

Dynamic Knowledge Spaces in Dental Medicine

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Abstract

The era we are living in is often referred to as “the age of communication”. World-wide telecommunication networks (using satellites, cables, wireless) are now facilitating the global pooling of healthcare information and medical knowledge independent of location. The assemblage of telematics and services offers a base for multimedia applications, for example E-Learning or E-Health. The WWW service has become a very important media for providing medical knowledge. Internet search engines attempt to employ intelligent search algorithms in order to optimize their search results. In the future, when we speak of an intelligent Web search based on semantic networking, it will be an absolute precondition that the search is performed through an interactive and dialogue-based structure, which in turn can only be qualitatively implemented on the basis of on a standardized, harmonized and referenced thesaurus and of glossaries containing the requisite definitions of terms. To decide what is clinically relevant and what is necessary for quality assurance in a successful practice management. For that, various multimedia on- and offline programs will be described. Furthermore will presented, the K-Space application for the knowledge space of medicine supports the global and intercultural knowledge transfer and enhances the interdisciplinary research and education. The K-Space DentMed initiative represents the semantic contextual knowledge spaces of the upcoming Web 3.0 generation with the automatic annotation and information retrieval of multimedia content.

Paper

John Naisbitt in his 1982 book “Megatrends,” postulated an important characteristic of our information and knowledge society: “We are drowning in information but starved for knowledge.” Today, in the age of the Internet, we are faced with this problem every single day, because Web searches and information selection are highly time-consuming activities. Internet search engines attempt to employ intelligent search algorithms in order to optimize their search results. Nevertheless, the question remains how “qualitative knowledge” can be selected, i.e. knowledge needed for supporting decisions in medicine and dentistry. Semantic search engines are one current approach to this problem. For this reason, a project entitled “Mr. Q, your personal Web Assistant” (Fig. 2) has been initiated.

To meet the requirements of Life Long Learning and the imperative anything, anywhere, anytime as described in (Ziegler et al. 2007), we must optimize quality assurance in diagnostics and therapy and provide supporting media for medical and dental training and continuing education that are tailored to specific projects and tasks. This requires fundamentally new structures for managing and presenting knowledge and content.

The problem of information overload in our society is amply demonstrated by the 97,719 new books published in Germany alone (Börsenverein 2007) and even more so by the over 20,000 international scientific publications *every day* (ISI – Institute of Scientific Index 2007). This is of focal importance for medicine and dentistry when it comes to the accessibility of relevant and verified knowledge in the areas of research, education, and clinical practice.

The transition from the analog world to the digital world seems to imply a solution to the selection problem. However, it has also itself caused a veritable information avalanche, significantly influenced by recent developments in the area of user-generated content.

While scientific publishers have seen themselves mostly as the keeper of the Holy Grail of knowledge, the next Web generations will show that the cultural definition of knowledge is embedded in the concept of “wisdom of community,” as exemplified by Wikipedia (non-reviewed) and Citizendium (reviewed).

The digital world not only changes the traditional pruning process, from the author’s manuscript via the editorial and production stages and delivery to the bookshop for sale to readers. It is also about to completely redefine traditional concepts in, and the very definitions of, scientific and technical publishing.

Until now, publishers mainly reacted to the digital transition by bringing their print products online, sometimes more and sometimes less intelligently, or by developing new products specifically for the Web, but still working under the constraints of the traditional publishing process.

The convergence between IT developments and modes of application eliminate the traditional thinking in categories (“pigeonholing”), making conventional publisher portfolios categories obsolescent as well. The only half-jocular comment, “By the way, I can even use my cell to make a phone call,” succinctly demonstrates this fusion between the different methods of utilizing technology and content.

Analyzing the most recent Web trends as they manifest themselves in Facebook, Digg, Flickr, Second Life, YouTube, StudiVZ, MySpace, Wikipedia, Citizendium and PLoS (Public Library of Science), it becomes clear that all these mega-trends developed mostly outside the publishing sphere and that the only way for publishers to position themselves in these markets is by buying into them.

