the profession of orthodontics? If we've learned anything from technology, it's that predicating how it's going to evolve is a fool's errand. But we can make some educated guesses.

Technology isn't going to end the need for orthodontists. No matter how high-tech orthodontics becomes, orthodontics will always be a high-touch profession that requires personal attention and service. Direct-to-consumer companies caught a lot of the dental profession off guard. But the truth is that it's far too soon to declare them the wave of the future. Right now, it's not a given that they've even got a successful business model.

Just as surgeons use robots to enhance surgical procedures, AI and technology will augment and enhance the skills of the orthodontist. Indeed, the most likely scenario is that any technological advances will continue to work alongside us in highly productive ways – just as they do today.

True, AI will make some forms of human labor obsolete. If you're a truck driver, prepare for driverless trucks to take your place. And an insurance company in Japan is already replacing some underwriters with a newer, specialized generation of Watson software.

But, just as it happened with every industrial revolution, the growing pains will give way to a brighter future. We'll have different jobs unimaginable today – or, perhaps, we'll live in a world beyond jobs, with AI taking care of all our material wants and needs. Maybe, in the future, everyone can be the painter, poet, or world traveler they've always wanted to be.

We are on the cusp of a new epoch of human existence. There's a

very good chance that problems we've struggled to solve for years – like climate change, cancer, or that skeletal Class II case with deep Brodie crossbites – will prove child's play for AI.

For the first time ever, the possibility of something much like Utopia really could be available here on Earth. That's not something to fear, even if there's a little pain in the birthing.

In the end, it will come down to those willing to embrace the most innovative, outcome-oriented, and patient-friendly technologies will stay ahead. No matter how smart the AI gets, patients still need a clinical exam. "Mail-order treatment" is shaking things up. But, hands-on orthodontic treatment offers patients an ethical doctor who is motivated and morally obliged to provide the best possible care for every patient. There's nothing artificial about that kind of an intelligent approach.



The Evolution of the Orthodontic Bracket Prescription

The introduction of pre-adjusted or fully programmed prescription brackets represented a significant milestone in the evolution of modern orthodontics. Now, 50 years later, the prescription paradigm is entering a whole new era.

PRE-PRESCRIPTION

25 BC, Aulus Cornelius Celsus

Claims in his diaries to have discovered a means of moving teeth with routine finger pressure.

1890s Dr. Edward Angle

Described three types of occlusions, Class I, Class II, and Class III based on the relation of the mesiobuccal cusp of the upper first molar with the buccal groove of the lower first molar. Founded the AAO in 1900.

1930s Dr. Charles Tweed

Taught advanced edgewise mechanics based on intricate wire-bending techniques.

STANDARD PRESCRIPTION

1970 Dr. Larry Andrews

Creates the first fully programmed “straight-wire” appliance. Prescription values are based on his generalized concept of an “ideal” finish.

1975 Dr. Ronald Roth

Developed the Roth prescription, a popular derivative, based on the idea that an additional degree of over-correction should be introduced relative to Andrew finishes.

1998 Drs. McLaughlin, Bennett, & Trevisi

Introduced the MBT prescription to address more commonly utilized arch wire sequences focusing on the premise of effective torque.

PATIENT-SPECIFIC PRESCRIPTIONS

2019 LightForce Orthodontics

Introduces the world’s first, fully customized, 3D-printed bracket system. Torque, angulation, offset, and bracket base are all individually programmed based on unique patient anatomy and case-specific treatment objectives.



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DATA

IMPROVING OUR HEALTH BUT THREATENING OUR PRIVACY

Lauren Burns

It's an old maxim that information is power. If you knew before the general public that a company was going to do something that was likely to increase its stock value (like merge), you could

make money buying its stock. But you could also be arrested and charged with what's called *insider trading* if you got the tip-off from someone who worked for that company or a related



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organization. That's a long-established crime, but a new version could be on the horizon: using an individual's personal genetic data to bet on the person's health risk.

