Narrator:	The following program was presented before a live audience at the Chicago Dental Society Mid-Winter Meeting. Dr. Peter J Lio is chairman of the television committee, and Dr. Patrick J. Pierre is commentator. Dr. Gerald McLaughlin assists Dr. Duret with the presentation. And now CAD/CAM Live. Dr. François Duret.
François Duret:	Thank you very much. Today I present to you the realization of a CAD/CAM crown. But before, I want to present, some friends which work with me, especially Dr. Bernard Duret, my uncle who work on the new materials. A very important engineer in my team, Eric Chapoulaud. And my friend Gerry McLaughlin, a very good friend and he worked with me two years ago. Thank you very much Gerry to be here today.
Gerry McLaughlin:	Thank you François and it's truly an honor to be here today because I understand, beyond being the first live presentation in North America, this is actually the first time that this equipment has ever been on this continent.
François Duret:	Yes, I am a little nervous about that of course.
Gerry McLaughlin:	Of course, but I see we're surrounded here by equipment. Perhaps you could give us a little bit of an overview of what it is.
François Duret:	Yes, I think it's a good idea. In this equipment, you have three parts. The first one is here. It's to take impression with this camera. You can control your impression on this screen. The second part, the slide please. It's like this. The second part is here. I work on the modeling here, on the design of a crown inside and the outside. And the last one here is a micro-milling machine. It's possible to prepare the crown in this part in a new material, or in a traditional material.
Gerry McLaughlin:	Now, I've worked with this equipment with your help, and I've been amazed at how it is both a whole new world for dentistry and yet there are so many parts that are really the same. It's just a different way of accomplishing the same thing that we have been doing, well, for centuries now. So I'd appreciate it if we could give it, actually show how it works, and perhaps the place to start is here with our patient.
François Duret:	He is a good patient.

Gerry McLaughlin: Yes! And I see that we have already prepared the tooth, and that's prepared in the traditional method. Is there any type of preparation that you prefer over others for CAD/CAM?

François Duret: Personally I prefer the chamfer. I prefer the chamfer for drawing the line, the margin line, it's better and furthermore for the micro-milling machine it is better too.

Gerry McLaughlin: Okay, so, it's an easier to read impression then, and for the milling machine, it finds it an easier time. But you could use any type of preparation if you chose.

François Duret: Yes, of course.

Gerry McLaughlin: Now, I see also in there that the teeth appear to be a little *flatter* color, as if they've been sprayed with some kind of paint or something. Could you tell us something about that?

François Duret: Yes, it's a special layer for taking a very good impression. It's very easy to use it, I can demonstrate that.

Gerry McLaughlin: Oh, if you would.

François Duret: Yeah. This is a special pistol, a special gun. This is a color … you can use different colors, and how do you can.

Gerry McLaughlin: And so you would do this actually right in the mouth?

François Duret: Yeah.

Gerry McLaughlin: And the other thing that strikes me right off is that I see there are three little spheres, attached to the tooth there. What are those all about?

François Duret: It's a grey button for correlate the different views. When I take a vestibular view, the lingual view, an approximal view, I must correlate each view to obtain only one object. A model, stone models, but virtual stone models.

Gerry McLaughlin: Well, I can certainly understand how that would be, because if you can't correlate all these different views, it would be just confusion for the computer. I guess it would be the same as holding up two slides and if they were identical, and you overlaid them perfectly, it would be very understandable, but if you move them just a little bit, you could understand nothing.

François Duret: Absolutely.

Gerry McLaughlin: So these are then the three reference points. Now, the way you have them on is with a clip, I see.

François Duret:	Yes, it's an example of a special clamps for correlation. It's a clamp with a rubber-band clamp. It's not a special clamp for a CAD/CAM.
Gerry McLaughlin:	So it's a standard rubber-band clamps that you've modified. Okay, and then those are clipped onto the mouth, and it seems to me that this is the place where we start to depart from the traditional.
François Duret:	Yeah.
Gerry McLaughlin:	From here, I know that we go on to the CAD/CAM camera, which is quite a special instrument here. Perhaps you can tell us something about it.
François Duret:	This is a very special instrument, for different reasons. The first one, this is with this small camera, you can take an impression, we can take a picture in the three dimensions, not in two dimensions, as the precision is very high. You have two lenses, here and here, and you take this camera in your hand like that.
Gerry McLaughlin:	It looks to me that it's quite a large unit, I know it's shrunk quite a bit. Is it going to be getting smaller still?
François Duret:	Yeah, today it's a little heavy and certainly a little big, but it's not very difficult to reduce that, it's a first prototype in north America.
Gerry McLaughlin:	Yes, well, actually, in fairness, I have worked with it myself, and certainly for one patient or two patients it's not that bad. If you were going to do all day, that might be a problem. But now could you show us how this works?
François Duret:	I now take some pictures in the mouth of my patient. In the beginning, on the vestibular, not in the beginning, I personally prefer a special occlusal view. It's my habit. After, I take an occlusal view. But the occlusal view of the preparation. After the view of *moignon*. Gerry I prefer
Gerry McLaughlin:	Well, that's a path of insertion. *moignon* is just path of insertion.
François Duret:	And after, different view around the preparation. For the full view, I use a very special box. Please, Gerry, can you describe that, because you use it now.
Gerry McLaughlin:	Certainly. This is a checkbite that had been taken previously. After the tooth had been prepared, silicone or rubber base, or any similar material that you would use for a checkbite could be used. In this case, it's silicon. And the patient simply bites down onto it. Perhaps you can show us how this would work. The reason for this is that it will allow us to have a picture of the opposing occlusion, albeit a negative picture, but with the same three spheres in place, so the correlation would be perfect on the picture. Now that checkbite is taken, and it's trimmed back a little bit, and then it is, certain landmarks on it are identified with a special pen, which just makes it easier to identify them later. So let me take that from you, and perhaps we can actually show how the pictures are done. Could

