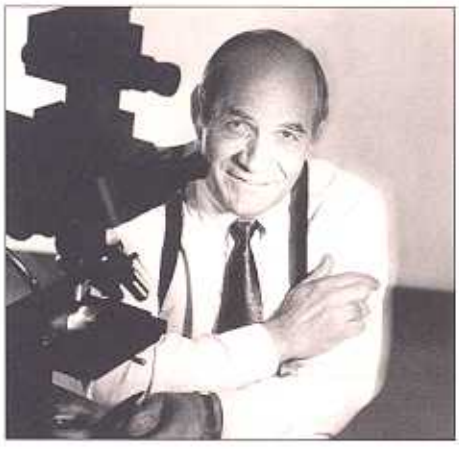
Computer-Based Mechanot

Dr. Larry White Interviews Prof. Bi

r. White:
Computer technology has helped orthodontists administratively for some time, yet it seems we haven't exploited its potential for diagnosis and treatment planning. What have you and Dr. Fiorelli done to remedy this deficit?

Prof. Melsen:
I believe that there are many reasons why the possibilities of computers have not been fully exploited. Diagnosis is not always expressed in exact terms and the definition of the treatment goal has, to some extent, been considered an art which can only be simulated by the computer to a limited degree. The treatment goal in children is partly reached through growth and partly by tooth movement. Growth of the individual patient can be predicted only to a very limited degree, but when it comes to tooth movement, the computer can be used. Once the tooth movement is well defined, only one force system is correct. This can be estimat-



Dr. Larry W. White received his D.D.S. and M.S.D., Orthodontics, from Baylor University College of Dentistry. Dr. White is a diplomate of the American Board of Orthodontics and currently serves as editor, Journal of Clinical Orthodontics and as manuscript reviewer, American Journal of Orthodontics and Dentofacial Orthopedics. He is a member and past president of the Rocky Mountain Society of Orthodontists, the Texas Tweed Study Club and the New Mexico Society of Orthodontists. Dr. White has been engaged in the private practice of orthodontics in Hobbs, New Mexico, since 1968.

Dr. Birte Melsen is professor and chairman of the Department of Orthodontics, The Royal Dental College, Aarhus University, Denmark. She serves as president of the Danish Orthodontic Society and holds memberships and honorary memberships in numerous orthodontic societies. She has authored more than 200 publications in the fields of growth and development studied on human autopsy material and bone, biology and clinical studies by the implant method. Dr. Melsen maintains a part-time adult orthodontic practice in Lübeck, Germany. She received the Jarabak Memorial Orthodontic Teachers and Research Award for 1995.

Dr. Giorgio Fiorelli serves as professor at the orthodontics specialization school of the University of Siena, Italy, and as visiting professor at the Department of Orthodontics, Royal Dental College, Aarhus University, Denmark. He has authored 26 publications in orthodontics and is particularly interested in biomechanics and computer-aided teaching. Dr. Fiorelli is a member of the Italian Orthodontic Society, the European Orthodontic Society and the American Association of Orthodontists. He has been engaged in the private practice of orthodontics in Arezzo, Italy, since 1983.

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ed by the orthodontist, as indicated in textbooks on biomechanics, or – quicker, easier and more precisely – found by the computer.

Dr. Fiorelli:
I fully agree with Dr. Melsen. Computers are machines that manipulate numbers. In order to take advantage of computer technology, mathematics should be the basis of orthodontic diagnosis and treatment planning. With some exceptions, such as cephalometric analysis, this has not been the case. We have used a mathematical approach in determining the needed force system for a specific dental movement and in designing the appliance capable of delivering such a force system. It has been possible to create software that could perform all the needed calculations and display the results of the calculations graphically. In fact, these tools are called "orthodontic calculators."

Dr. White:
Why did you feel that a computer program for biomechanics was necessary?

