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roots

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Magda Wojtkiewicz

Managing Editor

The importance of human connection

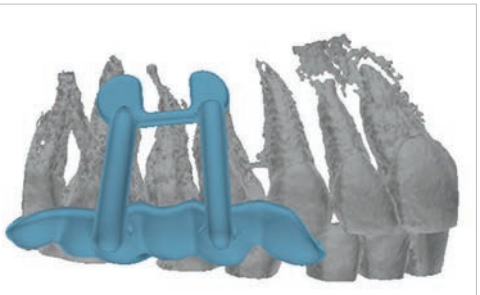
The COVID-19 pandemic has changed life as we know it. Repeated lockdowns and restrictions have affected millions of people worldwide. The impact is huge, and we might not realise it yet completely. The pandemic situation is still very uncertain and differs from region to region and country to country. Not everyone practises preventive measures such as mask wearing, maintaining a social distance and washing hands frequently, but people are more willingly using digital technology for communication. People who previously did not rely on the latest technology now have adopted novel digital methods to stay in touch with their friends, family or co-workers. Also many people are still working from home, and those who used to travel a lot are now travelling less or not at all.

In medicine, we have observed the advancement of telehealth, which might soon become widespread for many specialties. Medical practitioners and patients who have used technology that allows them to conduct and receive medical care remotely have found that it can work well for certain appointments, like cardiology check-ups and therapy for a mental health condition. It might not be an ideal solution for dentistry; however, certain help and information can be offered to the patient at a distance, and many dental professionals have started offering such remote dental consultations. Of course, there are problems for which patients need to see a doctor in person, but the pandemic introduced a new urgency to what had been a gradual transition to remote patient visits.

The pandemic has affected private lives, businesses and movements. While everyone's situation is different and some people have experienced enormous difficulties, many have found that it has been possible to deal with the crisis or even discovered new business opportunities. During the pandemic, people have learned to take care of themselves in many new ways, as they have had to adapt to new work or school schedules, change their fitness routine and reduce social contact. Many have started looking for new stress management strategies, focusing more on health and well-being.

One thing is common to continents and countries: many of us have realised how much we need other people, whether family, community or business colleagues. Human connection is invaluable, and even the most advanced technology cannot replace it.

Magda Wojtkiewicz
Managing Editor



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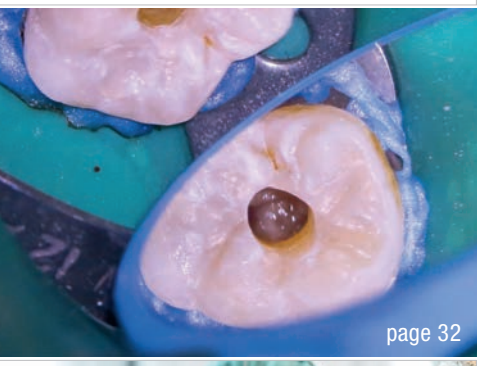

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Elements of dental instrument design

Dr L. Stephen Buchanan, USA

Dentists are inveterate inventors because every procedure we do is a prototype. All human teeth in a state of disease are alike but different, and in honouring those diversities, we invent all day long, every day in practice. Add to this the fact that dentists are very mechanical people. We do micro-procedures all day long, and we are regularly frustrated by the limitations of the tools and materials we use. Because of this irritation, it occurs to pretty much every dentist during our careers that some of these tools and materials could be better. This is how it begins.

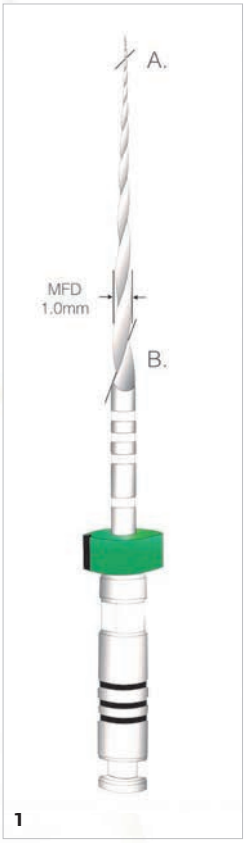

Fig. 1: Traverse rotary file. The design and fabrication of these instruments empower them to negotiate canals to their terminal points.

The epiphany, the "big idea", is the second-best experience in inventor land. More than most people realise, big idea epiphanies are perhaps the most fun dental nerds can have with all their clothes on, especially if it is never followed up with a patent application. However, the best experience in inventor land is seeing a new product you invented make it to success in the marketplace, but this is very rare, and it often involves a personal financial experience I call "the valley of death"—the inevitable delay in return after all the development money has been spent.

What is involved in applying for a patent? The first part is cheap—it is called a provisional patent—and it requires as little as a pencil-drawn illustration of the novel and inventive idea. In the US, the provisional application costs less than $1,000 for the legal work and application fees. After that, you have a year to write and submit your final patent application with claims. The legal expense for this is $5,000 plus the United States Patent and Trademark Office application cost.

