Soft Smile

VISION

ADVANCEMENTS IN **ORTHO PLANNING**

Advancements in Ortho Planning

A woman or man is only as good as their tools, or so the saying goes. When it comes to orthodontics, if these tools can open doors to care and help a clinician provide high-quality treatment, all the better.

One such tool that is quickly infiltrating the dental and orthodontic market is artificial intelligence (AI). While it can be found in every aspect of the dental practice from clinical scanning to practice management, perhaps the most influential, intriguing, and promising application has been in orthodontic digital treatment planning.

While there are many orthodontic treatment-planning solutions on the market, SoftSmile was created to provide clinicians with access to tools and solutions to create accurate, precise and beautiful smiles, while eliminating the need for third-party service companies. To do this, SoftSmile developed VISION, an advanced digital treatment-planning software that puts the power in the hands of the clinician and enables clinicians to manage workflows they may previously have had to outsource, with the ultimate outcome of making treatment accessible to patients around the world.

“Our solution is to give orthodontist better tools to treat their patients which will cut down on costs, cut down on time, and will open the market to new people because there’ll be more people who can afford treatment,” says Zoë Barnstone, marketing manager at SoftSmile.

One of SoftSmile’s goals is to eliminate barriers to care, such as location and price, that affect many patients. With VISION, clinicians have access to a set of tools that automate the technical steps of treatment planning, so that they can focus on the bigger picture or treatment strategy and planning,

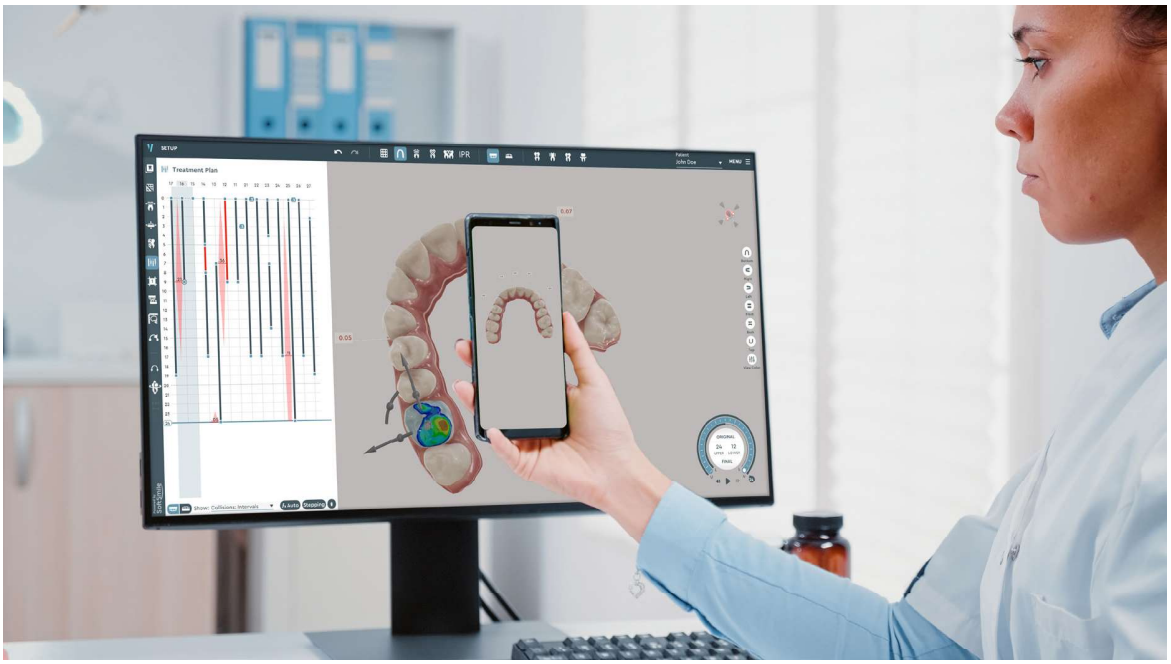
instead of intricate calculations and time-consuming details. By streamlining the technical stages with AI, treatment planning can be simplified, expedited, and performed in house, saving the practice and the patient time and money.