Prof. Melsen:
Since our first contact with Charles J. Burstone, who started giving courses on biomechanics to our postgraduate students about 20 years ago, we have put increasingly more weight on the teaching of biomechanics to our students. Realizing how difficult this is and the fact that not all schools have a strong biomechanical program, we decided that the development of this program could be a suitable way of sharing our experience gathered over decades with other schools. The interest shown by our colleagues at the teachers' conference in San Antonio confirmed that this was a good idea.

Dr. Fiorelli:
I had my first contact with Prof. Melsen and her approach to biomechanics in 1985. I really had to struggle with the biomechanics, but I was happy with the clinical results. In the meantime, I developed an interest in computers and started teaching in the school of orthodontics at the University of Siena by means of the computer. The students thought biomechanics was fascinating but too hard and time-consuming to learn. I then learned that I could take advantage of the computer and related multimedia technology. As a result, we started this project in 1991.

Dr. White:
How easy or difficult will your program on biomechanics be to learn?

"We have made treatment plans manually and with the computer, and we have found that the computer is more precise."
– Prof. Melsen

Prof. Melsen:
This program includes an instruction section that anyone able to read can follow, even users without any knowledge of computers. So far, we have only used the computer program in relation to the graduate teaching, but we have intentions to let the undergraduate students employ our program for their basic biomechanics course. The experience with interactive computer programs as part of the teaching tools in other areas has been very positive.

Dr. Fiorelli:
The software includes a teaching/learning tool and a treatment-planning tool. The use of the didactic part is very easy. The students had no problems using the program but, of course, it takes a lot of time to go through all the material contained in the electronic book. The use of this program as a teaching tool (you can project the computer image on a large screen with an LCD and an overhead projector) requires more time, as the teacher needs to have a good idea of the contents of the software in order to use the most appropriate parts when lecturing.

The second part, the treatment-planning tools (the calculators), requires a good knowledge about many of the topics discussed in the didactic part; otherwise, clinical interpretation of the calculations is almost impossible.

Dr. White:
Do you envision it as primarily a learning mechanism for the orthodontic novice or do you expect experienced orthodontists to benefit equally?

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Dr. White

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Prof. Melsen:
As already mentioned by Dr. Fiorelli, the program can be used at different levels. Through the interaction, different levels of information can be displayed on the monitor. The treatment planning part of the program is definitely aimed at experienced orthodontists, assisting them in appliance design (Figures 1 & 2).

Dr. White:
Does this software program consider the metallurgy of available wires in its biomechanical computations?

Prof. Melsen:
The chapter on metallurgy is a general survey (Figure 3). It does include data from a large and representative sample of wires from different companies. This chapter interacts with the appliance design part of the program in such a way that the most useful wires can be selected. Once the wire is selected and the desired force system is defined, the program can advise the clinician on the degree of bending necessary (Figures 4 & 5).

Dr. White:
Do you think this program will prove useful for planning all treatments, or should orthodontists rely on it only to derive treatment plans and biomechanics for difficult cases?

Prof. Melsen:
This type of treatment planning is cost/benefitwise not recommended for young growing patients, but for the difficult

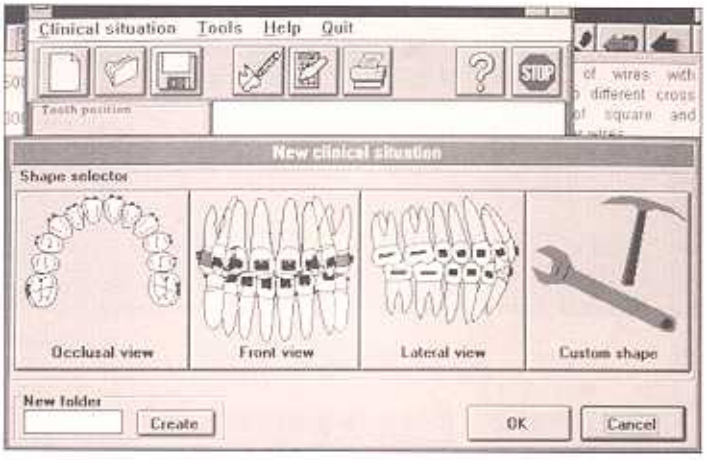

Figure 1. Menu from which the orthodontist can choose when wishing to simulate a tooth movement on standard teeth in any plane of space or on a scanned-in picture as in Figure 2.