you show us, François, how one would actually take a picture now? If you were going to take the optical impression.

François Duret: Yes, I can, now. But please Gerry, I prefer to take this impression before.

Gerry McLaughlin: Okay.

François Duret: It's my habit.

Gerry McLaughlin: Okay.

François Duret: I know that it's not your habit. I take the camera, and … sorry, you see, for example, my hand.

Gerry McLaughlin: Adjusting to … behind you whenever you speak. Okay?

François Duret: Okay. This is a typical view of opposite tooth. To take the picture, I push only this, this button here.

Gerry McLaughlin: The foot pedal. Foot pedal.

François Duret: Foot pedal, thank you. The picture is ready now, in three dimensions. Generally, I take another picture on this angle. I think it's better for the vestibular part of the opposite teeth.

Gerry McLaughlin: I noticed that you're always keeping the three spheres always in view.

François Duret: Yeah. And it's very interesting because it's the same sphere that I used in the preparation. Now, I take out this piece. And I take the view of the preparation. Thank you, can you raise the light? Thank you very much. More please. Thank you. This is a typical occlusal view. You can see the surface, occlusal surface of the preparation of each tooth, okay.

Gerry McLaughlin: And those lines that are projected on the tooth, that is what allows the camera to see in three dimensions.

François Duret: Yeah. I now take five or six impressions. Perhaps the *moignon* view. Please, Gerry, speak about that.

Gerry McLaughlin: Okay, the *moignon* view is actually a path of insertion view. On a single crown, very often, it will be the same as the occlusal view. But when you start working with bridges and longer spans, then *moignon* may depart from the occlusal view. But becomes very important for the same reasons that path of insertion has always been important. In fact, as you see this presentation, you'll begin to see how very similar the major aspects so are with this procedure, as with conventional.

François Duret:	Now, I take the picture of vestibular, lingual and proximal.
Gerry McLaughlin:	Perhaps I should point out, François, that the reason that you're taking many pictures is because the computer is going to be actually memorizing this tooth, but in three dimensions. And any one picture may not get all the information that you want.
François Duret:	Absolutely. Especially with this CCD. Because I have a CCD with 500 by 500 pixels.
Gerry McLaughlin:	500 by 500 pixels.
François Duret:	Yes.
Gerry McLaughlin:	So by taking multiple pictures, you're actually able to increase probably well beyond what you ever could use. The number of pixels in the picture.
François Duret:	It's easy to use a very … a very … a good pixel with more than 1,000 or 2,000 pixels, and 3,000 pixels. But to develop a special camera for dentistry, you must work two or three years. And two or three years ago, we used only, with a good price, of course, a pixel on 500 by 500. But if I take different pictures, I obtain more and more points for each area. And it's absolutely similar of only one picture with 2,000 points on 2,000 points.
Gerry McLaughlin:	Plus it would seem to me, François, that by being able to take them at different angles, you can eliminate problems such as undercuts that would make a single picture not very effective.
François Duret:	I'm sorry, Gerry, just…
Gerry McLaughlin:	I see on the screen, up on the top left, the word Acquisition. And then I hear the click, and the word Memorise comes up. And what … that what is happening there is that the acquisition indicates that it is ready for a new picture. And during the time that the word Memorise is up on the screen, the computer is taking this picture, converting it to digital information and storing it.
François Duret:	It's okay now.
Gerry McLaughlin:	So, you have the ability to take many pictures or a few pictures as you choose?
François Duret:	Yes, if you want really a nice, beautiful impression, you can take a lot of impression around your preparation. But today, I want to prepare the crown alone. And I want only some information, some precise information.
Gerry McLaughlin:	Okay. So now, once you've got all of your pictures, and you've taken your optical impression, what comes next? What do you do after you take the impression?