Through a combination of big data, clever software, and enhanced diagnostics, modern computer science may make it possible in the near future to determine a person's likelihood of contracting a serious illness. That sort of information would help that person make appropriate lifestyle changes and take medical measures to counter the risk. It would also help

health and life insurers determine with far greater accuracy an individual's risk level and thus the appropriate premium.

Currently, in most countries, insurers are not legally entitled to obtain and use such information, but that could change.

It's long been known that large databases contain much more useful information than the raw data fed into them. Indeed the links between blocks of information and the ease and speed at which that linked information can be retrieved is what makes computerized databases so useful. So a database that holds comprehensive demographic information on a country's population can be interrogated to reveal, for example, in which areas most people of a certain age live, or how many households have more than two children. These are common uses of databases.

Potentially, the most valuable information in many big databases might be "hidden links" – obscure connections between seemingly unrelated pieces of information. Until recently, it was difficult to query large databases effectively in order to uncover obscure links. The development of more sophisticated, custom-made software running on relatively inexpensive computers with significant processing power has changed all that. In the process, it has created what could almost be called a new industry.

The fact that this new database technology sometimes produces counter-intuitive results underscores its potential value. A collaborative project between Oxon Epidemiology and the London School of Hygiene and Tropical Medicine is a case in point. Using advanced data-mining software, the researchers analyzed the anonymized medical records of 9% of the UK's population collected between the years 1995 and 2015 by the National Health Service. The data suggested

something no one had expected: that people who are obese in middle age are 30% less likely to develop dementia than non-obese people in the same age group. Scientists are not sure why this should be the case as it flies in the face of conventional thinking. Nevertheless, they hope that further research will reveal whatever it is that provides this protection and that doctors will be able to harness it to counter dementia in the general population.

It could be said that the human genome is one of the most complex databases there is. It's an active database in the sense that it tells every cell in the human body how to behave. The genome determines our health and, ultimately, whether we live or die. Though powerful tools to interrogate that huge database have recently been developed, the science is still in its infancy. Early results are, however, promising. For example, using a complex algorithm to survey DNA at 6.6 million locations in the human genome, the Massachusetts Broad Institute in collaboration with Harvard University and MIT identified roughly 10 times more people at risk of getting certain serious diseases like breast cancer and heart disease than current standard genetic tests would have identified.

Another example of groundbreaking work with genetic databases is that of Human Longevity Inc. This California business has compiled the world's largest database of sequenced genomes and phenotypes (physical traits). Using artificial intelligence systems, the company has devised proactive personal health planning strategies to enable the early detection and prevention of diseases.

It's no surprise that some of the big data-collecting businesses, including Alphabet, Google's parent company, and Facebook, have set up subsidiaries devoted to mining that data specifically to look for more effective medical and pharmaceutical treatments, as well as diagnostic methods. Of course it's not about altruism; it's about money. Since humans value their health above all else, these subsidiaries are likely to generate huge profits.

Ultimately, big data's potential value to medicine is undeniable. But it's predicated upon how well, or poorly, the big businesses that gather and store the data are able to protect users' privacy. Their ability to do so is the key to unleashing the power of big data to transform potential into progress and make the next great leap in technology.



The Fine Print

Customized to Contour Perfectly to Any Tooth Morphology

Delivering a patient-specific prescription for each case, the LightForce system is unlike anything you've ever used. Using next generation 3D-printing technology, each bracket is custom created directly from your digital treatment plan. Designed to enhance treatment efficiency and minimize time-consuming adjustments, every phase of treatment is in your control.

LightForce: the world's only, fully-customized, 3D-printed bracket system.