Figure 2. An example of a clinical picture with an asymmetry of the lower jaw. On this image, the anterior segment can be displaced and the necessary force system can be defined.

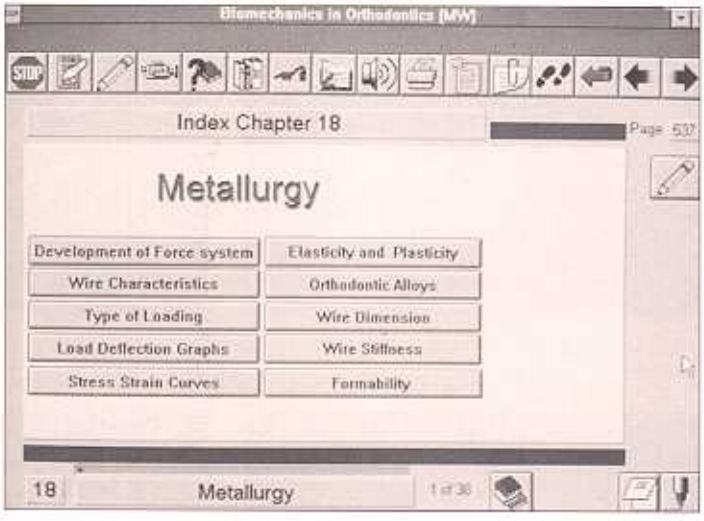

Figure 3. Survey of the content of the chapter on metallurgy.

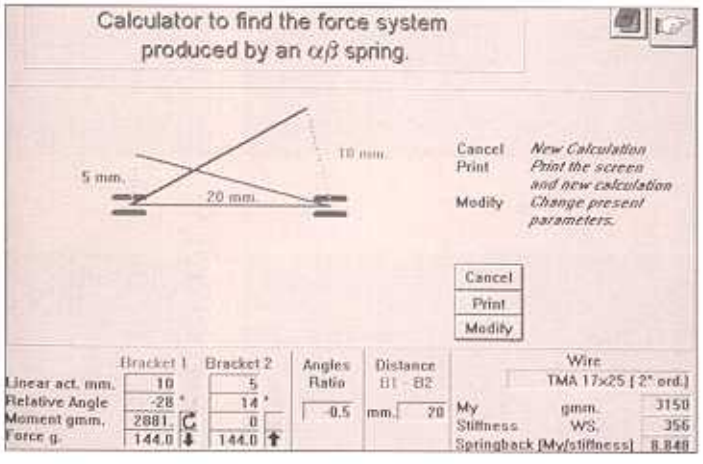

Figure 4. In relation to wire selection, the system offers three possibilities. In this illustration, a wire is inserted into two brackets and the clinician indicates the deviation with respect to the other bracket (measurements can be done in the mouth). When the wire is selected, the computer calculates the force system with respect to the brackets.

nongrowing patients with special problems such as, for example, the type of patient that ruins your day. I have personally been using the program with almost all patients in my private office, which is limited to adult orthodontics. I have experienced the reduction in treatment time, both total and chair time. It is especially useful for the type of cases most orthodontists, if not all, have hanging around for a longer period and often finish as compromised cases. We have made treatment plans manually and with the computer, and we have found that the computer is more precise. Calculations are done with precision and are not based on clinical estimates (Figures 6 & 7).

Dr. White:
You've had some time to work with this program. What advantages and/or limitations have you found clinically?

Prof. Melsen:
Since the last part of the program was developed, where the actual patient can be scanned onto the screen, we found a tremendous advantage both in regard to precision and in saving of chair time. Finally, this part of the program is fantastic when you want to discuss treatment alternatives with your patients. The patient can follow the tooth movement on the monitor. Lately, we used the computer to design appliances for a group of patients being treated with appliances designed according to a "handmade" free body diagram. We detected error in clinical result arising from error in design of the appliance. The error could have been predicted if we had been using the computer program initially.