Until recently, clinicians could either pay hefty fees to outsource aligners to the giants of the clear-aligner field, or try to fabricate aligners in house—a nearly impossible task for those without adequate treatment-planning software or the know-how to stage orthodontic treatment. SoftSmile provides the treatment-planning support to allow clinicians, regardless of experience level, to provide high-quality care with flexible production options—meaning that more clinicians can offer clear-aligner services, and at more affordable prices, whether they decide to produce aligners in house, or have them fabricated by other providers.

“There’s already an established market for this, but we came up with alternative solutions that in many ways exceed what the market players had already established,” says Damian Gerikhanov, chief technology officer at SoftSmile. “At a point, we knew we had to do something different, and it allows us to come up with some interesting solutions that increase ease of use, convenience, and high accuracy.”

These solutions include AI algorithms developed based on clinician expertise to ensure that information is geometrically accurate, consistent with tissue and tooth anatomy, and in line with biomechanical principles. These formulations help simplify every step of the clear-aligner process, from preprocessing to setup to postprocessing, and make each stage intuitive and fast, without compromising on quality. The technology can even be integrated directly with 3D printers, and automates most steps of the design and production processes. This improves workflow and the reduced time in treatment planning, discovery and manufacturing, leading to shorter appointment times and happier patients.

“Ultimately it all boils down to ease of use,” Gerikhanov says. “SoftSmile software is very convenient to use, while not compromising on speed and accuracy. And that’s what we’re focusing on: We maintain very high accuracy. We do validations,



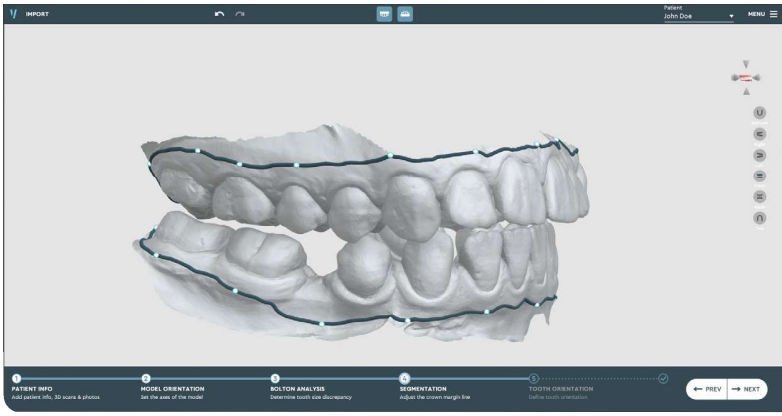
we perform experiments, and then we observe our clinical results. It extends through the whole process of treatment planning."

Preprocessing

VISION software streamlines the entire preprocessing staging, from the initial steps of uploading patient data to ultimately preparing a model for setup. To get started, clinicians create a patient file, and upload relevant images like patient scans or intraoral images to a cloud platform, so that the images can be accessed from any device the clinician has VISION software installed on.

The scans are then imported in the VISION workspace, where clinicians can adjust the coordinate system to match with the software. The software provides prompts for each step of the process for increased ease of use. Clinicians can indicate if any teeth are missing and then trace the distal and mesial side of the teeth to help the software generate the segmentation contours.

"Contours around the tooth designating where the border between the tooth and gingiva is need to be very accurate," Gerikhanov explains. "Other solutions require people to actually draw it around every single tooth by clicking around it. In our solution, that's not required; all you need to do is mark the tooth as present, and then the software just draws an initial estimate of where the contour is. We find that this initial estimation of the contour is very accurate."

