



# GEOTAR Manufacturing LLC

## LEONARDO

### HYBRID DENTAL TRAINING SIMULATOR

#### USER MANUAL



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## INTRODUCTION

Dear customer:

“GEOTAR Manufacturing”, LLC is welcoming you and appreciates your choice of our products.

This is a user manual that will help you get acquainted with main characteristics and opportunities of the Leonardo hybrid dental training simulator and is included in the set. This manual describes how to use the Leonardo hybrid dental training simulator. Before using this equipment, please make sure you have carefully read all the manual.

“GEOTAR Manufacturing”, LLC is not responsible for safety, reliability and proper functioning of the set if:

- setting or repair of the simulator has not been performed by a qualified employee of the company;
- the electric power system of the premise where the equipment has been installed is not grounded or does not meet current norms;
- the device is applied not according to its intended use;
- there was an intervention of persons who do not have the appropriate qualifications;

The following pages will allow you to get familiar with the product and learn its basic functions, and will provide explanations regarding the care and maintenance that can be carried out by the staff. We are sure that you will be satisfied with the usage and reliability of the product you purchased.

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## **1. DESCRIPTION AND OPERATIONS**

### **1.1 INTENDED USE OF THE HYBRID DENTAL TRAINING SIMULATOR**

The dental training simulator is designed for dental specialists' training and certification. The device allows to conduct training in dental practice, reproducing the real conditions of a patient's visit and exactly simulating the work on the dental unit. The simulator provides an opportunity to train dental specialists in use of local anesthesia, treatment of all types of caries, tooth preparation in orthodontics (inlays, veneers, crowns, dental bridges) as well as free preparation. Computer control of all manipulations will allow you to objectively assess your work and will give you an opportunity to look through the entire process of tooth preparation by means of computer graphics and synchronous video recording from the installed camera. It is possible to practice methods of tooth extraction (without computer control).

### **1.2 SCOPE OF THE SIMULATOR USE**

The simulator is to be applied at the departments of dentistry of institutions of higher education or simulation centers for the development of manual skills of undergraduate as well as postgraduate dental students.

### 1.3 TECHNICAL SPECIFICATIONS

Technical specifications of the simulator are presented in Table 1.

**Table 1**

PARAMETER	VALUE
<b>Overall dimensions in the working position, mm</b>	
Length	1450
Width	680
Height	1550
<b>Overall dimensions in the non-working position, mm</b>	
Length	1200
Width	680
Height	1100
<b>Weight, kg</b>	
Complete set	150
<b>Test substance</b>	
Drinking water according to the State Standard GOST 51232-98 Medical air according to the State Standard R ISO 8573-2-2005, GOST R ISO 8573-3-2005	
<b>Operating conditions</b>	
Ambient air temperature, °C	from +5°C to 40°C
Relative humidity (at +25°C), %	from 45 to 60
Supply voltage, V	220-240
Frequency, Hz	50
Maximum supply current, A	2
Air pressure*, MPa	from 0.4 to 0.7
Internal pressure, MPa	0.5±0.02
<i>*The nominal pressure of the test and control media is provided at a pressure of the supplied air of not less than 0.4 MPa</i>	

## 1.4 SIMULATOR APPEARANCE



Fig. 1

## 1.5 THE SIMULATOR PACKAGE CONTENTS

Table 2

ITEM	NUMBER, PIECES
Simulator	1
Camera	1
Networking cable, 220V	1
Monitor	1
Keyboard	1
Mouse	1
Passport	1
User manual	1
Technical documentation for purchased components	1 set

## 1.6 THE SIMULATOR DESCRIPTION

The hybrid dental simulator is a device of combined reality that uses the technology of combining the real world and virtual objects created by a computer.

The principle of operation of the simulator is based on the computer tracking system analysis of changes in the spatial position of the magnetic sensors located on the tip of the turbine, a micromotor, a carpule syringe and the manikin head, in the induced magnetic field, which makes it possible to ensure objective computer control over the course of operations performed in various types of mechanical teeth preparation.

Real objects include a manikin head, teeth simulators, gums, jaws, as well as dental instruments: a micromotor, a carpule syringe and a microturbine.

Virtual objects include mathematical models that repeat the geometry of real objects in every detail. The indication is carried out by comparing the actual manipulations with the reference model.