François Duret:	Well, my patient can be great now. It's finished for him. And I work on this different pictures. I indicate some very important points for drill the crown. For example, contact points, the margin of the crown, the growth of proximal tooth, opposite tooth, the cusp. It's very important to drill the crown.
Gerry McLaughlin:	Of course, well, show us how that's done.
François Duret:	It's finished for the…
Gerry McLaughlin:	Done with the gloves.
François Duret:	Yes, thank you. This is the first view. Remember, I take this view in the beginning. And with this view, I can describe the opposite tooth.
Gerry McLaughlin:	Right, because this was the view of the checkbite.
François Duret:	Absolutely. This is the second one.
Gerry McLaughlin:	Also a checkbite.
François Duret:	This view is from the occlusal point. Very important point. This one is the most important view. This view is the view of the *moignon*. You talked about this.
Gerry McLaughlin:	Yes, the path of insertion.
François Duret:	Vestibular view. Vestibular view too, but with a different angle.
Gerry McLaughlin:	Yes, so you see some … yes, angle. You see some portions on this picture that were not clearly visible on the picture before.
François Duret:	Yeah, and they want more points on the vestibular part of the adjacent crown, adjacent tooth.
Gerry McLaughlin:	Right.
François Duret:	This is lingual view. The second one. And this is a proximal view, a medial and a distal view. Two distal views. Because here, it is difficult to obtain the vestibular and proximal part of the preparation.
Gerry McLaughlin:	Now, you've taken here altogether, about let see 6, 8, 9, 10, 11, 11 views. And it's taken, it's taken obviously more time because we were talking and describing. How long does it actually take you usually to do a preparation?
François Duret:	Sorry?
Gerry McLaughlin:	When you get in a real situation, how long does it take you to take a full impression?

François Duret: Full impression?

Gerry McLaughlin: Yes.

François Duret: 5 to 10 minutes.

Gerry McLaughlin: Okay.

François Duret: If I work very slowly but precise.

Gerry McLaughlin: Okay.

François Duret: Good. Now, I work on this impression, on the opposite teeth. Perhaps I can work, and Gerry, you know this work, you can describe it.

Gerry McLaughlin: Okay, I'll try. Now, the picture that you're using here is the antagonist bite, the bite of the opposite occlusion. And the first things that you're pointing out is the three spheres, which are the three reference points. And you've labeled this particular view because it's a very important view. And it has more information, perhaps than some of the others. So the next thing is the Sillons, which is equivalent to grooves. And you'll be marking the grooves on each of the teeth. Now, obviously, the grooves for the opposing dentition are very important, because that's the one of the places where you're going to be very concerned in terms of contact. So, you've marked the grooves, and now the cusps. One of the things that I found interesting, François, is that in the software, the computer knows which cusps are important and which ones are not.

François Duret: Yeah, and you can control that. For example, I can destroy this cusp and put a cusp here. But it's impossible here to put a cusp. But this is controlled by the computer, because this computer knows that this is a normal occlusion.

Gerry McLaughlin: Right. So, because it knows it's normal occlusion, it knows that that particular cusp plays no role in the occlusal scheme. Now, the next thing that you're doing here is to define the grooves even more precisely. Because a precise groove, obviously, is very important.

François Duret: Yes, of course. I can change it if it is not good. When you change your tooth, you *wash* the general grooves. It's okay. The second one now.

Gerry McLaughlin: Again the three reference points. You do that in every picture.

François Duret: Yeah. It's enough here.

Gerry McLaughlin: So the computer knows enough information from just those three points?

François Duret: Yes. This is the occlusal view of preparation. Can you describe, when I put, I use the first point in all the time *XX* a sphere.

Gerry McLaughlin:	Okay, certainly. The three points … the three spheres that are in every picture are always numbered by the operator. So that the one standing alone is numbered first. Once you've done that, there's no need to number the second and third one. The computer will automatically do that. And in fact, if you do them in reverse order, it will correct it.
François Duret:	I demonstrate that at the next picture, for example.
Gerry McLaughlin:	Okay.
François Duret:	Now I draw the general grooves.
Gerry McLaughlin:	And this is to give a general orientation for the crown that's going to be placed.
François Duret:	Bombé
Gerry McLaughlin:	Bombé is an interesting term, because Bombé, I'm not sure what the English equivalent is. It refers to the widest portion of the adjacent teeth. And that's important because the crown has got to fit in harmony with the rest of the mouth. So if you have a dentition that's particularly broad mesiodistally, or rather, occulingually, your crown will be broad to fit in. And if it's a narrow and unusually narrow case, well, the crown will also fit into that.
François Duret:	Contact.
Gerry McLaughlin:	Contact points, obviously, very important.
François Duret:	No problem.
Gerry McLaughlin:	Yes.
François Duret:	No problem, it's a world language for dentists.
Gerry McLaughlin:	Yes. And here are the cusp tips, again very important because they will help guide the computer in its first line for the cusps of the new crown. Again, these new cusps will be in harmony.
François Duret:	I make a zoom now for the drawing of the margin of the crown. This is a zoom. And each point, each pixel is 16 to 17 microns square.
Gerry McLaughlin: range	So, then we're dealing here, when you're drawing on the finishing line in the
	of microns, rather than … the way we're used to thinking in terms of tenths of a millimeter.
François Duret:	I am sorry. It's very difficult for me to draw the margin, because I have no color.