The Grid Media study (Ziegler et al. 2007) has also impressively analyzed and described the (survival) strategies for publishers in the digital age.

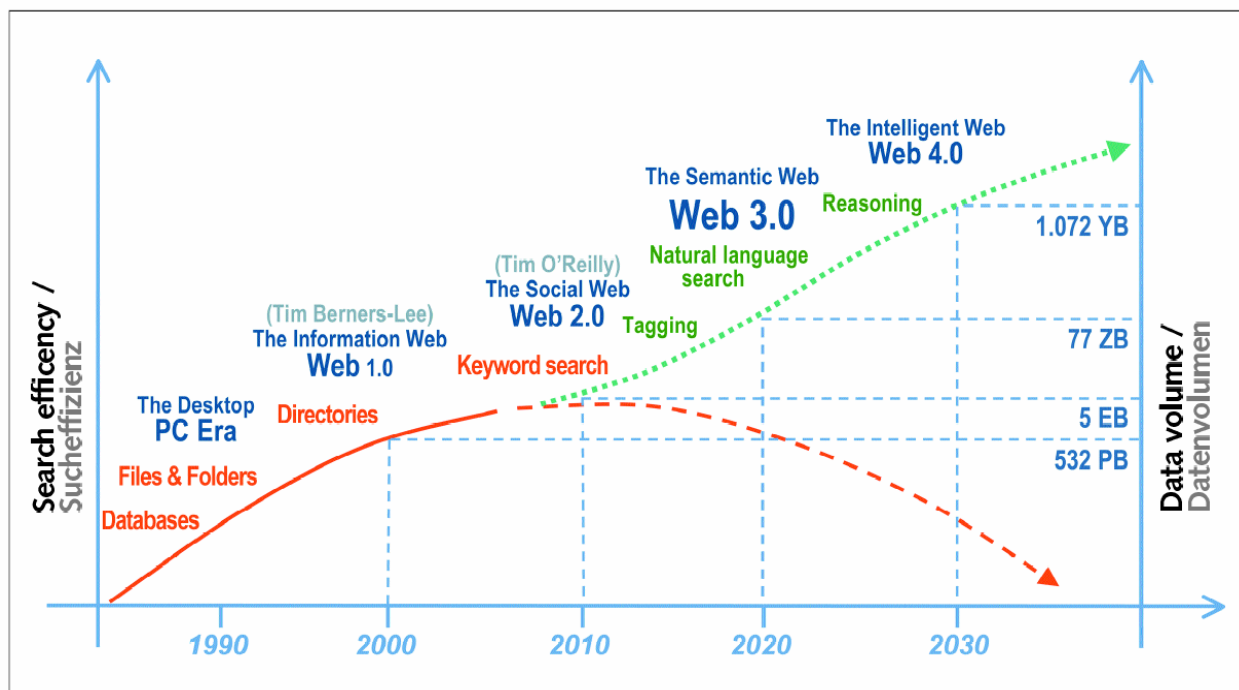


Fig 1 From the PC to the intelligent Web. 1 petabyte (PB) = 10^{15} bytes, 1 exabyte (EB) = 10^{18} bytes, 1 zettabyte (ZB) = 10^{21} bytes, 1 yottabyte (YB) = 10^{24} bytes. Adapted from Lyman and Varian.¹²

Fig. 1: From the PC to the intelligent Web. Adapted from Lyman and Varian.

K-Space DentMed – A Dynamic Knowledge Space

The present project initiative, K-Space DentMed, and the Visual Library 2007 product were developed on the basis of our experience in the global transfer of knowledge in dental research, education, and clinical practice and of the insights we derived from our participation in two EU research projects on “Telematics Systems for Quality Assurance in Health Care” and the pivotal project of the G7 states, “Global Health Care in the Information Age.”

The project is currently in evaluation Level 1 beta with a DVD-ROM with on-line updates of knowledge elements. In production mode (2008), K-Space DentMed will be successively made available on the Internet in several languages, by a subscription system and context-related product information provided by dental manufacturers and service providers. K-Space DentMed as a project will never be completed, because knowledge is and will always remain a dynamic and ongoing process.