Dr. Fiorelli:
Prof. Melsen stated that the software can be a good tool in refining treatment planning, even for a very skilled clinician. I would add that it can be even more useful for somebody starting with this biomechanical approach. Treatment planning on a scientific basis can be quite complicated and needs a certain time to be acquired, but the computer can help us. This treatment planning software will dramatically reduce the difference between the treatment planning of the very skilled and the average clinician.

The possibility of scanning models and cephalometric and intraoral pictures allowed us to obtain more precise calculations with regard to the specific problems. I still see some limitations in the software. The whole process could be made more automatic – we want to add more to the analysis of anchorage problems. We could also develop artificial intelligence for analysis of the calculation results and provide a hint on appliance

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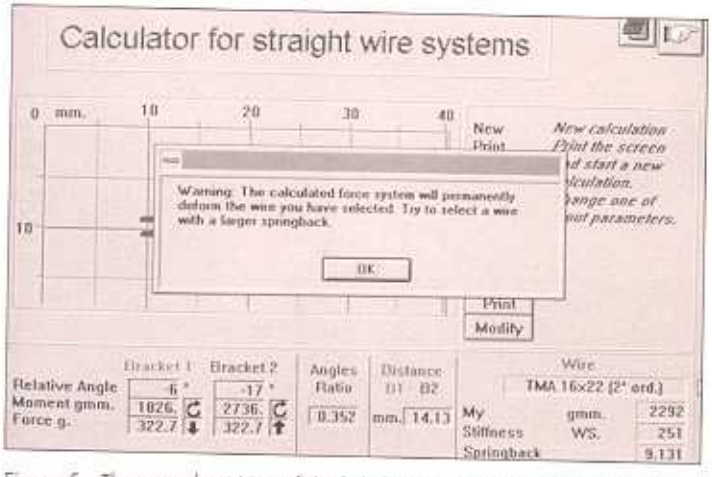
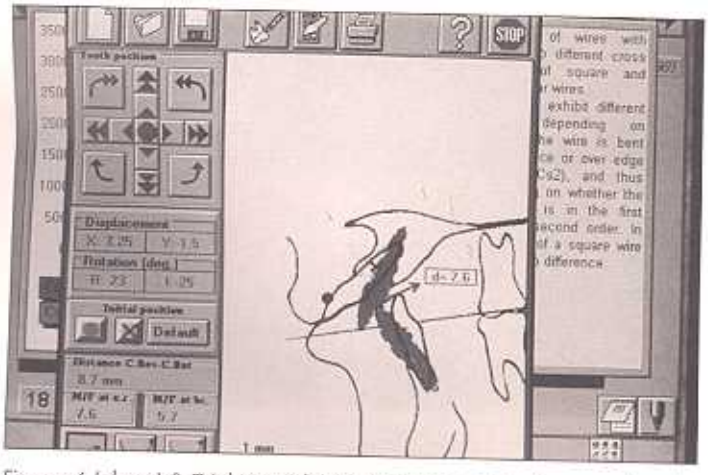
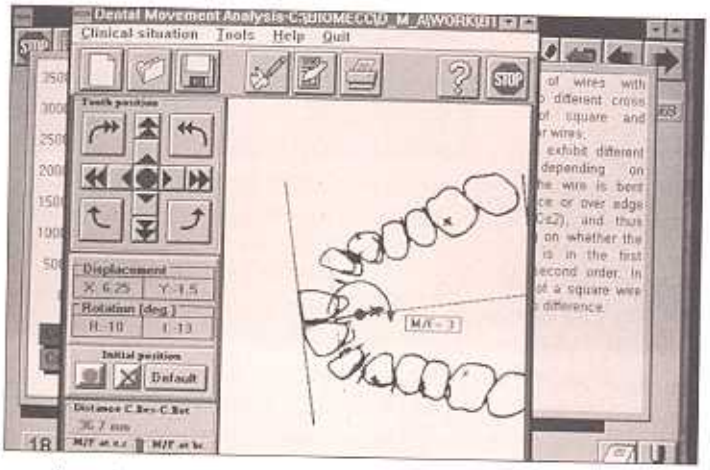