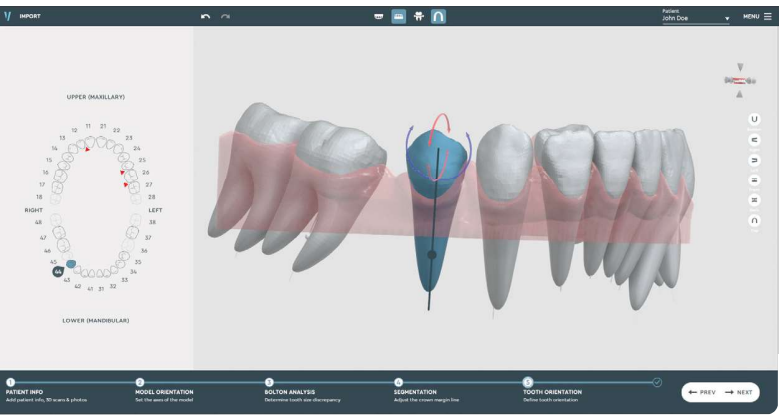


Sometimes, however, the contours may deviate slightly from the desired position. VISION has a convenient tool to easy correct in situations like this when the algorithm may not get it exactly right.

"Although the algorithms are very accurate, we find that ultimately, the person or user should have the final say and determination," Gerikhanov says. "If you don't have a convenient tool to fix any errors, it makes the whole thing pointless. So, we built a very robust AI-based tool for generating the initial contour, and then we invested a lot of effort into making sure that if any corrections need to made, that the correction is also very convenient and easy."

Gerikhanov emphasizes the importance of ease of use, particularly when it comes to segmentation and cleaning up the mesh, and expediting the entire preprocessing workflow. Once the segmentation is complete, there is still a lot of data missing, such as what the teeth look like in the interproximal areas, since scanners can't scan between the teeth. Scanners can also create artifacts, or garbage data, which need to be removed. With many software solutions, all of this needs to be removed manually, which can be time consuming and cumbersome.

"From a technical standpoint or the implementation standpoint, what we are doing is very different from



other solutions," Gerikhanov says. "We've done a lot of work making sure this is done automatically. The algorithms analyze tooth geometry and perform curvature analysis, and build the missing surface in a way that requires minimal interaction by the user.

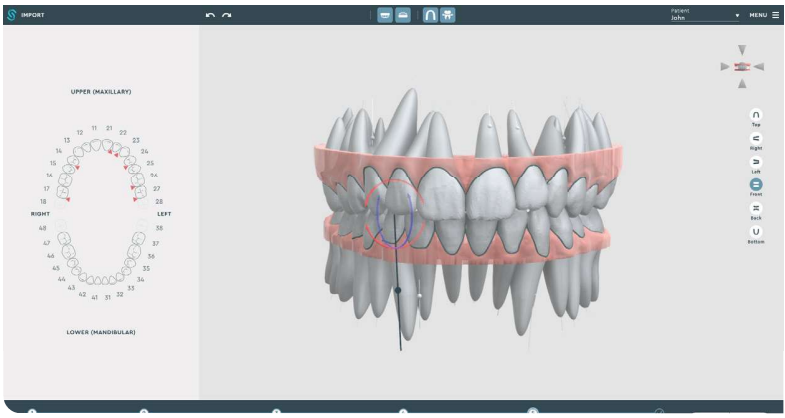
"We are also emphasizing the importance of the integration between automated AI-based solutions and user experience—and that is something that makes the AI more friendly and easier to use," he adds. "Clients that use the software and have produced hundreds or thousands of cases are saying that they are experiencing up to 30 times reduction in time spent on preprocessing."

And this AI is at the crux of VISION's speed and accuracy. The AI is constantly learning as new patient scans and data are uploaded, and as segmentations are edited. As the software collects more data, the algorithms will only get more accurate. Gerikhanov explains that this means the program will get better and better over time, and that eventually, the manual corrections will probably not be needed. First, however, more data collection is needed.

"Data storage is so cheap now, that we see no reason not to collect as much data as possible, and we expect only improvements as the data grows," Gerikhanov says. "As we collect more and more diverse data—diverse in terms of the clinical or anatomical situations, ages, and conditions of the patient, etc.—we are going to see a naturally occurring rise in accuracy. We are already seeing that, and the algorithms seem to be handling the data well, and are already improving in accuracy."