The generation of knowledge elements is effected in clinical competence centers through a transformation to context-related knowledge objects in order to represent dynamic poly-medial knowledge spaces.

Users (students, university teachers, hospital and private practitioners) navigate the dental knowledge space in a free or a structured manner depending on the task or problem on hand. They can access context-related sources of knowledge based on video media, including treatment methods, relevant literature, clinical studies for medical databases, materials, instruments, pharmaceuticals and medical products involved. Additionally, users are supported by an avatar with a personalized profile for semantic searches.

The focal questions are: What conclusion can we draw for the dental community from the above-named Web trends and from the developments outlined above? And how can we draw on this experience to develop a convincing concept for the world of dentistry?

Most products developed to date have been singular in nature, i.e. they offered no general approach to a comprehensive form of knowledge management and dentistry and therefore do not live up to the expectations of tomorrow’s poly-medial space. An analysis of the EU K-Space program entitled “Knowledge Space of Semantic Inference for Automatic Annotation and Retrieval of Multimedia Content” (www.k-space.eu) shows that the approaches suggested there are highly relevant to the K-Space DentMed project.

The principal questions are how knowledge can be generated in the context of a review process by the dental community and how the dental knowledge space can be presented so as to meet user needs – well-structured for training and continuing education curricula as described in (Littlejohn et al. 2007), free-form for task- and problem-oriented research, or target-group specific for laypersons and experts – without their getting disoriented.

Two central aspects are the focus of attention:

- Global communications are impossible without multi-lingual standardization, harmonization, and referentialization in the world of dental concepts, because medical definitions are frequently embedded in a specific cultural context.
- Semantic search functions using avatars that adapt to the user's individual requirements and desires facilitate a qualified profile search. A semantic context search presupposes the existence of a thesaurus.

These two topics are currently under development for the Quintessence International Publishing Group, where thesauri with more than 5,000 terms and definitions for implantology and orthodontics are for the most part already available in six languages; an avatar prototype also exists. The following chart shows the connections between all these concepts and products that will be available for immediate inclusion in the K-Space DentMed platform. Approximately 25,000 terms will be standardized, harmonized, and referentialized for global communication in eight languages, including Chinese and Japanese.

For the semantic web avatar, named Mr Q (*Question, Quantity, Quality, Quintessence*), the multilingual thesaurus is a “*Conditio sine qua non*” as described in (Pellegrini et al. 2006), in order to put the knowledge spaces into a context with its direct and indirect references. K-Space DentMed should be seen as a contribution to our global information and knowledge society, aiming at free and structured semantic and contextual research within the dynamic dental knowledge space.

The following figures show examples for using the dynamic World of Knowledge in Dental Medicine.