Gerry McLaughlin: I see, this monitor, I'm just noticing myself. There isn't, normally, this line is a bright red, easy to see. But this monitor is not doing that.

François Duret: Union European standard. It's better to use a very big zoom.

Gerry McLaughlin: Well, actually, we're pretty lucky we managed to rig this up. For a while it was looking like we might have difficulty, we'd be mixing the American equipment with the European standards. It was tricky.

François Duret: I have no color. It's a very big problem generally for me. The point is green, and the line is red. I can't see that.

Gerry McLaughlin: Yes, well on the monitors that the audience is seeing, they are seeing color. But the monitor that you're working on is just black and white.

François Duret: It's more simple to draw the margin line in the room.

Gerry McLaughlin: Yes, yes. Also, it must be frustrating you as I know that you prefer to draw the finishing line without zooming. And you're being forced here to zoom in, to be able to see it. So that must be awkward for you.

François Duret: Yeah, it's okay. It's a good exercise for me. But I prefer the color than black and white.

Gerry McLaughlin: I'm noticing here, François, that when you took the pictures, there were lines across all of the teeth. And of course, they're not here now. The picture is beautifully clear. The shadows from the laser are missing.

François Duret: It's okay. I work more speedy, now. But please describe my work.

Gerry McLaughlin: Okay, but don't wait for me.

François Duret: Sorry, you speak just before, but it is the number of the point.

Gerry McLaughlin: Yes, yes, numbering the spheres.

François Duret: This is a very simple example. You see the number one here.

Gerry McLaughlin: Yes.

François Duret: The number two here, and the number three here. It changed automatically. That proves that … what you said before.

Gerry McLaughlin: So all you need to do is number the first one, and need not remember which the other two are. A point that may not stand out immediately, but it is certainly

very clear and important is that when François is drawing the finishing line, it is not necessary to get the whole finishing line on any picture. Because the computer will take all of these pictures, memorize them, and create a single composite tooth. So, it's quite similar to when we pour up the model and make a die. If we were to memorize it, we'd need to see it from all different angles, and no one view of it would give us the whole story. But by adding the bits and pieces together, we're able to come up with a perfect memorization. Of course, if we try to do this with three impressions, and each one only has half of the margin, it's not really possible. But mathematically, using the laser probe, it's a simple affair, easy to do.

François Duret: I use my special method for drawing the margin. Remember.

Gerry McLaughlin: Yes, the famous Duret rubber band method.

François Duret: For example, I put a point here, and I put a point here, and after I take a point. I think it's more easy to do as a marginal, but…

Gerry McLaughlin: Zooming in and zooming out is quite simple.

François Duret: Yes.

Gerry McLaughlin: Sometimes it's very helpful.

François Duret: Okay. One, two, three. Now it's not very necessary to use, to draw the margin line. Because I have all the margins.

Gerry McLaughlin: So between all the other pictures that you've worked on, you've done the entire margin. And so here, all you need to do is just label the three spheres and the computer can still use the information from those pictures.

* * * * INTERMISSION * * * *

François Duret: When you do the margin, you can destroy the last point. For example, I put a point here, it's not a good point. I can destroy it.

Gerry McLaughlin: Suppose you had done the entire margin, and decided you really did not like that margin. Can you just erase the whole margin that you've drawn?

François Duret: Yes, I can. I chose AF, anti-finishing line. And it's finished.

Gerry McLaughlin: You can, I can certainly see from these photographs why you prefer the chamfer. It does make it quite simple to read the finishing line.