The largest hit comes when the inventor must declare, at the one-year mark, any foreign countries that are to be included in the application. This is the part that can suck $100,000 out of your pocket within two to four years, and the deadline to this fateful decision often comes before the full potential of the patent application is known, as licensing negotiations can be on hold for months and years before a company prototypes, licenses or dumps the product.

There is an inventor joke that goes, what is the most predictable way to become a millionaire from patenting inventions? The answer is, start with $5 million, and sooner or later you will be a millionaire. So, what goes into a successful new product, and how do we avoid a crash and burn?

Peter Drucker states in his essay "The discipline of innovation" that "there are of course innovations that spring from a flash of genius. Most innovations, however, especially the successful ones, result from a conscious, purposeful search for new innovation opportunities, *which are found in only a few situations* (my emphasis). Four such areas of opportunity exist within a company or industry: unexpected occurrences, incongruities, process needs, and industry and market changes. ... Three additional sources of opportunity exist outside a company in its social and intellectual environment: demographic changes, changes in perception, and new knowledge." I highly recommend reading the entire essay in *Harvard Business Review*'s compilation *On Innovation*.[1]

The question to ask oneself before jumping in is, have I found one of these areas of opportunity with a product/service/tool that will make dentists' lives better? If the extent of the answer instead is, I want to be an inventor, that is cool as long as you know what you do not know and you do your homework before spending cash and heart muscle on a vision quest. Falling in love with your invention can deafen you to your friends' sage advice, then break your heart and empty your bank account like dating a ridiculously good-looking person without character.

If you want to get your mind right about this, watch Kristen Wiig's "Red Flag" skit for *Saturday Night Live* on YouTube and then keep an eye out for red flags that surface during development. Watch the opera *Carmen* to understand how you can be in love with someone or something that does not love you at all. Or, just do it like I have: spend hundreds of thousands of dollars on "brilliant" patents for products that will never get built or licensed.

The value of prototyping

Dan Fischer, founder of Ultradent Products, advised: "It's one thing to draw and create something in dimensions as large as a napkin or a piece of paper. It's another thing to create them at the sizes that may be needed to enter

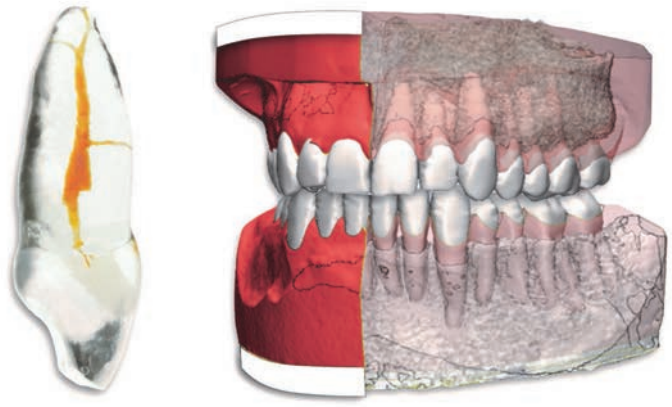

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Fig. 2: TrueTooth and TrueJaw 3D-printed procedural training replicas created by my company, DELabs.

inside of a canal or inside of a cavity preparation."[2] My experience has been that I can seldom intellectualise, during early stages of an invention, what the final product will look like and exactly how it will behave. Stated another way, I can only get half way there before a prototype must be fabricated and put into action to know any more about it. I have had 22 US and foreign patents granted and usually have several in process, and I can say without embarrassment that very few of my ideas ended up the way I thought of them working upon conception.

Successful innovation requires careful deconstruction of the failures of every round of prototyping, redesigning the next round to answer the identified problem(s) and fabricating another prototype—rinse and repeat until it works the way you hoped. The design process for Kerr Endodontics' Traverse rotary negotiation files required 23 prototype iterations before the instruments worked to my specifications (Fig. 1).

Once in a great while, the challenge is to accurately deconstruct an unexpected success. This is undoubtedly a quality problem, but these can be as mystifying as the unexpected failures. It took me two and a half years of using a System B Heat Source (Kerr Endodontics) with the continuous wave of obturation technique before I understood how a method that took 2.5 seconds to perform could be superior to warm gutta-percha techniques taking 10–15 minutes to complete. Weirdly, the continuous wave electric heat pluggers I designed worked the first time they were used. More typically, GT Files took several years of trials to get right.