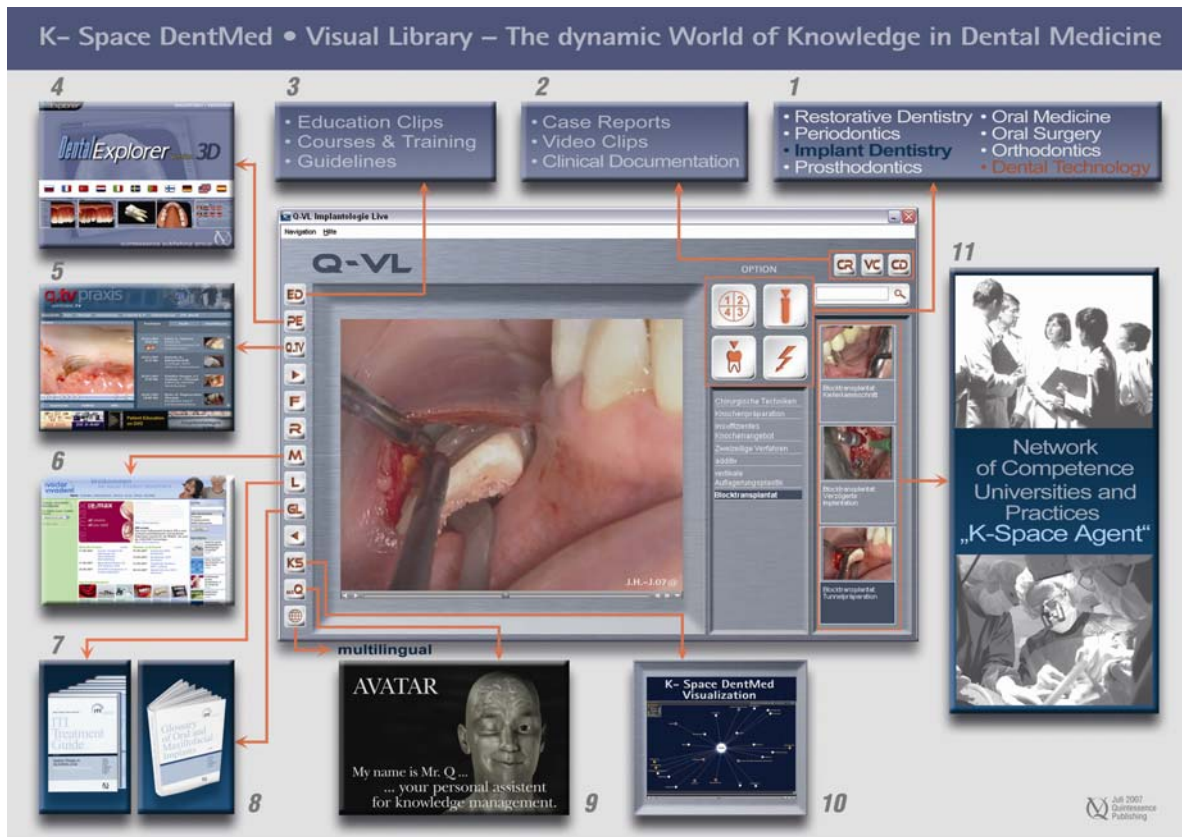


Fig. 2: K-Space DentMed / Visual Library

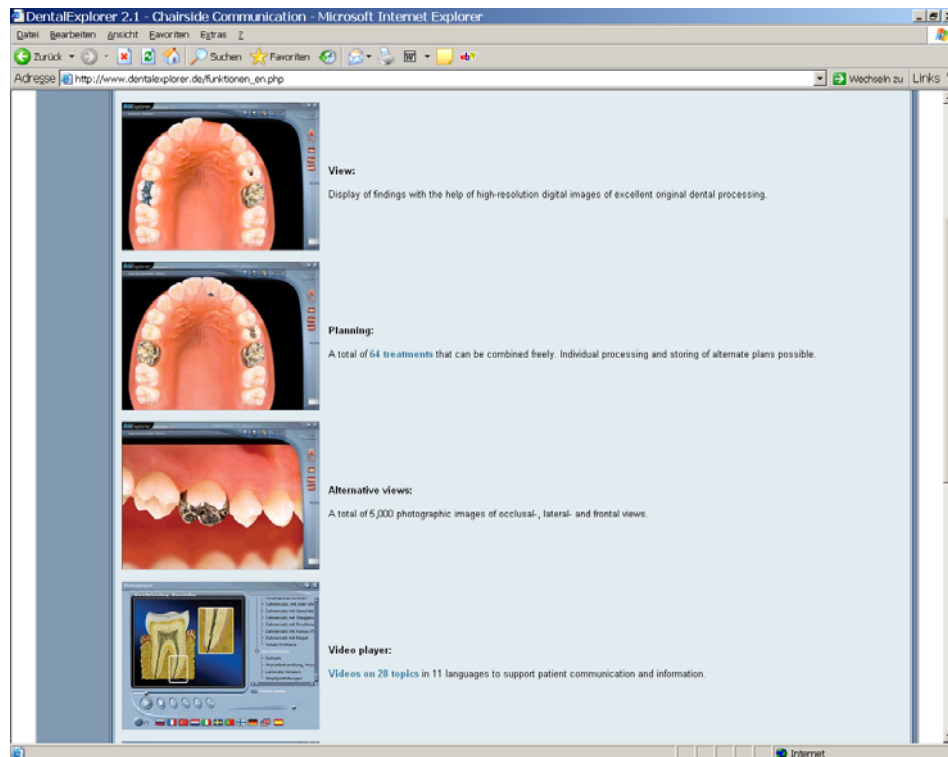


Fig. 3: DentalExplorer in 11 languages (see screen 4 from Fig. 2)

