Virtual Orthodontic Treatment Planning
This article provides a summary presentation of modules and functionality for orthodontic treatment planning using digital models in the imaging software OnyxCeph³™ 3D available at the time of printing.

Options for planning fixed appliances, aligners, surgical splints and retainers are discussed as well as various aids and other appliances.

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Preface

The recent years have shown a rapid development in the field of 3D-imaging systems. From the perspective of orthodontics, beside digital volume models and face scans - especially digital surface models - are gaining importance. A major motivation behind this is most likely the multitude of emerging opportunities for improving workflows in the doctor’s office - ranging from saving time, material, laboratory capacity, occupancy costs and others to the optimization of treatment progress and result.

For effective use of this potential in given workflow a suitable infrastructure in regard to hardware, software and service providers is required.

As manufacturer of the dental imaging software OnyxCeph™ with focus on its use in orthodontics, Image Instruments has continuously worked on development and implementation of a uniform concept for digital management, evaluation and comprehensive utilization of 2D and 3D image data.

OnyxCeph³™ designed as dental imaging software represents a Windows™-based client/server host application with high performance local NexusDB SQL-database. By now, the software is used by more than 2,000 registered users in more than 50 countries for tasks relating to image based archiving, diagnostics, treatment planning, consultation and statistics.
Depending on the type and scope of the usage of patient-specific image records, the modular basic concept of the software, that is approved as medical product, offers different program versions and flexible licensing models.

The remainder of this publication discusses a range of functions for digital models in the context of virtual planning for specific orthodontics treatment cases which are available in the current version of OnyxCeph\textsuperscript{3TM}. Those are integrated into the much wider scope of OnyxCeph\textsuperscript{3TM} in which all image-based findings for a patient can be combined coherently for planning and performing orthodontic treatments.

![Figure 1: Fusion of CT and segmented model findings using registration in the Combine 3D module.](image-url)
Digital Models

In recent years, the utilization of digital models has become increasingly interesting in the field of orthodontics. This increase corresponds to a growing availability of affordable and practicable intra-oral and model 3D scanners, more powerful software applications and manufacturing technologies capable of producing the virtually planned treatment or transfer devices for an effective integration into the real-world treatment process.

However, a large number of orthodontic experts interested in digital models might lack detailed insight in how to employ the new technology in the daily workflow of their practice and which prerequisites have to be fulfilled for such an integration to be beneficial.

Therefore, this article aims at answering important questions concerning the software-related requirements and possibilities of digital models.

Virtual Workflow

Independent of the particular task at hand, the functions available in the software can be understood as a sequence of flexibly interchangeable processing and planning steps in between data import (scanning) and data export (manufacturing), see Figure 2.

While the software supports a distributed workflow between the doctor's office, own and other laboratories and further service providers, this is not the focus of this document. Please note that this support includes digitally aided ordering, communication, validation, correction and approval of treatment data as well as data management and the option to administer an arbitrary large number of clients.
in parallel between which data can be exchanged and synchronized online and offline. This has led OnyxCeph\textsuperscript{3TM} to become intensively used as frontend in the cooperation of offices, clinics, laboratories and health insurance companies.

Figure 2:  Concept of virtual planning of orthodontic treatment in OnyxCeph\textsuperscript{3TM}
I. Scanning

A variety of both direct and indirect optical surface scanners and direct and indirect radiation methods with surface extraction can be employed for spatially capturing the dental arch.

At the present time, doctor's offices and laboratories primarily use the first group of methods where photogrammetry, laser scan or phase shift projection technologies help to determine the 3D position of surface points with an accuracy of about 10^{-2} mm which are then combined to a polygonal surface mesh. These methods are well established in fields such as prosthodontics and implantology and represent the current state of the art.

Specialized requirements for orthodontic applications arise because the complete dentition including gum und palate, possibly with complex malocclusions, needs to be captured and the occlusion must be registered in the correct bite relation optionally including information about the mandibular joint.

Nowadays, intraoral scanners for direct capturing on the patient are becoming increasingly important next to the model scanners which are used for plaster and polymer models.

Figure 3:
Structured-light projection scanner orthoXscan by Dentaurum
II. Planning virtually

The applicability of the virtual planning steps in OnyxCeph\textsuperscript{3TM} described here is not restricted to any particular scanner as long as the topology, resolution and size of the scanning datasets lies within a certain range and as long as the jaw relation is captured precisely.

