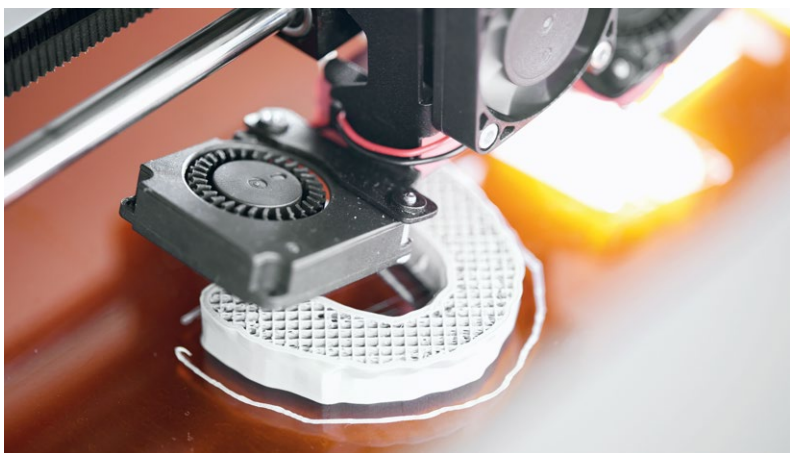
The advantages of filament printing in general
and of the SIMPLEX 3D filament printer in particular

With this system, any orthodontic office or laboratory can enjoy a successful start with digital workflows – virtually at the touch of a button

SLA, DLP, or FDM/FFF: additive 3D printing is setting the pace in dentistry and is also becoming increasingly interesting for orthodontics. Not only is the technology becoming faster and more precise, the market for print materials is also continually evolving. But how can additive manufacturing benefit orthodontics? And what are the advantages of using filament printing to fabricate models? In this interview, Annett Kieschnick looks at the opportunities and possibilities that 3D printing can bring to orthodontic offices and orthodontic laboratories.

Annett Kieschnick
Freelance specialist journalist, Berlin

Digital orthodontics today: how far have we come?
Digital technologies have enhanced the field of orthodontics for a number of years now. There has been an enormous surge in innovation in the area of intraoral scanners and they are now considered a game-changer in digital orthodontics. Thanks to direct digital data capture, the entire workflow can be mapped digitally. With digital models, users not only save time, resources, money, and space, they also benefit from precise planning and reproducibility. A model can be fabricated in the software with just a few clicks. The virtual model can then be evaluated in all planes. The software is used to analyze the patient situation and to plan treatment. Whatever the requirement – be it measuring tooth size and position or creating the setup – digital tools provide valuable support. Treatment scenarios can be easily simulated. The digital model can also be archived to save space, and retrieved later at any time by calling up the patient data.



The main application area of 3D filament printing is the fabrication of all kinds of orthodontic model.

How can a dataset be efficiently transformed into a physical model?
3D printing is becoming the method of choice for fabricating a physical model. Compared to milling, printing a model is less expensive. One disadvantage that is often mentioned is the additional post-processing effort (additional finishing) that is required with some printer technologies (DLP, SLA). That's why it makes sense to compare different 3D printing technologies and to choose the right technique for orthodontic purposes. With filament printing (FDM/FFF techniques), for example, there is no need for any post-processing such as washing or curing. At the same time, depending on the printing system, models printed from filament meet all the requirements of an orthodontic model.