Understanding the market

In the same article, Fischer encourages potential inventors to study and realise what the dental market really is going to be like for the proposed product. He cautions that "early inventors can start doing multiplication, without ever subtracting or dividing. We're usually multiplying, and we're multiplying how many units we feel are going to be bought by how many dentists who are going to use them. How many times a day can be multiplied by how many patients in a year. We can come up with tens of millions of dollars of projected successes. ... If we're not careful, the numbers become so tantalising in our brains that it's difficult for us to accept a small start that may be required first. It's that human nature thing that can run away with us if we're not careful."

Perhaps most important is that the tool solves a genuine problem that dentists currently encounter and that the benefit of the solution (the new tool) is greater than its cost. Taking it a step further, Drucker, in his book *Innovation and Entrepreneurship*, states that to be successful any new product, tool or technique must deliver a 10× advantage to make it worthwhile for new users to go through the expense and difficulty of changing their current mode of work.[3] The best tool on earth will not sell if it costs too much to buy and requires too much effort for too long for neophyte users to achieve competence.

Finally, inventors must understand that both markets and technology are dynamic realities, a factor that must be seriously considered. The right innovation developed before its time is not going to happen until its time arrives. Bill Gross, a serial entrepreneur from the age of 12, explains in his TED Talk, "The single biggest reason why start-ups succeed", that timing trumps all other variables.[4] My experience indicates that he is dead on in his assessment. Inventors must ask themselves whether the market is ready for their idea and whether all the technologies necessary for the success of their product already exist. Sometimes a great idea needs to be put on the back shelf until the timing is right.

For example, when I met Chuck Hull, the inventor of stereolithography (3D printing), I asked him whether we could use 3D printing to print an actual-scale tooth replica from reconstructed CT scans. He replied that it was possible, but that it would be 20 years or so before costs would go down and the resolution of 3D printing would be small enough.

3

Fig. 3: Endo-Bender plier. Note the smooth ergonomic contours where the clinician's thumb and palm connect with it and the end view showing the concave upper clamp jaw and the convex lower bending anvil jaw that together can immediately emboss a smooth curve on to the very last flutes of a negotiating file to enable it to bypass coronal or apical impediments. The lower jaw graduates from a 0.5 mm bending radius to fully flat for straightening previously bent instruments or pluggers.

4

Fig. 4: Buchanan Continuous Wave Plugger, one of DELabs' Legacy Collection instruments, with unique handle and identification features. Note the oversize stainless-steel finger grips to optimise manual control, separated by a narrow waist that enables smooth instrument flips, and identification rings in ISO colours next to each working end. Note the rings on each finger grip, designed to provide enhanced grip for gloved fingertips; these grooves have a concentric pattern to enable cleansing them of sticky dental materials.

His prediction was realised 22 years later, after the original patents expired, the costs of the machines went down and the resolution improved so that a printed root or canal curvature was smooth rather than staircased, and my products TrueTooth and TrueJaw were born (Fig. 2).

Designing the anatomical interface between dentist and tooth

Tools designed *by* dentists *for* dentists are the most efficient tools to use. In my experience, Intuit, the QuickBooks accounting software company, takes that a step further in requiring creative employees to "Design for Delight" in order to acquire users who are active promoters of the product.[5] Designing for delight means creating a quality experience for users as the top priority, rather than designing for minimal cost of manufacturing—which is OK if one accepts the fact that the result will be less elegant in practice. It is not much more work and expense to design facility and elegance into tools. For example, during the development stage of my first dental invention, the Endo-Bender plier, two separate toolmakers edited my design to be cheaper to make (but less fun to use), so I fired them, bought a block of carving wax, cut out and finished the upper and lower members to *my* specifications, and had them cast in stainless steel and welded together—so worth the extra effort (Fig. 3).

5

Fig. 5: The custom secondary bends in the working ends of the Legacy Collection DG16 bent-ends endodontic explorer enable earlier identification of molar orifices in calcified pulp chambers and when cutting minimally invasive access cavities.

Another example is the new DELabs dental instrument and procedural kit line, the Legacy Collection. Given the go-ahead by DenMat's Hartzell Instruments, my mission was to design a unique new dental instrument handle for traditional as well as custom working ends from my own instrument sets (Fig. 4). The signature handle has large-diameter finger grips to improve clinical comfort and manual control. The surface is made by lathe-cut rings that increase in pitch just under fingertip positions, yet are able to be easily and completely cleaned of blood, sealer, etc. by rotating the handle back and forth under an alcohol gauze (unlike other common texturing surfaces on instrument handles, such as cross-hatch knurling and complex grind patterns, which are difficult to fully clean). The stainless-steel finger grips are separated by a narrow waist that aids baton twirling to quickly switch between working ends.