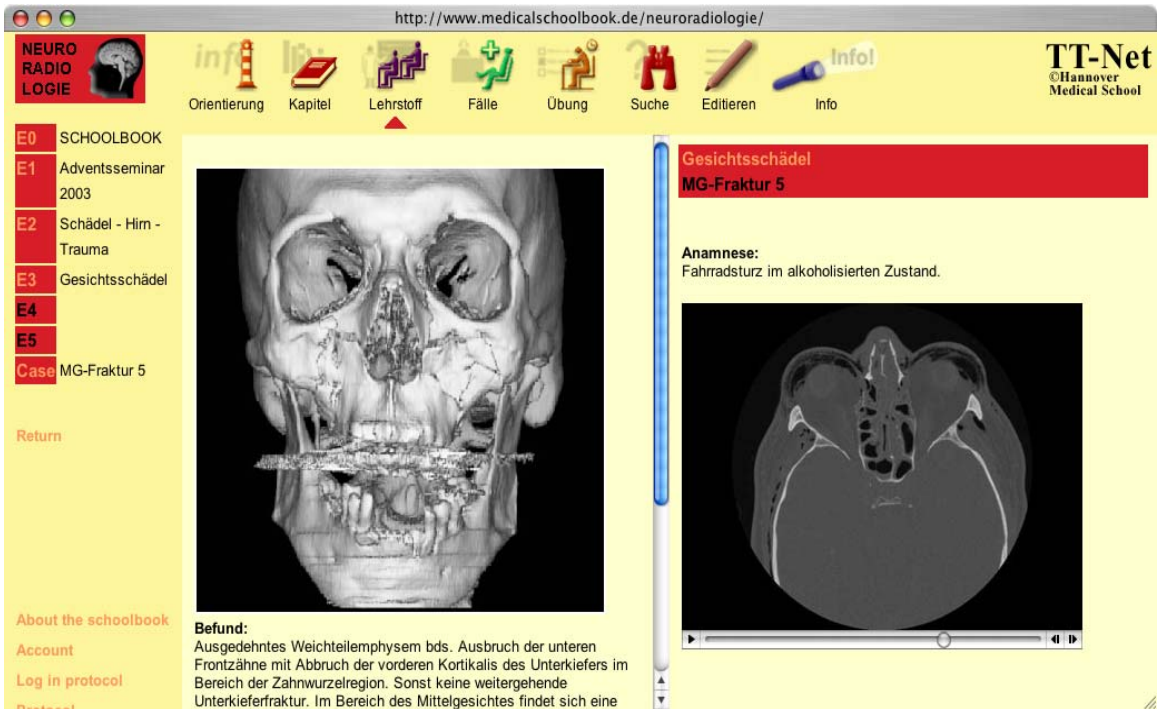


Fig. 4: Schoolbook Neuroradiology

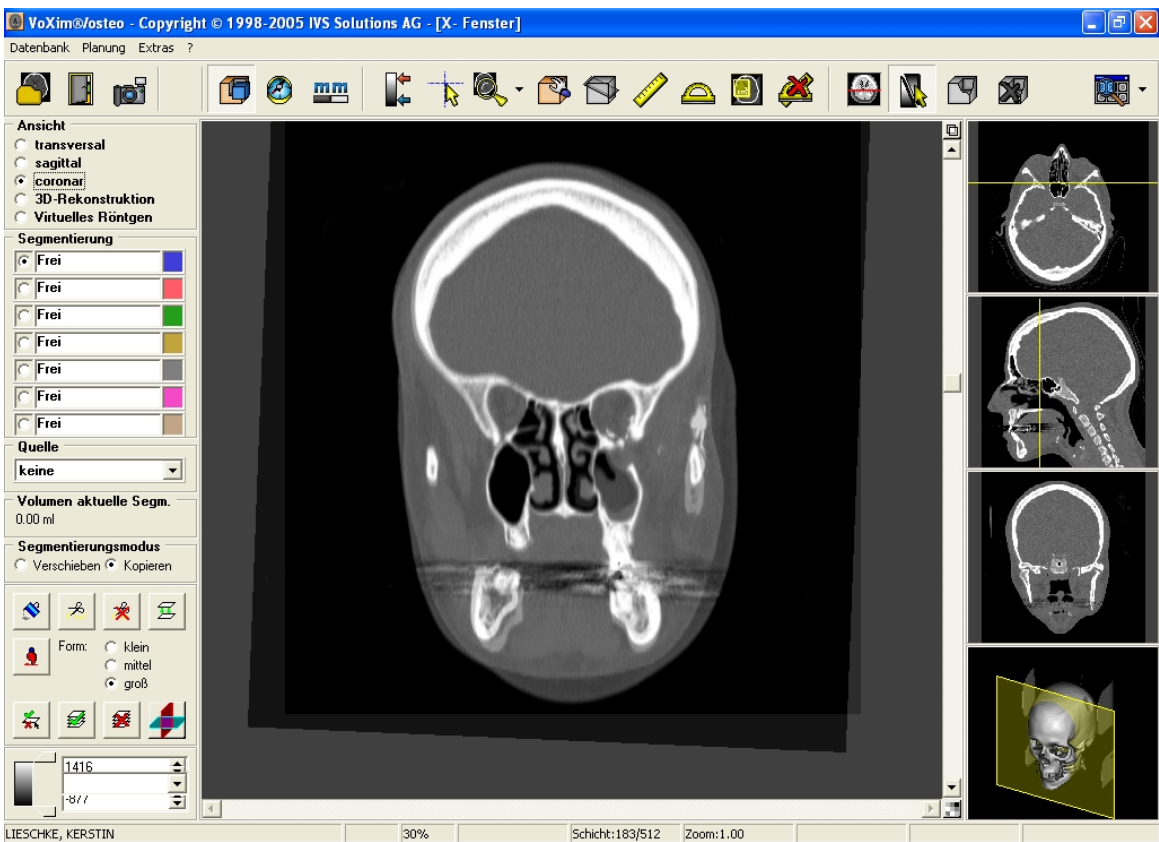


Fig. 5: Interactive OP Planning for Oral and Maxillofacial Surgery

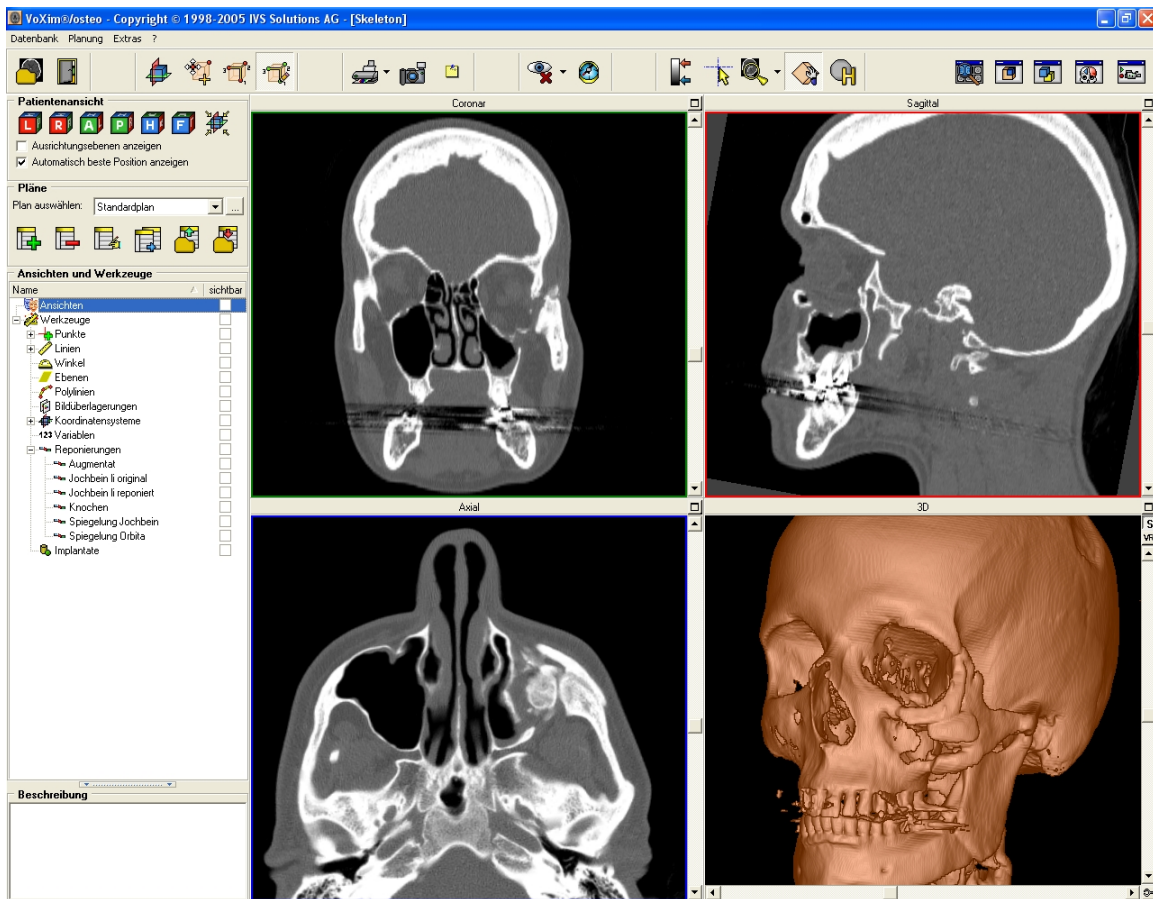


Fig. 6: Interactive OP Planning for Oral and Maxillofacial Surgery

Conclusion

In the future, when we speak of an intelligent Web search based on semantic networking, it will be an absolute precondition that the search is performed through an interactive and dialogue-based structure (human/computer interface, Koch 2006), which in turn can only be qualitatively implemented on the basis of on a standardized, harmonized and referenced thesaurus and of glossaries containing the requisite definitions of terms. These prerequisites are met by the dental research project entitled “Mr. Q, your personal Web Assistant” and the thesaurus.

An international team of experts is currently compiling a multilingual harmonized reference work entitled GLODMED (Glossary of Dental Medicine), comprising approximately 15,000 terms and their definitions in six languages (English, French, German, Italian, Portuguese, and Spanish). The GOT (Glossary of Orthodontic Terms, Daskalogoannakis 2003) and GOMI (Glossary of Oral and Maxillofacial Implants, Laney 2008) subprojects have already been published, having been realized through close cooperation between the research community, practitioners, the dental industry and the publisher. The demand by the Scientific Council (2005) to grow the transfer potential between research and industry is therefore met.

However, one aspect of the current, more general discussions on evidence-based medicine ought to be assessed critically. While the development of semantic Web searches is highly commendable when it comes to the individual generation of task-related or problem-related ontologies from a variety of concept in a quality-assured manner, this knowledge is invariably explicit (orientational knowledge) and cannot replace implicit knowledge (operational competence). Consequently, the guidelines developed by the professional societies that constitute the Association of the Scientific Medical Societies in Germany (AWMF 2008) offers orientation or recommendations for physicians – but their actual professional competence resides within their implicit knowledge, which defies formal linguistic expression.

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