Many orthodontists are not aware of the potential of digitization for their day-to-day work. Where do you see the advantages of digital orthodontic technology?
I don't believe that people don't see the potential of digitization in orthodontics. From my perspective, I think it's actually the initial outlay that is a challenge as well as the change it-

self and the learning curve for the dental office team as a whole. Many digital processes are not billable either. Just the same, the advantages outweigh the drawbacks. Many of the benefits only become apparent when you work with digital technologies. Ultimately, it's not just a matter of replacing an analog step with a digital workflow – entire process chains are transformed. The resulting benefits are wide-ranging, and include digital archiving, treatment monitoring and documentation, greater accuracy, and less time required. Some orthodontic offices that use digital workflows now no longer need alginate at all, meaning that cleaning and disinfection of impression trays, for example, are no longer required. It is understandable that the initial outlay and the cost of training can dampen enthusiasm. Those who are unsure about the digital possibilities can inform themselves in detail by speaking to colleagues, for example, or through specialist groups, professional organizations, or the German Federal Ministry of Economic Affairs. Subsidies and low-cost loans or grants are available. Ultimately, digitization is another building block in state-of-the-art orthodontics and provides for greater treatment comfort.

What are the differences between filament printing and the resin-based printing technique?
With both techniques, the model is built up layer by layer. Resin-based printing techniques (SLA, DLP) begin with a liquid photopolymer that is cured following exposure to light.
Alternatively, e.g., for orthodontic models, there are printers known as filament printers that use the fused filament fabrication (FFF) technique. In this case, the filament (thermoplastic resin in wire form) is heated and applied using an extruder; this can almost be compared to a hot glue gun. Both methods of fabrication have advantages and drawbacks. Many orthodontic offices and orthodontic laboratories choose filament printing, for example if they do not want to work with synthetic resins as they want to avoid additional hazardous materials and emission of fumes. With the SIMPLEX 3D filament printer system from Renfert, for example, the filaments that are used are mainly bioplastics that can be recycled and industrially composted without the need for complex processes. In this way, orthodontic offices and laboratories can print 3D items in an environmentally sustainable manner. Unlike other printing techniques, there is no hazardous waste. Filament printing does not require complex post-processing work either, as the printed items do not need to be cleaned or cured – meaning fewer work steps and fewer chemicals! Moreover, a resin printer is generally more expensive to buy than a filament printer. In other words, a filament printer can be an excellent alternative for fabricating orthodontic models.

"The convenience of 'plug and print' impresses many users. Renfert has put its value proposition "making work easy" into practice here in a single piece of equipment."

Renfert has launched a 3D filament printer system on the market. What is so special about it?
The key is "plug and print".
SIMPLEX is the first all-in-one dental system that comprises a modified FFF printer, dental slicer software, and adapted materials, and is also easy to use. No prior knowledge is required; you only need to press a button. SIMPLEX couldn't be simpler to install or use, making it ideal, especially for beginners.

What items can be printed with the system?
There are currently four preset parameters: for the fabrication of planning and diagnostic models in white PLA, for working models in viridian green PLA, for planning and diagnostic models with gypsum-filled filament, and for aligner models with a heat-resistant filament in white. Why are there specific parameters for each model? Because the diagnostic model should primarily have a clean, white appearance, while the wall thickness of the working model must be designed so that it can also withstand 2.5 bar in the pressure pot. The thermoformed aligner model, in contrast, must be heat-resistant.

The print quality of the first generation of filament printers left quite a lot to be desired. How would you rate the results when printing with SIMPLEX?
You can't compare the printing results achieved today with those of the first generation. Unlike the first generation, SIMPLEX offers an immense improvement in print quality with high dimensional accuracy. Someone with a resin printer might see that differently. However, the question should be: what quality do I need for day-to-day work in the dental office and laboratory and how much effort am I prepared to invest in it? The quality is perfect for orthodontic models. That's why SIMPLEX seems to be the ideal partner for everyday fabrication of models.

What are the economic advantages of filament printers?
As this printer essentially runs in the background and loading it or creation with the Model Creator are completed relatively quickly, it saves a lot of time compared to analog fabrication of models, particularly as no post-processing is required after printing either. However, it also saves material, as there is barely any rubbish or waste. At the same time, the manufacturing costs are lower compared to the fabrication of gypsum models and there is also less noise too. All in

all, the fabrication of models using a filament printer is more cost-efficient, more sustainable, quieter, and cleaner.