François Duret:	What do you prefer, you, Gerry?
Gerry McLaughlin:	Well, I think I agree that the chamfer is the best one to work with.
François Duret:	Your crown by CAD/CAM was with chamfer?
Gerry McLaughlin:	No I… Yes. I had prepared another crown that I first learned CAD/CAM on. Before I learned CAD/CAM. So the first one I learned on, unfortunately, was a shoulder for half of it. So, I've since learned my lesson.
François Duret:	But I know that you are very, some very important idea about that is the reason why I asked you to…
Gerry McLaughlin:	Thank you, thank you.
François Duret:	It's finished.
Gerry McLaughlin:	Okay, now, the computer from here takes all of these pictures, and combines them all up. And makes it into a single picture. Is that correct?
François Duret:	Yes, that's correct.
Gerry McLaughlin:	Okay, now how do we do that?
François Duret:	Before, I stop.
Gerry McLaughlin:	And that's it?
François Duret:	And I think, perhaps it's a good opportunity to … to see some slides.
Gerry McLaughlin:	Okay, but you know, right before we do that, I wanted to make the comment that it seems to me that once we're through preparing the tooth, certainly what you were doing at the computer could be easily handled by an auxiliary, an assistant. And perhaps even the impressions themselves could be. So the dentist could prepare the tooth, place on the clamp with the spheres and be done.
François Duret:	I think it's better that a dentist take impressions, and draw the margin and draw what he wants. But after, he can work, for example, with a technician.
Gerry McLaughlin:	Okay. Okay, let's look at those slides.
François Duret:	Slide please. This is exactly the part… What's matter now? This is for example a die. You see, slide please. The second step is points in the space. This is an old view. But you can see different points for each point on the surface of a preparation, of a die. Slide please. And after, you see the surface. Because computer now, the computer for us works now. And this is the work of this computer. You see here each view of this die.

Gerry McLaughlin:	So these are the same die from different views?
François Duret:	Absolutely. You can turn your die in the space, as you turn your model in the space.
Gerry McLaughlin:	Just so, so it's just as if you were holding a plaster die and looking at it from different directions.
François Duret:	Absolutely right. Slide please, Jean-Marc. New slide. I want to speak about *Moiré* of course.
Gerry McLaughlin:	Yes, well, I think this would have to do with the precision of your final result.
François Duret:	Yes, everybody speaks about the precision of *Moiré*. This is not the older *Moiré*, because it's a very old method. At the end of the last century. But if you see, the most popular view of *Moiré* is this one, from the professor Takazaki from Japan. You see different levels. And the way that we used between two levels, there are only 10 to 15 microns. This is a result of an electronic action.
Gerry McLaughlin:	So the … let me make sure I understand this, François, are you saying that between two lines, the one dark line and the next dark line, the closest that you could make that.
François Duret:	Absolutely right, Gerry, right. Slide please. Here, you see some fiber, optical fibers. And it's very interesting, because each fiber is 20 micron diameter. Slide please. Now, you see the result with the impression with a dental camera.
Gerry McLaughlin:	So let me make sure I understand you. This would be, what appears to be the wrinkles on those stripes, is the thickness, that's showing the thickness, a 20-micron thickness of the fiber. So we're seeing a fiber going across there and distorting the bars.
François Duret:	And we can prove at each moment that precision, that resolution, that the sensibility of this camera, it's under 20 microns.
Gerry McLaughlin:	Okay.
François Duret:	Slide please. Okay. This is next part. Can you slip the slide. Now, the second step. We use the CAD.
Gerry McLaughlin:	Well, so, let me again make sure that I'm oriented here. We've already.
François Duret:	Last slide, and last slide too. Thank you very much. Another one. Sorry, Gerry.
Gerry McLaughlin:	Okay. What we've accomplished so far, then, is that we've taken an impression of the tooth. And what you have done with the mouse on the pad has been to

give a little more information to the computer, so that it can correlate all those views and make it into one clear picture in its mind, so to speak, of what this tooth looks like. And obviously, that's very important, because that's the starting point of the inside of the crown that we're going to be forming.

François Duret: Of course. Now, I think it is a very interesting view. Because imagine processes and computer doing the first part of the impression. If you can see this picture, here, you have the preparation. In the center, it's the blue, it's the blue part, the preparation.

Gerry McLaughlin: So the blue is the tooth that you've prepared.

François Duret: Yes. The red part is the proximal teeth.

Gerry McLaughlin: So those are the proximal surfaces of the adjoining teeth.

François Duret: Yeah.

Gerry McLaughlin: Okay.

François Duret: The pink, I think.

Gerry McLaughlin: Pink or violet, I'm not sure. But I think we know which one it is. The pink-violet.

François Duret: The pink is opposite teeth. And you see different points, green one, red one, and different line. The green one is for the proximal, proximal teeth. The cusp, and the high level of occlusal surface. How do you call it?

Gerry McLaughlin: The occlusal, the height, or the occlusal table. So it shows … it shows the, it is defining the environment in which the final crown has to sit and function.

François Duret: And these different points on the surface of the proximal view is Bombé, and the contact.

Gerry McLaughlin: Right.

François Duret: Now, I think it's ready to work on the CAD.

Gerry McLaughlin: So let me step back for one second, François, and give maybe a little more general view of what's happening. We've taken an impression, and at this first computer station, we have defined the die, the preparation, and the adjacent teeth, and the occlusion, the opposing occlusion, as it stands right now. Then this takes the information, and ships it over to a second computer, where if we choose to do so, we can interact with it, and help design the crown.