The simulator included the magnetic positioning system, a foot control, suction/water supply system, a micromotor, a microturbine and a carpule syringe. The hybride dental training simulator has an operator instrumentation arm on the pantograph on the right side (an air water syringe, a micromotor, a mictoturbine, a carpule syringe) and an assistant instrumentation arm on the pantograph on the left side (a saliva ejector, an air water syringe) with mounts to the right and left side of the simulator body. In the middle, a



manikin lifting mechanism is attached together with a simulator of the back of a dental chair that can be controlled from the controller up/down/forward/backward.

There is a jaw, a magnetic field sensor and a magnetic field generator mounted in the manikin head. The manikin head contains a universal model of a jaw for preparation and restoration of 28 teeth. The gums are soft. On the jaw model, it is possible to replace all teeth; the teeth are removable and are fixed in specially designed holes in the jaw, fixing teeth without a screw, as a result of which it is possible to practice techniques of tooth extraction (without computer control).

On the upper part of the body of the simulator, there is a pantograph with a LED lamp and a camera on which the monitor with a touchpad is mounted. The whole process of working with the manikin is displayed in real time on the screen.

The camera allows to record the lesson, and provides an opportunity to remotely view the real-time process of the training session.

The simulator has a player that records the lesson, where you can view the entire process of the training task in a 3D mode and simultaneously in real time. It is possible to save the recorded lessons on a thumb drive or in the cloud.

After the end of the lesson, it is possible to get an independent assessment by lessons and the debriefing. After each lesson, the student can see his/her assessment results presented in the form of a flow chart and a digital parameter.

Three types of local anesthesia may be practiced:

1. incisive block;
2. nerve block;
3. intraseptal anesthesia.

Control of the use of anesthesia includes assessment of three parameters: selection of a method of anesthesia, selection of a local anesthetic, selection of the length of the needle, concentration of a vasoconstrictor agent, injection site, anesthetic administration rate. During the manipulations, the screen displays the accuracy of getting into the proper area with the needle, anesthetic administration rate; the rest of the parameters are shown in a flow chart at the end of the lesson.

There is a possibility to prepare solid dental tissues with the purpose of removal of abnormal tissues and creation of the shape of the cavity that ensures its convenient and technological filling, maintenance of hardness of the tooth, as well as its stability, reliable fixation, aesthetic characteristics and medical efficacy of the seal on the manikin in real time;

an opportunity to practice all types of tooth preparation of caries according to Black's classification.

Free teeth preparation for practicing the skills of operating the simulator is also possible.

There is an opportunity to practice manipulations in orthodontics (inlays, veneers, crowns, dental bridges).

In addition to training, the system contains a program-examiner, which stipulates a number of its undeniable advantages, namely: the possibility of continuous improvement of the level of manual skills; low probability of medical errors in future professional activities.

### **1.7 EQUIPMENT UNPACKING AND SET UP**

The simulator is supplied in a box containing the following:

1. Simulator
2. Monitor
3. Lamp
4. Keyboard and mouse
5. User manual

Examine the package and its contents for damages that might have occurred during shipment. All details should be examined. Please inform the shipping company immediately if you have found any damages. Please inform "GEOTAR Manufacturing", LLC immediately of any missing components, damages etc.

The simulator should be installed by a highly qualified "GEOTAR Manufacturing", LLC specialist.

### **1.8 DESCRIPTION OF BASIC COMPONENTS**

The hybrid dental simulator (Fig. 2) consists of:

1. Simulator body with equipment storage drawers
2. Manikin lifting mechanism
3. A manikin head with a human torso and a simulator of the back of the dental chair equipped with a set of mounts for removable jaws and a magnetic field generator.
4. LED dental lamp on the pantograph
5. Display with a touchpad
6. Video camera
7. Operator instrumentation arm on the pantograph

8. Assistant instrumentation arm on the pantograph
9. Foot control
10. Container for clean water
11. Container for used water
12. Lifting mechanism control console
13. Keyboard and mouse
14. X-ray unit