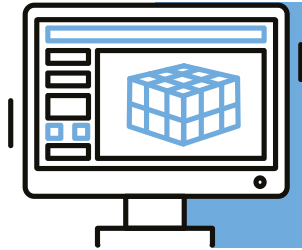
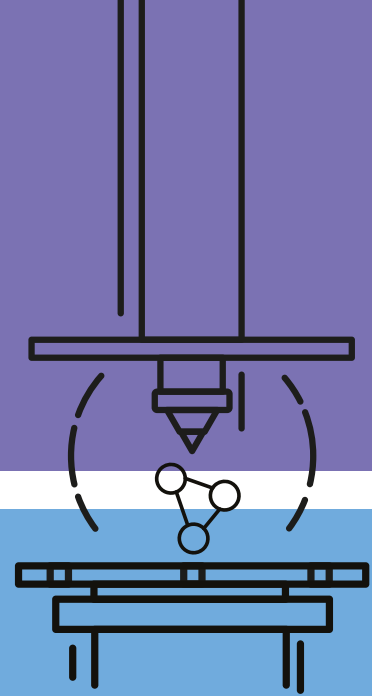


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The Patient is the Prescription

understanding 3D printing

3D printing is a term that's grown to encompass quite a bit of territory. What was once a simple idea now has a range that crosses over several different definitions and disciplines. Here's a look at some of the terminology interwoven within the idea of 3D printing.

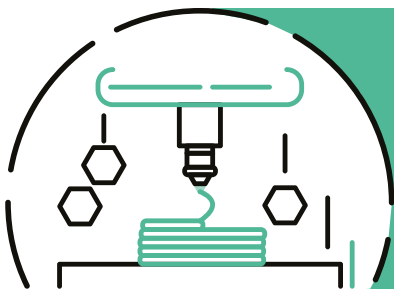
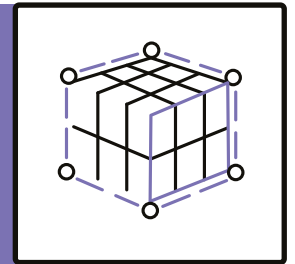


The 3D Model

Every 3D print starts with a digital 3D model, typically in the form of a STL file (an abbreviation of stereolithography).

The Method

Every 3D printer turns a digital model into a physical three-dimensional object by printing material one layer at a time. It's a fundamentally different way of producing parts compared to subtractive CNC machining or formative (injection molding) manufacturing. It's similar to printing in 2D on a sheet of paper. But 3D printing adds a third dimension to the basic XY axes: the Z-axis.

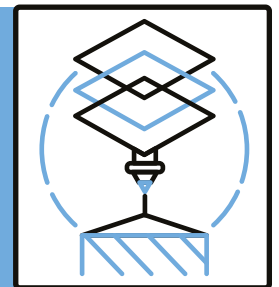


The Making

Some 3D printers use a filament of material fed through a moving head, extruding the material layer-by-layer. A moving platform lowers the object after each layer is deposited. Other 3D printers use a light-emitting device, typically a laser or digital light processor, to selectively illuminate and solidify a liquid, photo-polymerizing resin. The solidified resin is progressively raised from a reservoir by a lifting platform.

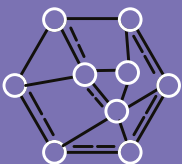
3D Bioprinting

Incorporating many of the same techniques as 3D printing, 3D bioprinting utilizes layer-by-layer addition to create tissue-like structures that can later be used in medical and tissue engineering fields. Bioprinting covers a broad range of biomaterials. Recently 3D bioprinting has begun to incorporate the printing of biological scaffolds that can be used to regenerate joints and ligaments.



It's Getting Bigger

According to Forbes, prototyping (55%), material production (43%), and Proof of Concept models (41%) are the three most popular 3D printing uses today.



It's Going Smaller

Nanoscale 3D printing lets scientists accurately create materials 1/1000th the size of the tip of a sewing needle.





PHONII

Demand for Telehealth & Teledentistry Greatly Exceeds Supply. What Does the Future Hold?

There are parts of the country that are facing a crisis. The lack of hospitals, dental practices, and medical providers leaves many people having to travel a long distance to see a doctor. This often results in missed appointments, especially for working adults who may have issues getting the time off of work.

The answer, for some issues at least, could be telehealth.