Each scan is assigned to the correct patient and session using standardized and additional custom interfaces to practice management systems. For capturing data explicitly for a patient, a large number of image sources can be connected using extensively configurable interfaces.

OnyxCeph\textsuperscript{3TM} also supports the management of an arbitrarily large number of offices (clients), each with a separate trunk of patients which are backed by independent partitions of the underlying database. These client areas are created and synchronized by the concept of containers, where accepting a container imports all enclosed data into the correct client for that partner. Besides regular patient information, the container can contain 2D and 3D images, presentations, and (order) forms and can be transferred on- or offline.

This functionality is also used for synchronized data exchange between offices and/or laboratory locations, e. g. for sending plannings of bracket positions or aligner steps (on the basis of intraoral or model scans) online to dental laboratories for manufacturing of transfer or treatment trays. Another example is the ability to validate and optionally correct the steps implemented by the laboratory directly in the doctor's office.
- **Import, prepare and align a scan record**

Importing scan data is integrated in the ImageAquire module and basically requires the same steps as recording any other 2D or 3D image data. The files resulting from the upper and lower jaw scans are presented in a preview area and can be moved to the according session panel using Drag&Drop.

![Image](image.png)

Figure 4: Importing, preparing and aligning scan data
The second part of the import procedure allows adjusting the virtual model to a patient-related reference system with respect to dental symmetry, incisor position and mean occlusion. If an articulated model was scanned, the axis of the articulator can be used if handed over by the scanner. Alternatively, an average axis position is assigned using clinical reference values.

At this point, the surface meshes retrieved from the scanner can be tested for topological errors, repaired, cropped and adjusted in their visualization properties.

All adjustments of the model alignment are stored as additional transformations which can be reversed if necessary.

- **Cutting, trimming and adding sockets to models**

For improving properties of the data set in respect to archiving and processing, the module Socket offers various options to further optimize the scan data.

Besides repeated fine adjustment of bite position by means of the occlusogram, trimming both upper and lower jaw using trim lines and trim planes and mounting of standardized virtual sockets of different sizes and geometries is possible. Optionally, the model can be labeled by imprinting patient data or free text.
A welcome side effect of this step is the often significant reduction of data set size due to the replacement of areas not required but captured in high resolution by optimized geometry. One option in the context menu of the object list allows color-coding of original and scanned surfaces.

- **Segment, separate and complete models**

If a digital model is not only to be used for documentation, measurement and consultation purposes but also as basis for virtual planning, it must be further processed for the use in the respective workflow. The Segmentation module allows such preparation, irrespective of the designated treatment and specific type of treatment or transfer device to be virtually planned. It operates in three subtasks which are independent, but logically built on one another:
1. Segment crowns
2. Separate crowns
3. Complete crowns

Segmenting Crowns comprises automatic recognition and marking of all areas of the surface mesh within a pre-defined crown-specific search radius. If necessary, the user may manually correct the automatically detected gingival transition.

In the step Separate Crowns, each part labeled as crown in the original mesh is extracted as new 3D object. The remaining jaw and the now open gingival regions are closed by analyzing the surrounding geometry and ensuring a realistic shape. At the same time, the original jaw objects are left unmodified in the data set.

In the step Complete Crowns, the user can choose between different options for completing the extracted crowns into single teeth and calculation of reference points which determine the individual tooth coordinate systems.

Figure 6: Module Segmentation: Segment Crowns (top), Separate Crowns (middle), Complete Crowns (bottom)
The completion can be repeated using different template teeth and, if necessary, manually modified and adjusted in type and length of the synthetic root.

Figure 7: Options for root shape when completing crowns

Figure 8: Segmentation module window
**Measuring the model: Module Digitize**

In the Digitize module, the user can apply preinstalled analyses for metric measurement and diagnostic assessment for the model types deciduous, permanent and mixed dentition. All reference points required for computing these analyses can be marked on the teeth or gingival surfaces or reference planes in the same manner as points are specified in other image findings.

About 40 different analyses are available as preinstalled evaluation methods. These analyses can be complemented by individually composed measurements.

Analyses can be selected individually or in groups, while, according to the concept of evaluation described above, a point placed once is available in any analysis. All results can be further used in print and presentations forms and other functions for evaluation, visualization or processing provided in OnyxCeph™.