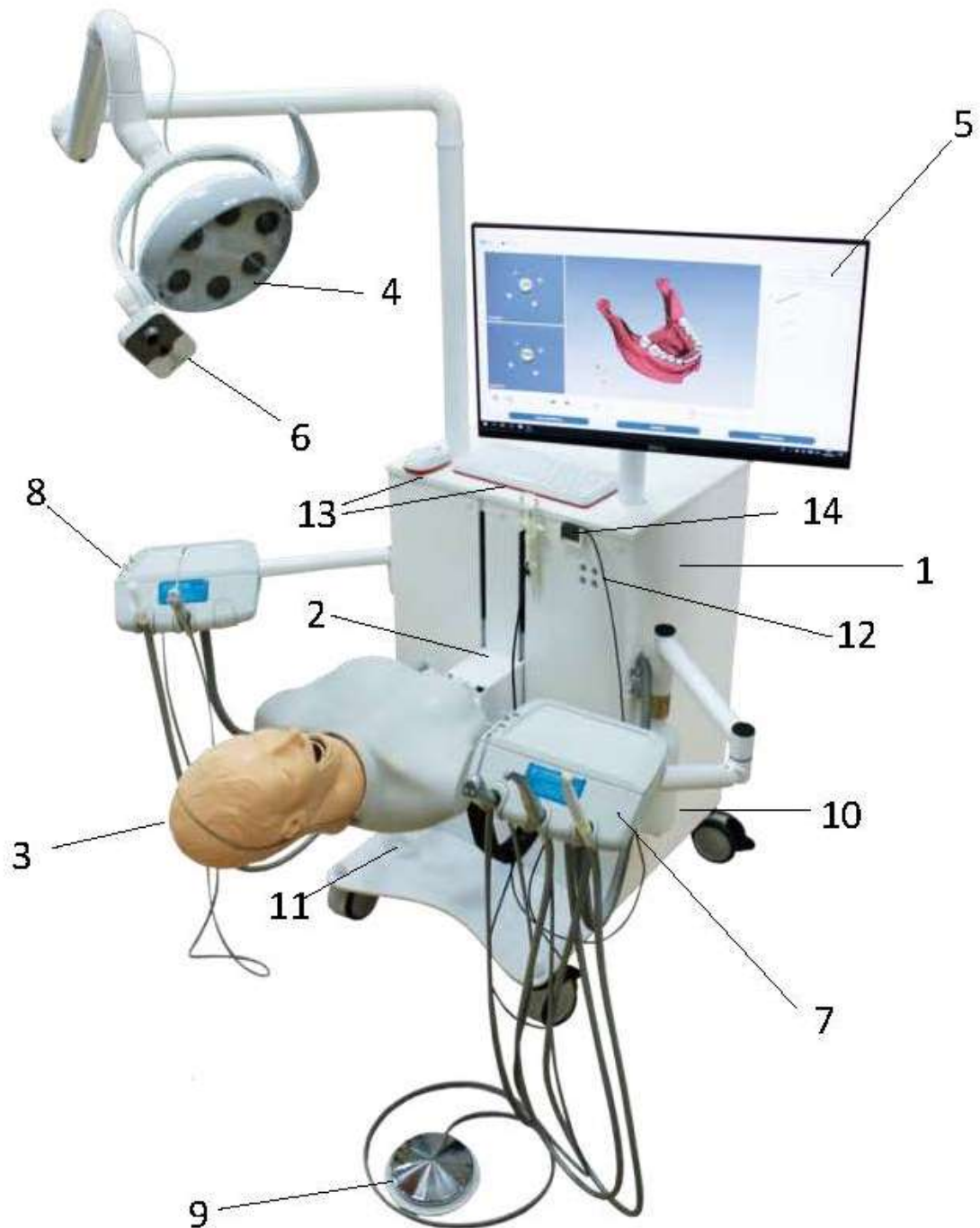


Fig. 2

## 1.9 CONTROLLERS

### Overview of the operator's instrumentation (Fig. 3):

- 1 - Carpule syringe
- 2 - Air/water syringe
- 3 - Microturbine
- 4 - Micromotor
- 5 – Switching on water supply
- 6 – Switching on air supply