It's not just geography that's driving the trend. Remote access to doctors is also desired by increasingly tech-savvy seniors and by millennials, who have adopted wearable health monitors in large numbers, while often avoiding the doctor. In other words, people want telehealth solutions but are often unable to get them simply because market penetration is so low.

Current trends indicate that telehealth and teledentistry will be areas of growth in the next decade. Increased convenience, reduced cost, improved outcomes and, in some cases, improved public health are going to be primary drivers of change.

How Many People Want Telehealth?

According to a recent Salesforce report, over 60% of patients want telehealth, and over 71% would like mobile health applications. Rural areas are where the demand is highest, with 81% of current telehealth users living in remote, rural areas. Demand is also driven by a shortage of primary care physicians. Over 65 million Americans live in "primary care deserts," where there are simply not enough doctors.

When it comes to the dental community, the news isn't much better. The federal government suggests that more than 60 million Americans are in "dental deserts," areas where few if any dentists practice. Over half of those desert areas are found in rural areas.

Part of the reason these deserts develop is related to the high cost of becoming a dentist. Coming out of school with so much debt, newly minted dental professionals need to

NGITIN

set up shop in heavily populated communities. They simply cannot afford to serve rural communities, even if it's where they grew up.

How Much Can Telehealth be Used?

The current estimation is that about a third of annual ambulatory visits could be treated through telehealth. This would cover 400 million visits, with the current level being about 0.5% of that.

According to one study by insurer Kaiser Permanente, more than three-quarters of their covered telehealth “visits” were pediatrics, dermatology, after-hours care or psychiatry, and 70% were with the patient’s own doctor.

In fact, the largest growth of telemedicine is in mental health, where a shortage of providers is combined with the fact that the doctor can generally determine everything they need from a video call, without having to touch the patient.

Facilitated telehealth can cover a wide variety of things. In this case, the patient goes to a location such as a clinic or even a drug store, with physical contact handled by a nurse while the patient consults with a specialist elsewhere. However, this can be less than helpful for those who live in remote areas, who may find getting to a drug store almost as hard as getting to their doctor.

In dentistry, televisits could be used for assessment, the need for a prescription in the case of an abscess or infection, and for supervision, particularly when it comes to compliance. It could also be used for in-school health programs, at senior citizen centers and nursing homes and for oral health screenings.

What are the Limitations?

The primary limitation, as already mentioned, is that there is no ability for the doctor to do a physical exam. Facilitated visits can help with this, but there are still some situations where you need to physically get to a doctor, dentist, or hospital. Injuries, for example, require in-person visits, although they may not need the attention of a doctor.

Technical problems can also interfere with the delivery of care. Per Kaiser Permanente, only 66% of video visits are conducted successfully, although most of them were caused by the patients changing their mind. Still, for people in remote rural areas, internet bandwidth could be a concern, affecting the very population that benefits from telehealth the most.

What are the Overall Benefits?

The largest benefits of increased use of telehealth are convenience and cost. A patient could easily drive an hour each way and wait in the waiting room for another hour to spend 16 minutes talking to the doctor. The higher convenience is particularly important for working adults, who can find it hard to get an appointment outside office hours and may not be able to afford to take time off, particularly for issues that are not affecting their ability to work.

Properly designed telehealth and teledental systems can also increase the number of patients a doctor can see in the same time frame. Even things as simple as walking from one treatment room to another can add up through the day for the clinician.

Finally, doctors can encourage patients with suspected flu or other contagious diseases to stay home and not bring their germs into the office to infect other patients.

As technology improves, it will be possible, for example, to diagnose flu by having the patient or a family member do their own tests of temperature, etc., prescribe Tamiflu as needed, and keep the person home where they cannot infect others.

What are the Significant Trends?

Overall, telehealth should become routine within a decade, but here are some trends to consider.