The Segmentation module does not only compute a completed geometry for each tooth but also executes automatic "Landmarking" (assignment of tooth-related reference points and coordinate axes) which provides most of the reference points needed in subsequent planning steps. These points can be checked and, if necessary, corrected in the Digitize module. However, single, not directly tooth-related points (e.g. points for localizing the WALA-Ridge in the lower jaw or those for classifying the bite relation) have to be placed by the user before or after segmentation in the module Digitize.
Figure 9: Printing a finding
(on the example of measurement acc. to Weise)
When opened with a segmented model, the user can, in addition to traditional model analyses, also carry out quantitative assessments of misalignment and treatment need (e.g. PAR- and IOTN-Index).

Figure 10: IOTN-Assessment in the Digitize module
The Onyx-Model Analysis™ 3D represents another evaluation option and can be applied for mixed and permanent dentition. It calculates the space discrepancy for each quadrant on the basis of a mathematical dental arch model pre-aligned to the current situation acc. to specific criteria and on the evaluation of the effective crown contacts.

Figure 11: Space requirement calculation Onyx-Model Analysis™
Orthodontic planning modules

On the basis of a finding exported from the module Segmentation, which was possibly verified and extended in the Digitize module, various orthodontic treatment options can be planned virtually. Depending on the program version, different modules are available whose functions can be applied separately or in combination with each other to the images of the specific patient case. In the following this will be illustrated by means of some examples:

- Planning bracket positioning on the malocclusion: Module FA_Bonding 3D
- Defining a virtual treatment objective: Module V.T.O. 3D
- Planning bracket positioning on the treatment objective: Module Wire_Bonding
- Transferring virtual bracket positionings: Modules Kylix, Splint, Bonding-Trays, BracketAdapt
- Planning aligner treatments: Module Aligner 3D
- Planning surgical splints: Module Weafer_Creation 3D
- Planning retainers: Module Retainer 3D

Figure 12: 3D thumbnail context menu with functions and modules
Planning bracket positioning on the malocclusion: Module FA_Bonding 3D

As a result of either the FA-Analysis (accessible in the Digitize module) or the "Landmarking" in the Segmentation module, bracket positions on the tooth surface can be computed according to the MBT-rules from the mesial-distal crown axis, the crown heights 2-2, and the clinical crown axis (FACC).

On the basis of the FA-Points and the crown angulations determined by the crown axis, the FA_Bonding module allows assigning virtual brackets from an internal bracket library as single brackets or in predefined groups. With additional parameters from this library, the brackets are placed automatically in respect to position, angulation, and base distance and can be manually adjusted using an intuitive bracket navigator.

Alternatively, the user is allowed to skip the segmentation step and the computation of the FA-Points and may place the brackets largely independent of computer generated suggestions directly on the malocclusion scan.

Figure 13: Bracket placement according to MBT-rules
Defining a virtual treatment objective: Module V.T.O. 3D

For planning methods requiring a target setup of the teeth, the module V.T.O. 3D provides a rich functionality for automatic and interactive positional corrections of the teeth on a segmented digital model.

With the focus on professionally recognized ortho- and prosthodontic criteria for occlusion and mandibular joint, different steps can be applied in a logical order of a proposed workflow. At the same time, a multitude of interaction tools allows the user to individualize the planning in order to meet the requirements of even highly complex cases.

Figure 14: Definition of a treatment objective in the V.T.O. 3D Module

The elementary idea of planning a treatment objective is the alignment of the single segmented teeth along their mesial-distal orientation on a Monson-curve ("Core Line") which is defined by the mesial center of the central incisors and the most distal points of the posterior teeth on the surface of a Monson-sphere with a case specific radius.
In order to adjust the teeth to an optimal constellation in the treatment objective, each tooth can be offset to this curve individually in position and orientation. Extracting teeth and enamel reduction can be incorporated as well as fixed teeth (e.g. implants).

When starting the module, the parametrically described core line curve is best fitted to the tooth arch given in the malocclusion while preserving the mid- and most distal points. Simultaneously, the crown inclinations are set to the values the user selected from the inclination table. These parameters unambiguously define the initial position and orientation of each virtual tooth.

Procedural steps that build upon each other are available in the form of a wizard. They can subsequently applied separately or en-bloc and, if necessary, customized by parameters. Examples are setting up a vertical arch symmetry, adjusting dental and skeletal centers and harmonizing angulations and crown height relative to the arch before or after the arch is fitted to the skeletal mandibular shape using a guide value for the transversal FA-WALA-distances.

For compensating the space discrepancy in a single jaw by applying crown offsets, IPR, extraction or by adjusting the radial bow curvature (Curve of Spee), various numerical and visual controls and interactive algorithms are available.