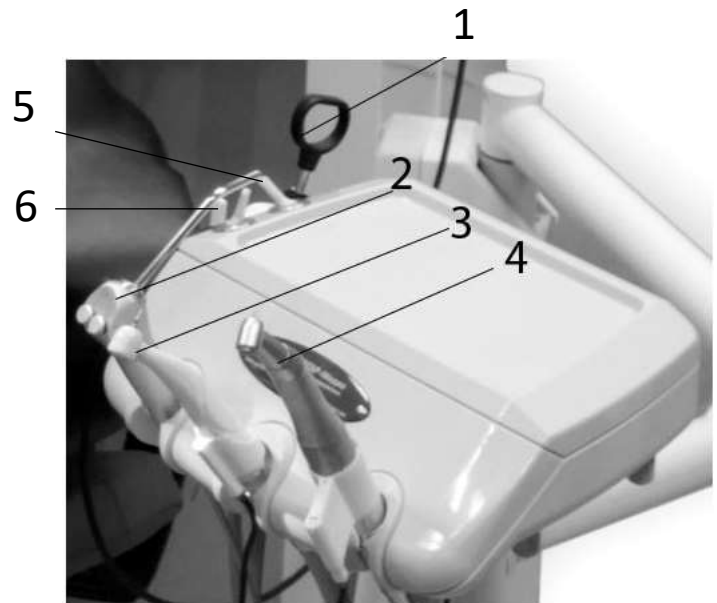


Fig. 3

### Overview of the assistant's instrumentation (Fig.4):

- 1 - Air/water syringe
- 2 - Saliva ejector and high volume evacuator
- 3 – Switching on water supply
- 4 – Switching on air supply

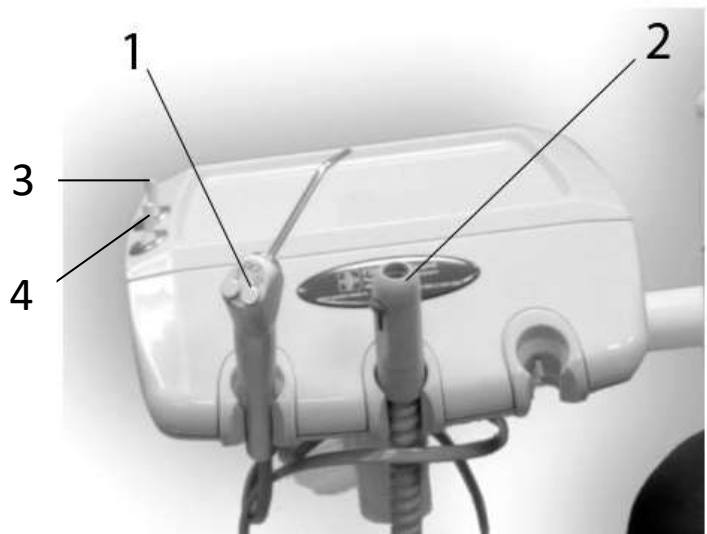
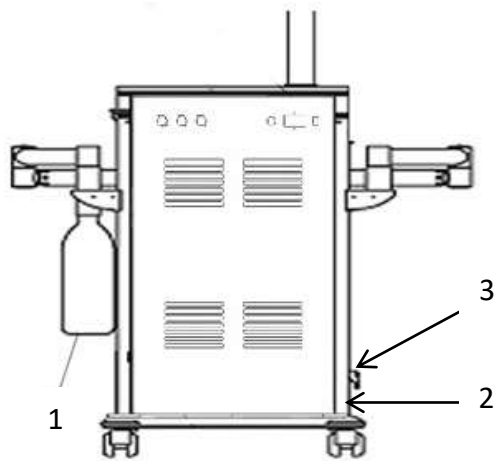


Fig. 4

## 2. PREPARATION FOR USE

### 2.1 SIMULATOR SET UP

Before setting up the hybrid dental simulator, make sure that the air and power systems have been connected to the simulator. Set up the air supply system and adjust the pressure. Fill the bottle with water and place it properly.



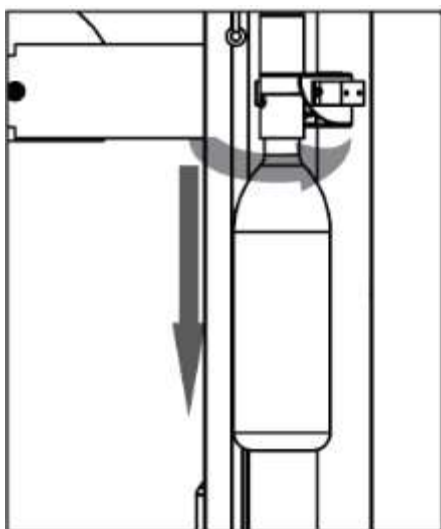
- 1 - Water bottle
- 2 - Air supply port
- 3 - Manometer

Fig. 5

#### Note

The air used for the hybrid dental simulator should be dry and should not contain any oil or be contaminated. If necessary, use a dry compressed air system.