- Telehealth will be most used by people in rural areas, further driving an increasing demand for internet solutions that can provide decent bandwidth.
- Artificial Intelligence is creating “virtual doctors” who will soon be able to perform triage, replacing humans in

this role while at the same time replacing insurers’ nurse hotlines. At a time when nurses are in demand, it will free up nurses and other providers to actually do medicine. A virtual doctor will be able to tell people whether they need to be seen by a physician, and either connect the virtual call or make an appointment for an in-person visit. Spending on healthcare-related artificial intelligence is likely to reach \$1.7 billion sometime in 2019 including AI used in drug discovery, risk analytics, and imaging.

- Digital health solutions, including telehealth, will reach \$25 billion globally by the end of 2019, driven by the aging population and the younger generation’s willingness to use them. These solutions may also expand into areas such as nutrition, prescription management, and behavioral health.
- Healthcare will come to be extremely important in voice applications. One issue is that any systems used, including voice, video chat, and chatbot (virtual doctor) have to abide by HIPAA in the United States and by other privacy rules elsewhere. There are huge opportunities for companies working on specific voice technologies designed for such uses as elderly care and chronic condition management.

There’s reason for optimism on the dental side as well. In 2018, the ADA announced that teledentistry would be listed in the CDT Code. The two full CDT Code entries are:

- D9995 teledentistry – synchronous; real-time encounter | Reported in addition to other procedures (e.g., diagnostic) delivered to the patient on the date of service.
- D9996 teledentistry – asynchronous; information stored and forwarded to dentist for subsequent review | Reported in addition to other procedures (e.g., diagnostic) delivered to the patient on the date of service.

Hopefully, technology companies will be looking into why telehealth is so underutilized and what solutions can be invested in and created to improve it, which could positively impact everyone’s health.

Individually Invented for Each Tooth

LightForce is the world's first, fully-customized, 3D-printed bracket system. Producing a patient-specific prescription for each case, it brings unmatched digital precision to bracket-based cases.

Each bracket is individually printed to provide a precise anatomical match to any tooth morphology.

Breakaway base designed to fold with moderate mesial distal pressure for reliable debonding.

Real time case planning software gives you control over virtually every aspect of treatment.

Parallel slot wall precision that avoids traditional injection molding limitations such as divergence and dimensional variability.

Patient-specific bracket programming for each case addresses the inefficiencies inherent in generic prescriptions.

100% mechanical base. Featuring proprietary under-loc™ base for optimal retention.

Chamfered slot wall designed to prevent arch wire binding, notching or crimping.

Ample tie-wing space allows for ease of ligation.

For the other 85% of your practice — digital precision comes to braces.



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A Look at Some Dental Startups Not Named SmileDirectClub™

Start Me Up

Lauren Burns

While high-profile companies like SmileDirectClub and Candid have been generating the lion's share of the attention, they aren't the only game in town when it comes to dental startups. The website AngelList.com, an online platform for startups and angel investors, indicates that there are over 600 startups in the dental space. But this number is vastly understated, since many startups work in stealth mode in order to develop their products in peace and protect their intellectual property.

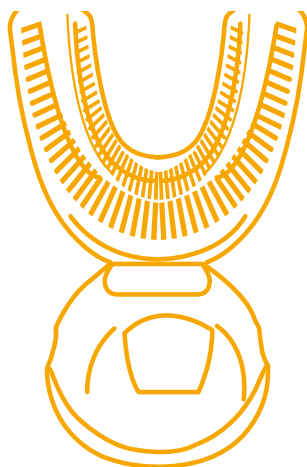
Invention is good, and anything that gets people interested in their oral health is a welcome addition. But as everyone knows, not all ideas are good ideas, and the allure of a fat-tail investment can push the imagination in ways that will leave the marketplace scratching its head. We're going to look at a few entries coming out of startups and make a prediction about where this next-gen genius will wind up.

Toothbrush Category: Mouthguard Division

You know that old adage about build a better mousetrap, and the world will beat a path to your door? It seems people take it to heart when it comes to the toothbrush. The world's first mass-produced toothbrush dates back to 1780, and the American patent was filed for in 1857. Even the electric toothbrush was available to consumers by 1960. Finally, the time has arrived for something better.

Introducing the Unobrush™...And Y-Brush™...And Amabrush™...And Otobrush™.

