

## Dental ergonomics mirrored in mechatronics

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### Summary

The goal of advanced dental ergonomics is the optimization/adaptability by modularization and automation implying flexibility by means of mechatronics. For patients and dentists, the new systems are very flexible and easy to handle, no matter the adopted working position. Mechatronics in dental medicine equipment is used in order to create bioprofit health care and innovations in design, products communication, unlimited flexibility and lasting durability. Human centered design requires the use of advanced simulation techniques for efficient integration of human factors in the verification procedures.

**Keywords:** dental ergonomics, mechatronics, simulation, automation, modulation.

### Introduction

Pick up a brochure for a nearly any hand tool, and more than likely you'll find that somewhere it says the tool features an "ergonomic design". Working with equipment that's comfortable to use and having properly designed work areas relate directly to safety, especial in the prevention of work-related musculoskeletal disorders. They reduce the muscle fatigue in workers that can lead to injuries and illnesses.

"An ergonomist can go into a workplace and help a company redesign itself"

Ergonomics tests were conducted very early in the design phases. This include examining the toll under development and comparing it to a competitor's product and then making detailed video sequences of the tool being used in a variety of applications. These were analyzed and targets set for the next iteration of the tool. One ergonomics expert suggested the following just might be

the most important question you can ask yourself when selecting a tool: is this product ergonomically designed for the way i use it?

The risky features of a job can be removed or reduced through changes to the design of workstations, tools and work organization [1],[2].

*Each study must describe:*

- body area affected;
- mechanization
- risk factors:
- task design
- type of solution:
- machinery design
- workspace organization
- supporting claming
- workstation design
- component selection
- component design
- automation
- tool design
- relevance of the case in other situation.

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Ergonomics, also known as human engineering or human factors engineering, is the science of designing machines, products, and systems to maximize the safety, comfort, and efficiency of the people who use them.

Ergonomists view people and the objects they use as one unit, and ergonomic design blends the best abilities of people and machines. Designing with people in mind often requires advanced technology, such as computer-aided design/computer-aided manufacturing (CAD/CAM) programs, robots and mechatronics to simulate human responses.

Over 60 universities in the United States now offer graduate or undergraduate degrees in human factors and ergonomics. Ergonomics draws on many disciplines in its study of humans and their environments, including anthropometry, biomechanics, mechanical engineering, industrial engineering, industrial design, kinesiology, physiology and psychology.

Typically, an ergonomist will have a BA or BS in Psychology, Industrial/Mechanical Engineering or Health Sciences, and usually a MA, MS or PhD in a related discipline. Many universities offer Master of Science degrees in Ergonomics, while some offer Master of Ergonomics or Master of human Factors degrees.

This commitment to “human-centred design” is an essential ‘humanizing’ influence on contemporary rapid developments in technology.

### The Best Fit for Safety and Comfort

The up to date projects in dental medicine refer to:

#### 1. New dimension choice:

- total modulation with rapid coupling;
- operational automatic systems;
- balancing arms–“zero-gravity”- and auto equilibrate aspiration;

- dental light with remote command;
- powerful lighting;
- antiretracting device of sprays;
- sprays and aspiration circuit with disinfection cycle;
- electromechanic action of the dental chair(without oil);
- multifunction pedals for the unit and chair;
- microprocessor autodiagnostic
- maintenance control system;

#### 2. Maximising of the operating freedom:

In spite of some producers that consider ergonomics as a “dogma” and technics as a “myth”, and forget about the patients and the dentists, the new systems are very flexible and easy to handle no matter the adopted working position [4].

The goals of the **advanced dental ergonomics** optimization for adaptability are: modulation and automation implying flexibility by means of **mechatronics**.

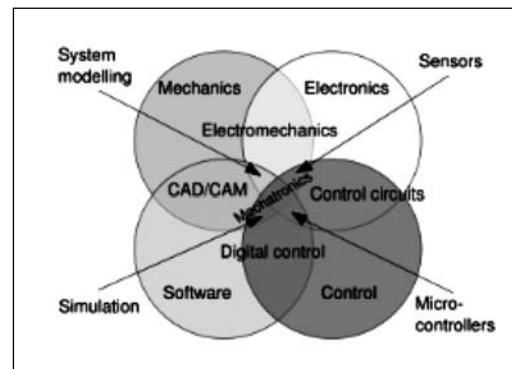


Fig.1. A typical mechatronics Venn diagram

Mechatronics is the synergistic combination of several engineering disciplines (Fig. 1).

Mechatronics is centered on mechanics, electronics and computing which, combined, make possible the generation of simpler, more economical, reliable and ergonomic versatile systems.

Modern production equipment consists of mechatronic modules that are integrated according to a controlled architecture. The most known architectures involve hierarchy,

polyarchy, heterarchy and hybrid. The methods for achieving a technical effect are described by control algorithms, which may or may not utilize formal methods in their design. Hybrid-systems important to Mechatronics include production systems, synergy-drives, planetary-rovers, automotive subsystems such as anti-lock braking systems, spin-assist and every day equipment such as autofocus cameras, video, hard disks, CD-players, washing machines, etc. [3]

A typical mechatronic engineering degree would involve classes in engineering mathematics, mechanics, machine component design, mechanical design, thermodynamics, circuits and systems, electronics and communications, control theory, digital signal processing, power engineering, robotics and usually a final year thesis.

*Mechatronics* provides biofit health care and innovations in design, products communications, unlimited flexibility and durability in dental medicine.