What would you say to the argument that a filament printer is slower than a resin printer?
The argument that a resin printer is faster is irrelevant for many users. Printing runs in the background, also at night, so it doesn't really matter if it takes an hour less or more. If printing is carried out overnight, the completed models can be removed from the unit the next morning and work can continue again right away. Gloves are not required to clean the models or the print platform, and a light curing unit is not required either. In short: it's not the printing speed that counts but rather the overall workload – and this is lower with SIMPLEX. For an orthodontic office that prints four models a day, for example, a single filament printer would be more than enough. For that number of items, you don't need an expensive unit that coughs out 20 models in half an hour and then sits idle for the rest of the day.

What is so special about the newly developed slicer software?
To use a printer, you need to know what it's supposed to do. This requires that the data-based object (model) is read into the slicer software. For this purpose, the STL file created in advance in the CAD software is imported into the slicer software. The specific parameters are then set, e.g., material. This is not necessary with the optimized SIMPLEX sliceware. You only need to import the STL file into the slicer and to run the pre-installed program. This special Renfert mode is what is so special about SIMPLEX, as all parameters are already pre-installed. That's what makes it so simple for beginners: SIMPLEX can be used without any prior knowledge. Thanks to Expert mode, where all parameters can be set individually, the system is also of interest to users who are experienced in 3D printing.

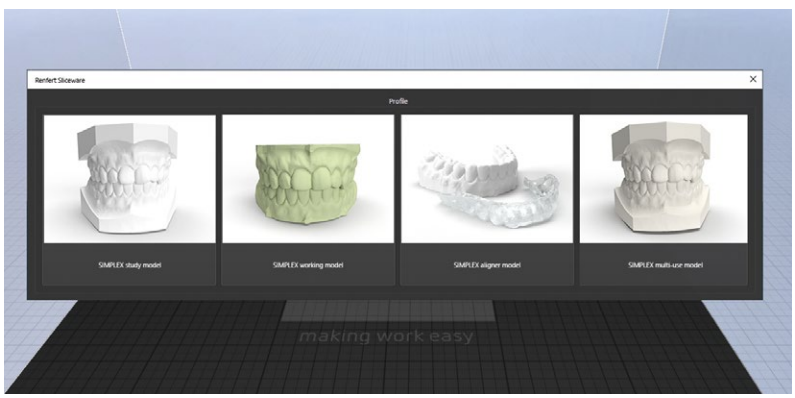
Printer, software, filaments: The specially coordinated system of three components is what makes SIMPLEX such a simple option for orthodontic applications.

Do the SIMPLEX filaments have special characteristics?
Renfert is a German manufacturer that only uses validated materials. One special characteristic, for example, is the heat-resistant material. Renfert is one of only a few manufacturers to offer a special filament that is adapted to the specific needs of aligner fabrication and the thermoforming technique*. There is no need for curing or post-processing. This means that any splint material with a thickness of up to 1 mm can be thermoformed without any difficulty.
Less heat-resistant filaments already deform at a splint thickness of 0.3 mm. In addition, Renfert offers a filament with a high gypsum content that is therefore already billable in some German states.

*Exception: Zendura Clear Aligner & Retainer Material

One final question: how would you rate SIMPLEX in a nutshell?
Thanks to the convenient plug and print concept, this cost-efficient system consisting of hardware, slicer software, and material makes it easy to get started with digital orthodontics. In a nutshell, that means: no major effort, no large investments, and an automated, controllable, and valid process without time-consuming trial and error. You only need to select the program and the unit does what it's supposed to do: print a model. Essentially, you can get started with digital workflows at the touch of a button!

Thank you very much for these interesting insights into digital printing of orthodontic models!



SIMPLEX sliceware with pre-installed presets for orthodontic use.

Sources: DT Christian Born; Whitepaper "The future of efficient model fabrication in orthodontics"