François Duret: Yes, because at the first time, you obtain only the surface that you can take the impression. But you don't use a CAD/CAM, you use only a lecture of a surface.

The CAD's computer helps design. Your computer builds a surface. Here, it doesn't build the surface, it builds, not a surface, but some points in the space only.

Gerry McLaughlin: So the first computer really has been just describing and discovering what is there. It's now at the next stage that we really get into CAD/CAM, the computer-assisted design and computer assisted milling. So next station is the CAD, where the computer assists us in designing the crown.

François Duret: Yes, and it's certainly one of the best parts of the CAD/CAM in dentistry. I want to explain that only a short moment. First scanner, for example, or magnetic resonance, you know, you obtain only the picture of the object. But never you *build* another surface. In dentistry, for the first step, in medicine, you build a new surface with your impression. And it's really new for medicine. Because it's a new way.

Gerry McLaughlin: The applications just stagger the imagination. And it's … really, I feel, very fortunate that it's starting in dentistry. So let's see, let's go over.

François Duret: As anesthesia.

Gerry McLaughlin: Yes, as anesthesia.

François Duret: It's very closely, if I remember.

Gerry McLaughlin: Yes indeed. I may move in here a little bit. We won't mess up the cameras too much. Now, what do we have on the screen here? This looks like another type of view of the same, of where we ended on the last computer. That this view, this is a view of what exists at present.

François Duret: This is a view of your preparation. Of the preparation, it's not yours, sorry, but it's a view. And now, I want to, to correct the margin. If I don't agree with this margin.

Gerry McLaughlin: Okay, now if you did agree with it, which I would assume is the usual, do you usually agree with it, or do you usually change it?

François Duret: No, usually I work very speedy. And obtain a crown with good results. It's very good for general practice. But here, I want to demonstrate each step that you can make with the CAD/CAM. But it's not necessary.

Gerry McLaughlin: Okay, well, I think that's a very important point. Because we'll be spending a lot of time showing all the possibilities of the changes that can be made with the CAD, and perhaps even with some of the other aspects, when in fact, most of the time, you don't need to do them. And what I've seen you do here already,

and I talked right over, was that the computer has, while we were talking, in fact a few minutes ago, completed adjusting the finishing line, taking the wrinkles out of the finishing line, and finding the actual finishing line, even though some of the data that you entered may be imperfect. And that's, the one that's switched from the white line to the yellow, that was the computations taking place.

François Duret: Now, I think we can work on this screen. For example, I chose to modify, to make a modification on the margin, okay? I want to make a modification between this point, for example … it's a good margin. It's difficult to change this margin.

Gerry McLaughlin: It's a heartbreaker.

François Duret: Yes, perhaps between this point and this point. Okay?

Gerry McLaughlin: Okay.

François Duret: This point, and this point. This is a part. Of the change.

Gerry McLaughlin: Okay, and I see we're gonna to be seeing this, as we almost always will throughout here, from different angles, so it's like holding your die up, and looking at it from the buccal and the facial, or the buccal and the mesial and the occlusal.

François Duret: This is, in the red line, this is a margin that I want to change. Okay?

Gerry McLaughlin: Okay.

François Duret: And now, I draw a new margin. First point. And you can obtain here the section of the preparation. And you see the new point here. I can move it and put it here. I put another point here. It's okay here. Another point here. It's okay. Here, it's okay. And here, I moved it just a little. It's okay.

Gerry McLaughlin: Good.

François Duret: Now, I obtain a new margin. And I can work on the dilatation.

Gerry McLaughlin: Okay, the dilatation, that is a very important one. And that would translate, I suppose most easily into dilation. But really, the way we traditionally think of it as is cement space.

François Duret: Yeah.

Gerry McLaughlin: And it's equivalent to a present technique to where and how many layers of nail polish do you put on the die.

François Duret:	You have three steps in dilatation. The first one. Please, slide. I think, for you, Gerry, it's easier to describe the slide.
Gerry McLaughlin:	Okay. Well, I'll even get ahead of it, and I'll describe it, there are three aspects to the dilation that we deal with. The first one is the vertical dilation, or the vertical height. And this would be equivalent to placing die spacer on the occlusal surface of the die. The radial refers to sides of the die. And that would be the cement space on the, along the proximal surfaces and the facial and buccal of it. There's a third aspect as well, which is the base height. And the base height is the area in which you have no cement space created. So you can, dealing in microns now, determine how thick you want the cement to be on the occlusal surface, how thick you want the cement to be on the outer surfaces, the radial surfaces, and how high a collar that you would like to have without any cement space at all, for a very snug, tight fit, much as we traditionally do with our nail polish or more exotic die spacers now. The difference here is that if we want a 250 micron space, we get a 250 micron space. If you want a 25 micron space, you get a 25 micron space. It's a level of control that we've just never had before. So François, perhaps you can show us how you do that.
François Duret:	Can you give me a slide please?
Gerry McLaughlin:	There we go.
François Duret:	Very good.
Gerry McLaughlin:	Well, good.
François Duret:	You see three dilatation, or two sorry. Because the first one is the preparation.
Gerry McLaughlin:	Yes, the blue line is the actual tooth. The line, the red line, or pink line I guess, in the middle of that would be one vertical dilatation.
François Duret:	400, if I remember.
Gerry McLaughlin:	400 microns, okay.
François Duret:	Yes, if I remember this case, on this case.
Gerry McLaughlin:	Okay. And then the yellow line above would be if you chose what, what dilatation?
François Duret:	800, if I remember. It's a long time before.
Gerry McLaughlin:	Okay, but what you're seeing here with this slide, François, is that the effect of changing the number in the computer, telling it how much vertical space you want.