Figure 5. The mutual position of the brackets (the teeth) is indicated by the orthodontist. When the wire is selected, the computer reports the force system and, in this case, demonstrates that the wire will be permanently deformed. In a third program, the force system is given by the orthodontist, and once the wire is chosen, the necessary bending is indicated.





Figures 6 (above) & 7 (above right). Cephalogram and occlusogram have been scanned into the computer and the desired movements are simulated. The necessary force system with respect to either the center of resistance (Figure 7) or the bracket is provided. The desired force can also be expressed as one vector as in Figure 6, where the incisor can be moved by one force passing upward and backward at the given perpendicular distance from the CR.

Dr. White

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configuration. On the other hand, this step would deprive the orthodontist of an important interaction.

Dr. White:
Your program has been released on CD-ROM instead of floppy disks. Why did you make this adaptation? How will you handle future updates of the program?

Dr. Fiorelli:
A CD-ROM was necessary to contain the over 300 megabytes of the program. There are, in fact, 2,000 pictures, sound and one hour of animation and video that require a lot of space. We would have needed 200 floppy disks to store all this material. We now have prepared a small demo containing just one of the smallest of the 20 chapters of the book, and we need four floppy disks to distribute it. Future updates will be on CD-ROM as well, those who want updating to a new release will just need to substitute the old CD-ROM with the new one (we will sell these updates at a reduced price).

Dr. White:
With such a diagnostic and treatment planning instrument available, do you think orthodontists might forego the necessity of actually learning the basic mathematics and geometry necessary to compute appliance design?

Prof. Melsen:
No! Working with the program itself is a stimulus that urges the clinician to go back whenever there is something he or she does not understand. It is very easy to use the mouse. When the "hot words" are touched, the program will take you to the necessary information, so almost through a type of game, our students have been brought to a high level of knowledge of the fundamental mathematics and geometry necessary in appliance design. They don't have to do the calculations – these can be done by the computer – but an understanding of the background is valuable and makes orthodontics more the scientific discipline we want it to be.

Dr. White:
What kind of effect do you expect this program to have on orthodontic education – undergraduate as well as postgraduate?

Prof. Melsen:
We hope this kind of program will have impact on the general knowledge of biomechanics, which I don't think is always satisfactory within orthodontics. It also gives undergraduates a respect for orthodontics which may not always develop. The importance is also in the differentiation between the cases which can be treated satisfactorily with simple appliances like the straight-wire approach and those requiring more sophisticated mechanics.

Dr. White:
With such an exquisite instrument as this, what do you now do for an encore?

Prof. Melsen:
We are planning to do an update every second year on the basis of literature development of new materials and to introduce new cases. We will also make sure that our program is compatible with new general developments in computers and software.

Dr. Fiorelli:
Besides what Prof. Melsen has said, we will work on improving the treatment planning tools. We think it is still possible to make them more efficient and easier to use.

Biomechanics in Orthodontics – Talk with the Authors in Denver

You'll have a unique opportunity to talk with Prof. Melsen and Dr. Fiorelli at the AAO annual sesssion in Denver. They plan to be in attendance at the PEP Center in the Ormco exhibit at times throughout each day to discuss *Biomechanics in Orthodontics* and to answer your questions.

***Biomechanics in Orthodontics* (available in DOS Windows™) contains 650 pages of text, over 2,000 full-color images, 74 illustrated cases and 37 animations and video clips. The disk includes dental movement analysis, vectorial calculators, straight wire system analysis and a root spring calculator, all designed to assist with efficient appliance and wire design and selection. By importing your own radiographic or photographic images, you can perform accurate calculations relative to each patient's needs.**

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