Top technology in dental instruments and systems and top quality and innovative technology in high grade products for dentists and dental technicians which permit precise and economical work and guarantee satisfied patients such as:

- straight and contra-angle handpieces and turbines,
- dental equipment and treatment units,
- care materials and systems,
- new tech products (lasers, caries detector, etc.),
- dental laboratory equipment and apparatus,
- products for dental training and lots more must provide maximum comfort for the patients during treatment, precise, safe and economical work on the part of the dentists plus time-saving and cost-cutting procedures in the dental laboratory.

*That means:*

□ high-precision dental instruments for all dental procedures (endodontics, surgery, implantology, etc.): high speeds, straight

and contra-angle handpieces, heads, minimally invasive tip system, couplers, motors, early caries detection, prophylaxis, maintenance systems, instruments feature very high power, are very quiet and produce little vibration, are very precisely engineered, easy to grip and are very well illuminated;

□ dental equipment line: operator chair, left/right delivery system, over-the-patient delivery system, operating light, operator & assistant stools, exclusive brushless electric motor, curing light: state-of-the-art technology to deliver superior patient care, state-of-the-art workstations, dust extraction systems, laboratory motors, articulators and processing equipment use 3D CAD services to visualize your new laboratory, dental understanding, engineering skill, manufacturing performance, service excellence. Everyday, we strive to meet your professional needs with equipment that provides solutions to the challenges that you face; whether an incremental or a breakthrough innovation, cellular optic high-speed hand pieces.

*The equipment must have:*

- optimum balance between speed and torque results in high power, providing a faster and more consistent cut.
- whisper quiet operation (reduces high-frequency peaks and operates at a uniquely low frequency range to protect operator's hearing. It also runs at a very low decibel level of 57dB for a relaxed and safe working environment)
- highest concentricity for smooth, precise preparations and better restorative results.
- 3rd generation cellular optic glass rods providing 25,000 LUX, come with a five - year warranty and are brighter and the most durable after repeated sterilization.
- perfectly balanced design and a 360° swivel provide fatigue - free usage.
- multiple spray ports provide a fine spray mist for better vision as well as constant cleaning and cooling of the bur and the preparation.

- durability tests show hand pieces withstand repeated sterilization, which means longer overall hand piece life.

- an incorporated unique automatic pressure regulator in every hand piece allows optimum performance and maximum durability.

- and - did you know that you do not have to replace your light source or tubing to get started with high-speed hand pieces? All you need is a coupler!

*Advanced Design allows:*

- a simple, one step operation starts the cycle,

- Large sequence indicators show: "Power unit" - "Cycle in Progress" - "Sterilization in Process" - "Cycle is Successful" or "Cycle has Failed",

- an interlock system prevents the lid from being removed while pressure remains in the vessel.

- a two stage "over pressure" protection system incorporates a calibrated pressure release valve and a gasket offset device.

- electronic detectors turn off the power if there is insufficient water.

- optional temperature and pressure gauges show internal chamber conditions during the cycle.

- TST indicator strips provide independent verification that the correct combination of temperature, steam and time has been achieved for successful sterilization.

- for your assurance of quality, each autoclave is computer tested and issued with a unique performance test certificate showing that the parameters for successful sterilization have been met [4].

### **Modular mechatronic equipment**

Modular mechatronic equipment based on the concept of human-centered ergonomics design-in dental medicine- implies interdisciplinary collaboration.

*The research steps must to take into account:*

- equipment requirements in correlation with clinic data base (realized by imagistic view of the activity in modular devices research laboratories)

- a cinematic module adaptability analysis by means of a 3D software (creating a model)

- optimization for maximum handling flexibility, introducing modules interconnection by means of mechatronic systems in order to achieve an ergonomic medical act regarding to the patient and dentist's functional movement envelope

- complex automatic and mechatronic systems (hydraulic, mechanical, electronic, pneumatic commands ,using automatic coordination ).

*General objectives are:*

- the study of the affections incidence in dental medicine function the working way of the operator;

- anthropometrical studies for a data base and establishment of working systems specifications.

- activity study with equipment in ISO standards; choosing the methods of establishing the necessary space for the patient and operator by correlating clinic data with systematized anthropometrical data;

- documentation study for the identification of the automation mechatronic systems solutions in dental equipment;

- elaborating cinematic schemes for giving the right data for the automation software of the working system;

- elaborating modular equipment 3D models; realization of command electronic modules and elaborating automation software;

- realizing mechatronic subassemblies of the dental modular equipment;

- optimizing command systems and software for functional intercorrelation of the equipments' modules in order to allow personalized dental equipment

*The models and technology must follow:*

- correlation between ergonomic tasks- as a result of activity study- with systematic anthropometric data;
- the utilization of complex action systems, automatic coordinated, for the technical equipment optimization;
- improving dynamic performances of actual equipment by using mechatronic systems, which allow adaptation to the patient's and dentists requirements;
- improving of technical equipments performances;
- equipment design for functional flexibility;

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## Conclusions

An objective definition is offered by Chapanis (1985) which refers to ergonomics as a discipline which discovers and uses information about human behavior, abilities and limits, about design characteristics of certain equipment, instruments and systems, about profession's requirements, and also work environment characteristics, so that a productive, safe, comfortable and efficient utilization would emerge, done by man.

So dental ergonomics and medical dental equipment ergonomics - interdisciplinary applied sciences- are of higher importance in dentist's and mechatronic engineering information.

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