The maxillary curve is adjusted to the mandibular curve by setting overjet, overbite and the centric relation contact position of the posterior teeth as specified individually by the user followed by a correction of the autorotation. Afterwards, the remaining space discrepancy in the upper jaw can be resolved with regard to the occlusion, where a mandibular displacement is also available as option.
In any planning step, the user can choose to simulate the gingival deformation resulting from the tooth displacements with different models.

The transformations necessary for each tooth movement are recorded so that the feasibility of the planning can be assessed and logged at any time using thresholds and the selected analysis which is updated in real time.

Figure 15: V.T.O. 3D module window (virtual setup)
**Note:**

The V.T.O. 3D module allows setting up a virtual treatment objective in respect to a geometrically optimized teeth arrangement under predefined constraints. While any virtual adjustment of single teeth is carried out on the basis of empirical rules and is under permanent control of user-defined thresholds for all movements, the physical movement in the actual rearrangement is influenced by forces of skeletal anchorage, gingiva, neighboring teeth and treatment equipment, which cannot be measured or computed explicitly. Assessing whether a simulated tooth movement is feasible and can be achieved with a given treatment device is in all cases the duty of the professionally qualified user.

In the same manner, the gingival deformation resulting from the tooth arrangement is based on empirically adjusted simulation models.

![Figure 16: Real (left) and virtual tooth movement (right)]
In the current implementations, the V.T.O. 3D module allows a virtual representation of all steps during an orthodontic treatment aiming at a purposeful correction of misaligned teeth.

The variety and recombination of those single steps allows a high flexibility for various treatment concepts and desired treatment objectives. However, this diversity of options indeed places considerable demands on the user with regard to expedient use of the module.

For this reason, we especially point out that the planning module V.T.O. 3D, just as other modules, is subject to ongoing development. The primary objective is to simplify the use and reduce the time spent on virtual planning by further automation of substeps that require no or rare user input.

Similar to all other 2D and 3D planning modules, intermediate steps as well as final results of a setup planning can be saved as project, sent online for validation and approval, or saved as separate finding in the database for further utilization in other modules. An animation can be created for the findings exported from the module, so that they can be reviewed separately in full screen mode.
Planning bracket positioning on the treatment objective: Module Wire_Bonding

In the Wire_Bonding module, the user is allowed to specify the course of the archwire in relation to the target tooth arch. For this purpose, the two wire planes are automatically prepositioned using the FA-points of both jaws. The user can correct this positioning right at the start or at any other time, whereupon all data depending on these planes is updated immediately.

Figure 17: Wire_Bonding module window
The buccal or lingual arches with different profiles, dimensions and shapes are selected using the respective pulldown and selection elements and can be adjusted to the target tooth arch by translation or virtual bending.

In analogy to the FA_Bonding module, the brackets designated for a treatment can be assigned to the respective crowns separately or in groups. With this information, the course and profile of the wire as well as the center of each crown define the initial position of each slot and bracket.

Following the concept described so far, individualization of the treatment device maintaining the mostly straight prefabricated target wire shape has to be put into practice by an individual bonding base for each bracket on the respective crown. As an alternative, the brackets can be moved in the wire plane towards the crown as far as possible while keeping the correct slot orientation. This leads to an optimized thickness of the bonding base from a mechanical point of view and transfers the individualization mainly into the wire itself.

Figure 18: Alternative individualization: left: straight target wire and individual bracket base distance, right: individual target wire and minimized bracket base distance
Depending on the wire profile, in both cases the bracket navigator can be used for further modifications to the bracket position in the degrees of freedom remaining in adherence to the straight wire concept in consideration of collisions of neighboring teeth in the malocclusion setting.

At any planning step, the transformation of each single tooth computed in the virtual setup can be applied in reverse to the crowns and bracket groups to visualize the planned straight wire position of the brackets in the initial treatment stage.

Figure 19: Bracket positions planned on the treatment objective and transformed to the initial stage

This visualization is available at any time and can also be used to simulate the teeth and bracket repositioning over the course of a treatment using a linear tooth movement model.
The treatment planning from the module Wire_Bonding can again be saved as project and accessed using the project management in the card file of the patient.

In addition, the individualized wire geometry in intermediate or the final stage can be printed in true scale or exported as a coordinate file in CSV format for driving bending machinery.

Figure 20: Scaled print results of individualized wires

The planning of bracket positioning relative to the malocclusion model is stored as separate finding in the database so that it can be used for manufacturing transfer trays.