### 2.2 FILLING THE WATER SUPPLY SYSTEM UNDER PRESSURE

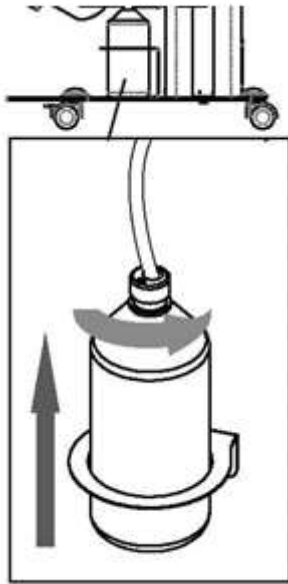


**Make sure that there is no system pressure during this operation!**

(Fig. 6)

- Unscrew the bottle, turn it clockwise. Holding the connection point of the bottle securely,
- Remove the bottle from the holder and fill it with liquid.
- Screw the bottle. Holding the connection point of the bottle securely, turn the bottle counterclockwise.
- The block must not let the air in. The air pressure is automatically reduced when the bottle is open.

Fig. 6



**Fig. 7**

### **Daily draining of liquid from the bottle**

(Fig. 7)

- Unscrew the bottle. Holding the connection point of the bottle securely, turn the bottle clockwise.
- Remove the bottle from the holder and pour out the liquid from it.
- Screw the bottle. Holding the connection point of the bottle securely, turn the bottle counterclockwise.

### **Note**

**The bottle is sensitive to heat exposure.** Do not put the bottle in a dishwasher or rinse it with hot water (over 50°C).

## **2.3 SWITCHING ON THE LAMP**

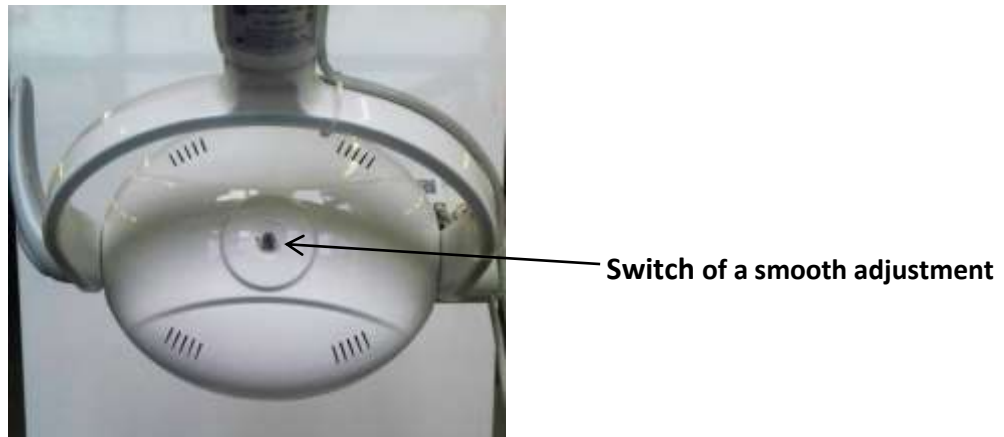
Switching on the lamp is performed by pressing the control buttons on the lamp body.

The LED has a smooth adjustment option.



**Fig. 8**

Light turns on or off when a hand is close to the sensor. The sensor's range is 20-80 mm.

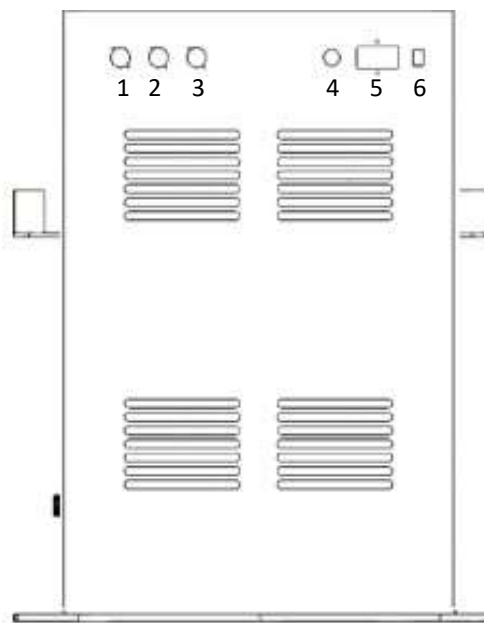


**Fig. 9**

### **3. SET UP AND OPERATION PROCEDURES**

#### **3.1 SWITCHING ON THE SIMULATOR**

Switching on the simulator is performed by pressing the buttons on the back of the device body



**Rear panel configuration**

1. HDMI port
2. USB port
3. Ethernet port
4. Switching on the computer
5. Overall switching on the simulator
6. Switching on the magnetic positional tracking system





**Fig. 10**

1. First, perform overall switching on the simulator (3), then switch on the computer (2) and after that switch on the instrument magnetic positional tracking system.
2. On the back of the simulator body, there is a HDMI port for connection of an additional display (1).