François Duret: 250.

Gerry McLaughlin: 250, okay.

François Duret: Yes. This is 250. The die space, zero microns, I change it, I prefer 10 microns.

Gerry McLaughlin: Okay.

François Duret: It's on a bit for me. For example. Okay. And the, hauteur base.

Gerry McLaughlin: The hauteur base is the base height, not affected by the radial.

François Duret: 500. This is my habit.

Gerry McLaughlin: So half a millimeter will have no die space at all. And then you'll have 10 microns die space going up the sides of the crown, and 250 on the top. Okay. Seems simple enough.

François Duret: Thank you. Now, you obtain the inside of your crown. You must build the outside. This is the second step. This a correlation of the environment.

Gerry McLaughlin: So what you're saying is that you're going to design this crown now, start to build the crown into the environment itself, making it fit this particular case. One thing we haven't said so far, that actually is very important in understanding this, is that in the computer itself, in its memory, is 32 idealized teeth. And what the computer will be doing from here on will be to take those 32 idealized teeth that have all the characteristics that we like, choosing the one that's appropriate for this tooth, and then modifying it so that it fits exactly the space that's been created for it, adjusting the bite, adjusting the various widths and dimensions. But at the moment, it's now going into its memory and taking out one of the idealized teeth. And now, we will, if we wish, choose to adjust it.

François Duret: Here you can see the proximal tooth. And yes, it's possible to use a micromilling machine for the first time here to prepare the inside of the crown.

Gerry McLaughlin: This is new since I've worked with this.

François Duret: Yes, it's a particular of my personal soft.

Gerry McLaughlin: So that will be some nice, a nice time saver. So now that we've designed the inside of the crown, it's already starting to manufacture.

François Duret: Inside, yes of course. Because you have the design of the inside of your crown.

Gerry McLaughlin: Of course, of course, that's a good time saver, very clever.

François Duret: Yes, very important. And if you want to change it, this is … can you project the new slide please? Because, if you see this slide, you can compare the screen here and the slide. We have some problem with the slide today.

Gerry McLaughlin: I guess, I guess.

François Duret: For example, you have here Bombé.

Gerry McLaughlin: Okay, so those, the red lines that are there, that's the line that connects up the widest points of the adjacent teeth. And so that would more or less define how wide our crown is going to be.

François Duret: This is our cusp.

Gerry McLaughlin: Okay, those two blue lines with the crosses at the ends are the cusp tips. And the new cusp will line up more or less on that line.

François Duret: This is the line of the grooves. It's possible to have a slide please? I'm sorry, because it's very difficult to correlate the last … And this is the margin of your preparation. It's possible to obtain the inside here.

Gerry McLaughlin: Now again … while that's drawing the inside, the picture on the bottom left of the screen is an occlusal view of the tooth and the environment. And then on the top left of the screen is a buccal view, and on the top right, it's looking from the distal through the teeth. And actually with what you've done, you can see exactly what I've been saying that this is very similar to working in the laboratory with a traditional die. You can actually see what looks like a traditional die being built up into that environment.

François Duret: Now, I think for the slide, it's too late now. I go more quickly. You can move the line if you want.

Gerry McLaughlin: Well, that's a good point. I'm sorry that I didn't make that. This is that any of those lines can be moved. Or you can simply accept what the computer has already calculated for you.

François Duret: Now, you choose if you want to adjust your crown with adjacent teeth or the opposite teeth. Of course, you have the opposite teeth today. You choose opposite. If it's possible this time to obtain the slide, we can explain. This is a … can you go … can you… Pouvez-vous aller en arrière s'il vous plait ? Voilà. Thank you. This is the last indication of the environment. Okay? You can see the different points that we used before.

Gerry McLaughlin: Yes. Those are the cuspid points, the contact points, the Bombé etc.