For the sake of completeness, it should be mentioned that the module Wire_Bonding already allows planning and simulating a wire geometry of higher dimension but in practical use it is largely impeded by limitations of manufacturing of spatially completely individualized wire shapes.
Transferring virtual bracket positionings: Modules Kylix, Splint, Bonding-Trays, BracketAdapt

After optimal bracket positions have been determined in the planning modules FA_Bonding or Wire_Bonding, the question remains how to transfer the virtual positions easily, quickly and precisely to the patient.

As answer to this question, a variety of solutions using direct and indirect bonding exists. OnyxCeph™ supports several of these transfer methods in separate modules (see Table 1). A few of them are proprietary to certain providers and only available for their customers. The modules Kylix, Splint, Bonding Trays and Bracket Adapt, however, are building on own method development and property rights registration and can therefore be employed by users of the OnyxCeph™ versions 3D Pro and 3D Lab without licensing law restrictions.

Figure 21: Virtual planning for bracket positions (left) and anchorage of brackets on the printed polymer model (right)
The Kylix 3D module allows fixing position and orientation of the bracket on the printed model by the help of bracket specific framing and spacing elements, which can be combined in a flexible manner and adjusted for each crown if necessary (Fig. 21).

Table 1:
Selection of transfer technologies supported in OnyxCeph³™

<table>
<thead>
<tr>
<th>Method</th>
<th>Indirect Bonding (on the model)</th>
<th>Direct Bonding (in the patient’s mouth)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Position</td>
<td>Orientation</td>
</tr>
<tr>
<td>Kylix_3D</td>
<td>x  y  z  a  i  r</td>
<td>x  y  z  a  i  r</td>
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<tr>
<td>Individua</td>
<td>x  y  z  a  i  r</td>
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<td>Excent</td>
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<tr>
<td>Orthorobot</td>
<td>x  y  z  a  i  r</td>
<td>x  y  z  a  i  r</td>
</tr>
<tr>
<td>Bonding_Trays_3D</td>
<td>x  y  z  a  i  r</td>
<td>x  y  z  a  i  r</td>
</tr>
<tr>
<td>Splint_3D</td>
<td>x  y  z  a  i  r</td>
<td>x  y  z  a  i  r</td>
</tr>
<tr>
<td>Bracket_Adapt_3D</td>
<td>x  y  z  a  i  r</td>
<td>x  y  z  a  i  r</td>
</tr>
</tbody>
</table>

(x, y, z) – position; (a, i, r) - orientation
Figure 22 shows a method suitable for indirect or direct bonding on the patient using a tray constructed in the Bonding Trays module with selectable thickness and fitting over the model with bonded brackets, which can be exported (e.g. in STL-Format) for 3D printing, optionally using bio-compatible materials. The applicability of this approach poses certain demands on the input geometry and is therefore not equally well suited for all brackets.

Figure 22: Bracket transfer tray on the virtually bonded model
The module Splint 3D also provides a method applicable to direct and indirect transfer. In this case, the bracket position is determined by jigs which are solidly seated on the crowns and are optionally interconnected to a splint. Brackets and jigs are flexibly interconnected by standardized bracket adapters\(^1\) and the geometry of the jig can be adjusted individually for each crown.

![Figure 23: Transfer of bracket positioning using single or interconnected jigs and standardized bracket adapters.\(^1\)](image)

\(^1\)Note:
The bracket adapters needed for the Splint 3D module are custom-made products of specific laboratory users of OnyxCeph\(^{\text{TM}}\). While Image Instruments can neither supply those components nor mediate their delivery, construction and integrating of new adapters is welcome and will be supported.
The module Bracket Adapt 3D facilitates a complete individualization of bracket bases on the manufacturing side. Using this technique, one possible example are individualized ceramic brackets which can be planned and produced using selective light curing of a photosensitive polymer compound with ceramic particles in 3d printing.

Figure 24: Planning and tailoring individualized brackets
Planning aligner treatments: Module Aligner 3D

The module Aligner 3D was developed for planning aligner treatments. It is started with a segmented malocclusion or treatment objective finding and allows splitting the treatment process and the respective tooth movement into multiple steps. The movement in each of these can be supervised using motion threshold values and can be adjusted if necessary. If attachments are to be used, they can be assigned from an attachment library, placed precisely on the crowns and also removed again at any point of the virtual treatment process.