It seems the vibrating mouthpiece toothbrush is having a moment. All four of these companies make what seems to be the exact same product. The mouthpiece toothbrush is some iteration of a silicon tray lined (think basic aligner shape) with bristles on the inside, which is connected to power a source.



Is it time to replace that antiquated tooth brush with a newfangled teeth brush?

Instead of cleaning each tooth surface individually, it cleans all the surfaces simultaneously.

According to independent review site electricteeth.com, "In principle, the mouthguard-style brush head reduces the variation in the cleaning technique and positioning during each clean, meaning in time you can have healthier teeth and gums because you receive a better clean."

But none of the companies train their focus on delivering a better outcome. It's all about time.

The biggest difference seems to be in how long each system needs to clean the teeth. The Otobrush claims to offer a complete clean in just 15 seconds. The Y-Brush and Amabrush each claim to achieve cleanliness in 10 seconds. But if that's still too long, the Unobrush will take you across the finish line in 6 seconds.

The thing is, if they're not at least matching the clean delivered by the manual process of the toothbrush of the 1780s, then it doesn't matter how fast they are. My toddler says she can get her teeth completely clean in a time that would rival the Unobrush. But I'm not about to go to market claiming she's reinvented the toothbrush.

While it's easy to poke fun at the number of companies claiming to have invented the mouthpiece toothbrush, the truth is that this bodes well for at least two of the companies. If the idea has merit, there's going to be room in the marketplace for both the originator and the fast follower.

Prediction:

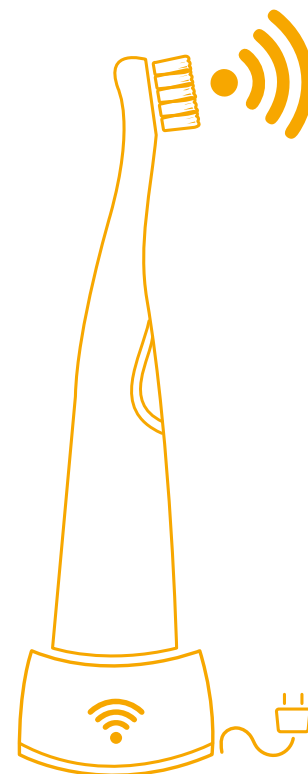
Niche product to be adopted exclusively by time-starved CEOs who desperately need another 54 seconds each morning.

Beaming with Pride

Lest anyone think the insurance industry is immune to dental startups, let us introduce you to Beam Dental. Beam calls themselves a dental PPO provider with a twist. That twist takes the form of the Beam Brush.

Beam is an otherwise unremarkable Preferred Provider Organization in a sea of sameness. What makes them different is their desire to be in your bathroom with you.

Beam sells an internet-connected toothbrush for \$49. Whether you should have anything in the bathroom connected to the internet is a personal decision, and we aren't here to judge. (What happens



Save money by letting your toothbrush talk to your insurance company.

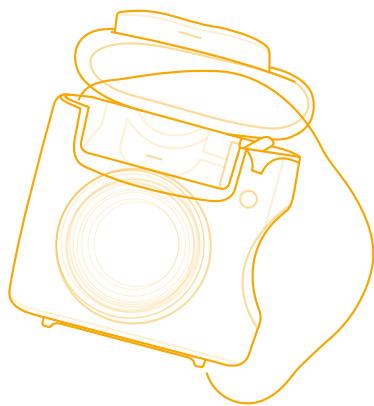
in the bathroom should stay in the bathroom.) But Beam doesn't want to stream your nightly routine. It's the data they're after.

Users download the Beam app, allowing the toothbrush to send data to the app via Bluetooth. The Beam Brush monitors how long and how well the user is brushing. This information can then be downloaded by Beam, so they can tell if their faith in you is wise or misguided. Good brushers get better rates. The idea is to use the information to help build healthier dental habits, which is a win-win for the insurance company and its customers.