François Duret:	Yes. Next slide please now. As you can see on the screen, on the CAD/CAM screen. You have here, you have on this screen please, you have a theoretical tooth.
Gerry McLaughlin:	Right, from three views again.
François Duret:	Yes, and the last line.
Gerry McLaughlin:	Exactly, the red lines and the blue lines from the last picture are showing how the theoretical crown fits in.
François Duret:	Yes. This crown comes from the memory of the computer. As you can see, on the slide, if it's possible to see the slide, I can, I can indicate this is, for example, a molar.
Gerry McLaughlin: ADA?	This is a pretty famous slide by now. Isn't this the cover of the Journal of the
François Duret:	Yes, and everybody uses it now. It's a great pleasure for me.
Gerry McLaughlin:	Beautiful.
François Duret:	Two days ago, there was a congress on CAD/CAM. And I heard that some people use this slide.
Gerry McLaughlin:	Well, I don't blame them, it's excellent.
François Duret:	Next slide please. This is an incisor.
Gerry McLaughlin:	An incisor.
François Duret:	Yes. Next please. Premolar.
Gerry McLaughlin:	Obviously.
François Duret:	And after, next please. All the teeth.
Gerry McLaughlin:	All 32. Now, these are the ones that you've already programmed into the memory, and that's the library of teeth that it pulls out when it comes time to design a new crown.
François Duret:	Exactly.

* * * * END OF REEL 1 * * * *

* * * * CAD / CAM LIVE * * * *
REEL 2

Gerry McLaughlin: Okay.

François Duret: Okay. Now, you can prepare the crown. You have on the screen, here the theoretical tools. And you deform it, automatically. Sorry. You can see the red line, it's lower in front of the cusp.

Gerry McLaughlin: Yes.

François Duret: And the margin, it's not good in front of the theoretical tooth.

Gerry McLaughlin: So, what's happening is at first it simply took the theoretical crown and placed it over our die. And now it's beginning to adjust it to fit.

François Duret: Exactly.

Gerry McLaughlin: With a single command, that's pretty neat.

François Duret: If you compare one tooth in front of a screen, you can see it's more easily to work on a screen.

Gerry McLaughlin: Yes. Well, it's certainly a lot easier to move a line here than to add wax or subtract wax.

François Duret: Yes. You see as a result.

Gerry McLaughlin: Yes, now it's fitting more precisely into the space needed.

François Duret: Margin. It's finished. Now, you can work on the occlusal surface.

Gerry McLaughlin: This is very important, the occlusal surface. Because I have no idea how many books have been written about what is the occlusal surface. And probably each of these books has its own special theory that varies from another one. Does the computer force you into any particular theory with occlusion?

François Duret: Yes. Two big particular parts. The first one is you can choose between, in the beginning, functionalist and *natologic* concepts. On the second step, your computer proposes to you the general centric point. If you don't agree with that, you can transform and move it. For example, I can move these centric points. It's very easy, not necessary to be a computer man. And I put it here. If I want, I can destroy this one.

Gerry McLaughlin: So let me see, if I understand, the first thing you do is you tell it which school of occlusion you belong to.

François Duret: Yeah.

Gerry McLaughlin:	And then, you can go beyond that. It will calculate according to those ideas. But if you want to modify them even more to your own school of occlusion, then you can take any contact points and move them wherever you like or remove them.
François Duret:	Yeah. Slide please. You can see, on the next slide, different contact points, theoretical contact points. You see, your computer knows, it's possible for your computer to know exactly the position of these contact points. And the dentist can correct it or accept it. Next please. You see for a maxilar. Next please. This is another subject I think. Okay. Now, I accept the surface, it's okay here.
Gerry McLaughlin:	Okay, by the way, by the way, I know I'm sort of interrupting here, François, but in case someone … anyone is wondering what the noise was, now that it's just stopped. Is the, I'd like to point out that the, again, that the milling is actually going on right now. And in fact, right on the screen now, that is the machine. It is a very interesting machine, and I'm having to bite my tongue here to keep from describing it too much, because it's a marvel itself. But that's what the noise in the background is. The machine is actually working while we're fooling around here, taking time describing these things.
François Duret:	It's a good surprise sometimes, because we save some technician work. But each technician smoke or drink a good whiskey. Okay, this is your crown. Now, I transform the occlusal surface to respect opposite teeth.
Gerry McLaughlin:	Okay, so you've got your crown that has been adjusted to fit the die. And now, it's starting to deform itself. It looks also like just giving it the command to match the opposite teeth.
François Duret:	Yeah.
Gerry McLaughlin:	Okay.
François Duret:	It's possible to control that. Because here, I have each part of my impression.
Gerry McLaughlin:	That list on the bottom right of the screen is a menu of choices for you, okay.
François Duret:	For example, I can see the opposite teeth. I chose, for example, that. And I build the opposite teeth.
Gerry McLaughlin:	So while the crown is still there, the opposite dentition will be showing right…