And the algorithms soon won't just be analyzing the scans. The VISION software will collect data on corrections of the machine's automated output made by the users. Ultimately, these corrections and clinical preferences will be built into the machine learning so that the algorithm can take into account what a particular clinician prefers. The algorithm will then use adaptive learning to adjust to the user's preferences and approach treatment planning with these adjustments incorporated in the future. While this feature isn't yet integrated into the software, it is another step in AI advancement that will catapult treatment-planning technology forward even more.

"This can be on the user level, as well as a practice level, or even greater like an organizational level," Gerikhanov explains. "People use the software in a very different ways from one another; they have their own styles, and their clinical approaches differ. We're having to maintain and support all these different variations of how people do things, and so we are collecting and will continue to collect as much data as possible. We want to make the AI base of the software adjust to individual preferences of different users."



Setup

No matter what the clinician's style or preferences, VISION software provides them with treatment-planning flexibility when it comes to setup and staging. Once preprocessing is complete, it's time for the clinician to determine how the teeth should ultimately be clinically aligned, and what they want to see at the end of treatment—and how they can correctly achieve those goals through staging.

"The idea of staging is to make sure that the sequence of motions that the team will be performing throughout treatment is optimal; that you're maintaining the optimal speed while avoiding collisions," Gerikhanov says. "We want to maintain a certain speed; how much is it allowed to move per aligner? You want to maintain optimal pressure, while also avoiding

collisions, and this requires a lot of expertise and intricate analysis of what's happening."

This detailed process is usually done manually in other software systems, which can eat up extensive time and also leaves room for errors. While SoftSmile software has a very sophisticated, flexible tool for performing staging manually, it also incorporates an algorithm to expedite the process. This AI-based solution does all of the calculations automatically, and builds an optimal sequence of motions which avoids collisions and also takes into account what pressure certain speeds should correspond to maintain the optimal speed while preventing collisions. Instead of having to intricately play with various settings and moving one tooth and then moving others manually, the algorithm does it automatically.

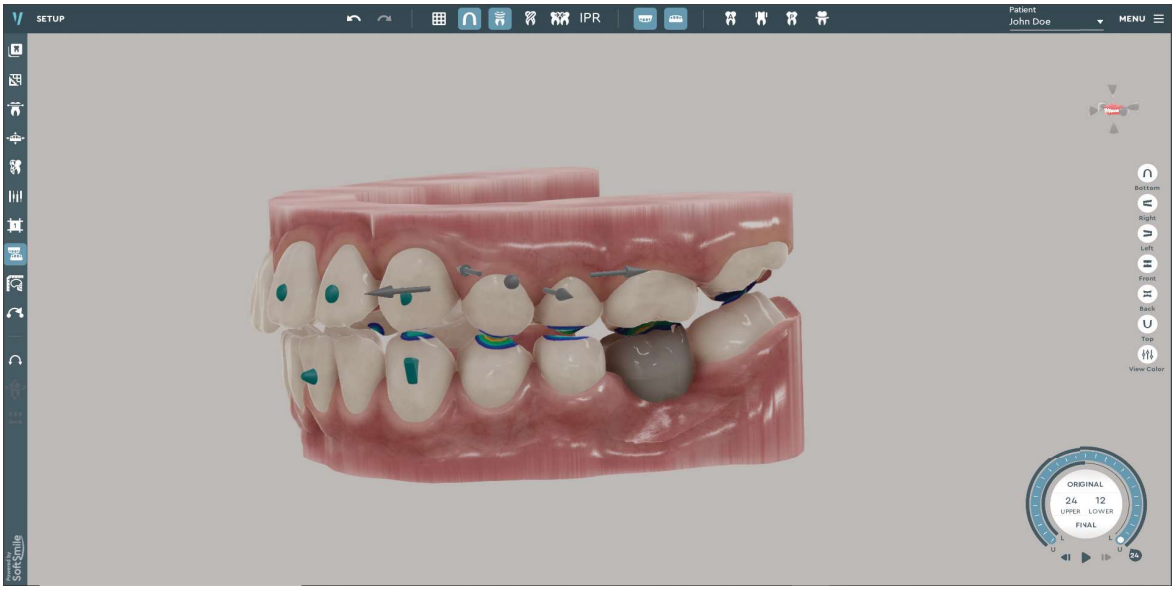
"Once it's done automatically by the machine, you as a user still have the final say," Gerikhanov says. "When you run the algorithm, it's going to output a solution which it thinks is optimal. And then you have a convenient tool on top of that to make corrections if required, or make adjustments that are more to your liking in terms of your own clinical preference."