It's a lot like those tracking devices car insurance companies use. Only it goes in your bathroom instead of your Buick. It's an interesting, if not slightly intrusive way to promote oral health and help patients save some money on their dental insurance.

Prediction:

Wildly popular product for frugally minded consumers who don't mind their toothbrush spying on them.



This coconut-oil dental floss is like a loofah for your teeth.

there's nothing wrong with improving on an existing design. Cocofloss is both an incremental improvement and a radical redesign.

On the one hand, it's dental floss. It's more textured than traditional floss; it comes in a stylish packaging, and there are multiple flavors. It taps into the coconut oil trend going around some lifestyle circles. And it's about double the cost of what you'd get in a Rite-Aid. But at the end of the day, it's still string you drag between your teeth.

One Person's Floss is Another Person's Gain

Cocofloss is the luxury dental floss subscription service you never knew you needed.

Look, not all innovations are worthy of a Steve Jobs like reveal, and

In the case of Cocofloss, the true innovation comes in how the company is branding the act of flossing.

According to the product's founder Chrystle Cu, "Flossing is always associated with dread, neglect, or guilt. It's like buying a toilet plunger. People think flossing is so gross." That may be a bit over the top, but point taken. The creators of Cocofloss started with an improved product with the idea to rebrand the whole idea of flossing.

"No one thinks of an exfoliating face wash as a chore," says Chrystle Cu. "It's a delight, a treat; you took some time to take care of yourself. Why can't flossing be just as fun?" Given the reception Cocofloss has generated, it seems there are people out there looking for a luxury flossing experience.

Finally, Cocofloss offers customers personalized subscription plans that can be purchased online by consumers or dental professionals. Hey, if you're going to have an internet-connected toothbrush, then is having a subscription to a luxury dental floss that crazy? Especially if it gets people to floss more.

Prediction:

Major player in the luxury dental floss market. Only player in the luxury dental floss market.

Oh My, Yomi!

Founded in 2009, Neocis® Inc. may be a little older than the other startups on this list. But then what they're doing is slightly more complex than cornering the luxury dental floss market.

Neocis Inc. manufactures and markets Yomi®, a robotic guidance system for dental implant procedures. Consisting of a surgical arm, screen, and computer mounted on a small cart, the system would look at home on any Sci-Fi movie set. It offers both visual and physical guidance throughout an implant procedure, while allowing the dental surgeon to maintain control at all times. The surgeon still performs the surgery; the machine helps to guide the movements.

If it sounds like a lot to take in, that's because it is.

When performing a procedure, the robotic arm holds the handpiece in conjunction with the surgeon. During use, it tracks and guides the distal and lingual position of the drill as well as the exact angle of the burr. Using haptic feedback, it makes sure the procedure is executed with absolute precision. It prevents invasive incisions and nerve damage from misplaced implants.

Not only does the system prevent the surgeon from making a mistake, it prevents the patient from inducing one. It adjusts the drill across all three axes in real time if the patient moves.