Figure 25: Planning incremental aligner steps:
top left: initial situation, top right: step N with exceeded threshold at the incisors, bottom left: step K with attachments, bottom right: treatment objective position with color-based monitoring of crown contacts
A substantial feature of the module Aligner 3D is the so-called progress-refinement option, in which an intermediate scan of the real treatment progress can be loaded into the initial aligner planning in order to control the tooth movement achieved and to update the virtual planning while retaining the initial treatment objective. For that purpose, the scan is loaded into the planning and different methods of registering it to the existing model are offered so that the remaining steps can be corrected using the actual tooth movement.

![Figure 26: Matching the planning to the actually achieved treatment progress using progress-refinement](image)

The entire planning can be saved as project and restored. Step models with the option of additional trimming, blocking, labeling and re-meshing can be exported from the project without generating and saving a separate finding for each step.
Planning surgical splints: Module Weafer_Creation 3D

Splints (waefers) for locking upper and lower jaw in position during an operation as often used in orthognathic surgery are supported in the OnyxCeph\textsuperscript{TM} planning module Weafer Creation 3D. This module allows designing of case specific waefers with features such as holes, labels and registration markers.

Figure 27: Weafer Creation 3D module window
In Case of additional CT or DVT data or registered face scans being available, the jaw relation to be fixed by the wafer can be set up for example in the 3D treatment simulation module.

Figure 28: Construction of surgical splints
Planning retainers: Module Retainer 3D

Planning and manufacturing of retainers is another example task which can be aided and optimized by using modern 3D-based methods. The module Retainer 3D provides intuitive drafting and construction tools for creating such devices as 3D object, which can be exported in a suitable data format for different manufacturing approaches.

Figure 29: Example retainer constructions
III. Manufacturing

This article is based on the concept that the orthodontic imaging software OnyxCeph™ also serves as connector between the imaging sources on the one and the appropriate manufacturing techniques on the other side in the portion of virtual planning covered by the software.

For this setting, the user is provided with a number of planning options aiming at optimizing treatment planning steps in orthodontics. Due to the highly varying quality of scan data analysis and revision of this data is often required. The module Image Adjust offers suitable tools for this task.

Similar to importing images, exporting of virtual planning results for manufacturing processes with the respective technologies often exhibits high data quality requirements. These processes are often generative manufacturing technologies, but also traditional techniques such as milling, cutting, eroding or bending are common.

Which manufacturing method is most suitable for the specific device, has to be analyzed and decided for by the user for each individual case in consideration of recent advances in technology and materials.

Program version OnyxCeph™ 3D Lab allows 3D data export in various formats (STL, OBJ, PLY, OFF, DXF, ZPR). Similar to data preparation on image import, particular post-processing options can be applied to exported records, e. g. combining of multiple objects, such as single teeth or brackets, into a record with closed ("watertight") surface in order to prevent manufacturing problems at an early stage.

In addition to saving 3D data as files in the export, sending this data including placing of orders to suitable 3D print service providers is possible.
Other data, such as virtually constructed wire arches and retainers can be exported as 1:1 print template for the purpose of manual bending as CSV file with all needed coordinates for a bending machine or robot or also as 3D geometry.
Conclusion and Prospect

The aim of this document is to present the 3d planning functions available in the dental software OnyxCep\textsuperscript{3Tm} at time of printing in order to give interested users an idea of requirements, effort and benefit of working with 3D records in general and digital models in particular.

Further tools for different treatment methods that are under development or already available are deliberately excluded.

To various extents and based on different integration concepts several basic functions of the software OnyxCeph\textsuperscript{3TM} are also available in applications of cooperating companies, e.g. in ivoris analyze of Computer Konkret.

In addition we provide specially configured program versions for partners of the OrthoAlliance group who deploy and distribute them within the scope of assuring their range of services.

At this point, it should be emphasized that we, being non-physicians who develop a software application for orthodontists in general and implement issues of virtual treatment planning in particular, depend on expert collaboration with professionals from private practices, laboratories, universities and also from industry and highly appreciate appropriate offers.
DDr. Silvia Silli from Vienna, Dr. Guido Sampermans from Echt and Dr. Georg Schmid from Bern are cited as examples for many others who have contributed to further improve the software OnyxCeph$^\text{TM}$ by constructive discussions, suggestions and expert advice for more than 10 years. In our opinion, the great interest our concepts arouse emphasizes that regardless of all the products already on the market there is still high demand for alternative and in particular feasible solutions and the potential for treatment improvement by means of suitable software applications is far from being complete.
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