Postprocessing

VISION's assistance doesn't end with staging. Once staging is complete and the treatment plan is finalized, the next step is fabricating a model that accurately represents the patient's dentition. The software ensures that molds are accurate and ready to go, with intuitive and integrated cutting lines and automated batching, so that fabrication will go smoothly.

"We are integrating with 3D printer manufacturers and producers, so that the software can communicate with a printer directly," Gerikhanov says. "You don't have to interact with these slivers and then go through multiple different versions or applications to actually send things to the 3D printer, if you're using your own printer."

SoftSmile's goal is to ultimately go chairside, to compete with the large entities that are already on the market, but found there was a lot of initial interest from midsize orthodontic labs. As a result, in addition to working with independent practices, SoftSmile integrates with larger clients that have established automated manufacturing setups and solutions.



"No matter what the scale of your production is—whether you have a homegrown little 3D printer somewhere in your basement which does printing, or you're a large company with a conveyor belt or a factory producing thousands of cases—we support you either way," he says.

But the initial goal of chairside support hasn't been forgotten. To support this, SoftSmile is building its own secure web portal (slated to go live by the end of the year) which allows practices to keep data synchronized and centralized in the cloud. Clinicians can then use the software to integrate with the portal, allowing them to keep and fetch that data that is stored in the cloud.

For practices that don't have a 3D printer, or don't want to dive into the messy work of production and cutting, etc., the software allows you to issue an order and then a SoftSmile manufacturing partner can complete the process. While sending out for manufacturing does extend the working timeline, Gerikhanov says that practices will still receive the finished product sooner than with other providers.

"Because we have global partners, and are present in different parts of the world, there will be someone geographically close to you, wherever you are," he says. "Therefore, you should expect things to be delivered to you faster, without holding up a treatment timeline."

A VISION into the future

Even though SoftSmile and the VISION software are ahead of the curve, they have no plans on slowing down. In addition to the upcoming web portal, increased chairside options, and individual adaptive learning, SoftSmile has big goals for advancing the software's capabilities and providing even more advanced tools for clinicians. For example, infrastructure for increased technical and clinical support is on the horizon to provide more comprehensive resources.

"Maybe you want to have someone do a quality check on your treatment plan, or maybe get an opinion on how to fix a certain issue in a case," Gerikhanov says. "That's something we are thinking about doing, as well as technical and increased manufacturing support."

SoftSmile is also exploring automated CBCT and CBCT extraction methods. Instead of relying on an extrapolated geometry of roots, CBCT extraction methods would build in patient-specific root geometry on top of the teeth.

"This would allow clinicians to see how the roots are interacting with each other throughout treatment—you could view if there are overlaps or collisions in terms of the roots," Gerikhanov says. "And this could be really helpful and important."

This constant evolution will be critical in ensuring that treatment planning continues to become more accurate, streamlined, simple, and effective, ultimately providing better patient care and more accessible treatment. Gerikhanov credits AI for making much of this possible, and is excited about how its capabilities will grow in the future. He's also intrigued to see how developments in AI will push the industry to continue to evolve to provide even more cutting-edge solutions—solutions that, as technology expands, people will come to expect.

"AI is doing things which we wouldn't think were possible until very recently," Gerikhanov says. "And obviously, while people are currently impressed by such feats of AI, soon it's going to become something very expected, something of a given. And if you don't do it, you're not good enough. Things are changing. Things are going to continue to change. And this is mainly because AI is making it very convenient and people get very used to convenience. We will all have to continue to push forward to provide the latest approaches for the best care."