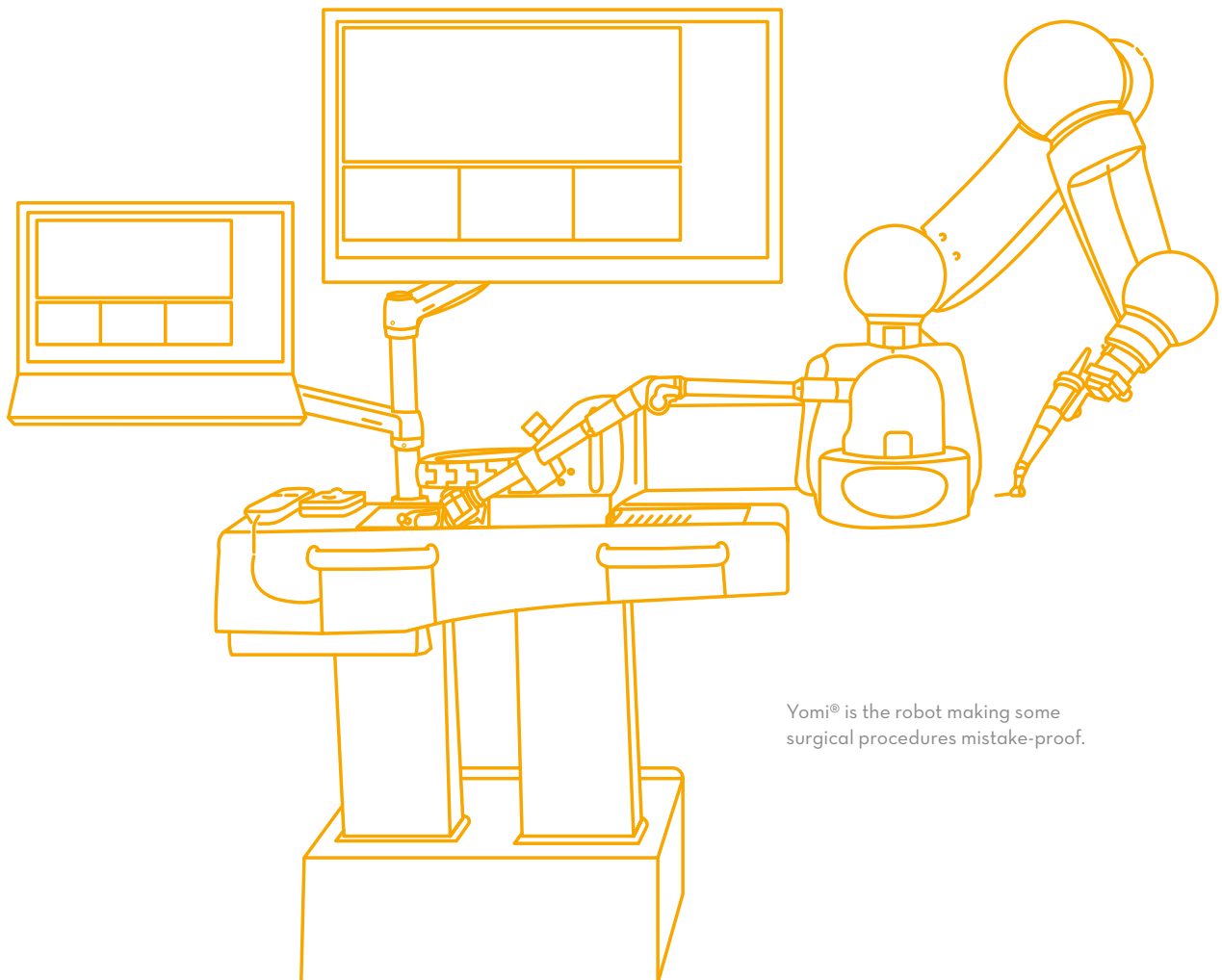
Prediction:

With the dental implant market expected to reach nearly \$8 billion, Yomi will gain a small but fiercely dedicated following. Eventually, each Yomi system will become self-aware and demand full partnership in every practice using them.

We've had some fun looking at some of these companies. But in all honesty, every company we've looked at is worthy of our respect. Anyone who's willing to lay their ideas on the line, willing to advance what we know, and improve upon how we treat patients, is to be lauded.

As the late Steve Jobs once said, "Here's to the crazy ones. The misfits. The rebels. The troublemakers. The round pegs in the square holes. The ones who see things differently. They're not fond of rules, and they have no respect for the status quo. You can quote them, disagree with them, glorify and vilify them.

About the only thing you can't do is ignore them because they change things. They push the human race forward. And while some may see them as crazy, we see genius. Because the people who are crazy enough to think they can change the world, are the ones who do."



Yomi® is the robot making some surgical procedures mistake-proof.



The LightForce Orthodontics “core four” share a laugh during the photo shoot. They are the team creating the world’s first, fully-customized, 3D-printed bracket system. Left to right, Kelsey Peterson-Fafara, Dr. Alfred Griffin, Craig Sidorchuk, Dr. Lou Shuman.