The Legacy Collection instruments and products come individually or in procedural sets, including a set for each conventional endodontic procedural step, such as diagnosis, isolation, access, negotiation, shaping and cleaning, obturation and assistants. The sets have curated instruments with traditional working ends, like the DG16 endodontic explorer, as well as with custom ends, like the DG16 bent-ends endodontic explorer (Fig. 5), which features a second bend to enable early identification of molar orifices in calcified pulp chambers and when cutting minimally invasive access cavities. Certain procedural sets include a double-ended mirror handle with 16 and 20 mm Zirc Crystal HD mirrors (Fig. 6). At either end of each Buchanan Continuous Wave Plugger and Buchanan Minimally Invasive Endo Plugger are ISO colour rings to indicate plugger tip sizes.

Getting your baby to market

In most ways, the lowest-risk path to new product development is to license the patent/s to a company that will complete its development and manufacture and sell it. However, dealing with a corporate structure can be nearly impossible because so many individuals, cells and divisions have to sign off on it—and that is assuming that they want to do it in the first place. Sometimes, the engineering department will stiff-arm marketing with a not-invented-here argument, and it is blocked.

My first file design, the Safety Hedstrom File (later to become the SafeSider by Essential Dental Systems), took so many years to be prototyped by the corporation I licensed to make it that the market for it passed before its introduction as rotary files made their debut. Conversely, the

licensee of my GT System patent, Dr Ben Johnson's privately owned Tulsa Dental Products, rapidly finished development of my GT Hand File just in time for it to be swept up into the rotary revolution, and GT Rotary Files became Tulsa Dental's flagship product for the following five years and still sell remarkably well.

In this case, hedging my bet made the difference between success and failure, and since then I have had most of my licensing successes in tool design with privately owned companies. The problem with this strategy is that the majority of those small, nimble companies that develop successful new products are bought by larger corporations, and then you have to work with them.

The reason corporations buy smaller companies is because of the much greater leeway these privately held companies have to spend development money and wait several years before seeing the return on their investment. The strength of corporations is their ability to wring every last penny of market value from existing intellectual property, but eventually they often suck more of the previously created intellectual property equity out of their acquisition than they create, and a long slow downward trend is seen unless further acquisitions can be put in place to obfuscate this reality.

The greatest entrepreneurial successes in endodontics—Tulsa Dental and EdgeEndo, for example—were only achieved because the endodontist inventors, Dr Johnson and Dr Charles Goodis, respectively, did it themselves by starting companies. Sonendo, a start-up out of a medical technology incubator with no previous dental experience, developed a multi-sonic root canal cleaning technology, building a company around it and in the process changing the specialty of endodontics. Starting your own company has the highest potential reward; however, it also has the highest risk profile—typical of most scalable revenue streams.[6]

Do not call my baby ugly: Some final pieces of advice

Be really fickle about whatever material, tool or technique you are currently using. I love tools for the power they provide to accomplish previously unattainable missions, like continuous wave electric heat pluggers reducing the time to three-dimensionally fill root canals from minutes to seconds. However, the day I find a better, faster or simpler way to fill root canals, continuous wave pluggers will be dead to me. Ideally, you obsolete your own inventions before somebody else does.

Listen to everybody's opinion, but make up your own mind in the final assessment. Most users have ideas about how existing products could be incrementally improved, but they lack the vision to ask for an entirely new product category—nobody ever asked Apple for an iPod, iPhone, iPad or iWatch. You cannot get to the finish line without persistence, but persistence by itself will never get you there either. Those who persist, but can pivot on a dime when faced with new data will get there first.

6

Fig. 6: The Legacy Collection double-ended mirror with 16 and 20 mm Zirc Crystal HD mirror heads. These mirrors reflect at least 30% more light and are more scratch-resistant than traditional rhodium-plated mirror surfaces. The 16 mm mirror size is great for views into mandibular molar access cavities when sitting in the 12 o'clock position.

With that said, there is nothing like the thrill of successfully seeing an invention through all the impediments that stand in its way. Never forget that, with the right lever and fulcrum, you can move the world.

Editorial note: A list of references is available from the publisher. This article was first published in the US edition of roots—the international magazine of endodontics, *vol. 9, issue 1/2019.*

about

Dr L. Stephen Buchanan, DDS, has lectured and taught hands-on endodontic continuing education courses for 30 years, both in his DELabs Academy in Santa Barbara in California in the US, as well as in dental schools and meetings around the world. He currently serves as an assistant clinical professor at the Herman Ostrow School of Dentistry of the University of Southern California and University of California, Los Angeles School of Dentistry, both in the US.

Dr Buchanan is nationally and internationally known as an expert in the research and development of new technology, instruments and techniques in endodontics, designing many of these products, including 3D-printed teeth and jaw replicas TrueTooth and TrueJaw and the Legacy Collection dental instruments and procedural sets, for his company DELabs. He is the owner of more than 22 US and international patents, and his tools are used by endodontic specialists and general dentists worldwide. Dr Buchanan also maintains a private practice limited to micro-endodontics and implant surgery in Santa Barbara and is a diplomate of the American Board of Endodontics and a fellow of the International College of Dentists and American College of Dentists.