### 3.2 ADJUSTMENT OF THE MANIKIN HEAD POSITION

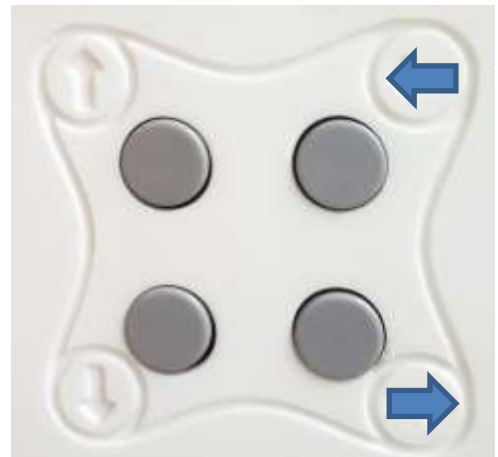
Adjustment of the manikin head position is carried out using a lifting mechanism control console.

#### **Manikin working position**

Change the manikin head position into horizontal position using a console and pressing the respective buttons  and , then lift it in a vertical position  to ensure convenient operations with the manikin.

**Place the manikin into the shipment position, perform these manipulations in reverse order.**

**Adjustment of the manikin in the horizontal position: Fig. 11**



**Adjustment of the manikin in the vertical position: Fig. 12**





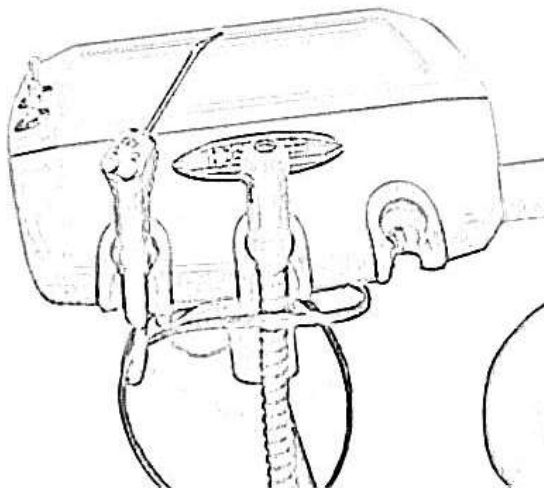
### 3.3 OPERATING THE HANDPIECE BLOCK

Select an instrument set in the handpiece block and remove the instrument from the holder (Fig. 13).

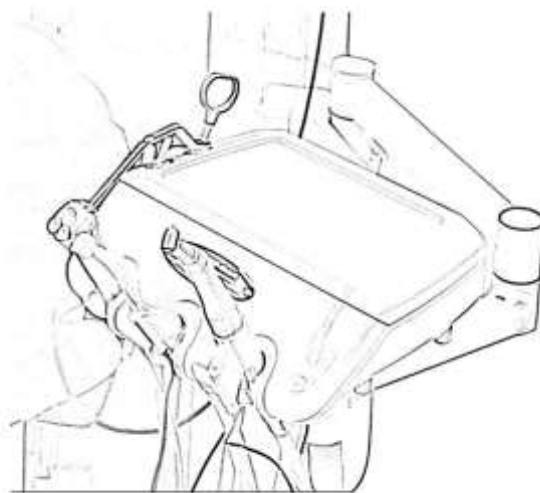
Switching on the micromotors and microturbines is performed by pressing the pneumatic foot control (Fig. 14) of the handpiece block. The change in the rotation speed of the bur of the pneumatic handpieces or the value of air supply into the pneumatic handpiece is regulated using a proportional valve located in the pneumatic pedal of the handpiece block.

The maximum pressure of the working air pressure supplied to the pneumatic handpieces is limited using the respective regulators located in the handpiece block (Fig. 13).

Having finished your work, insert the instrument into the appropriate slot.



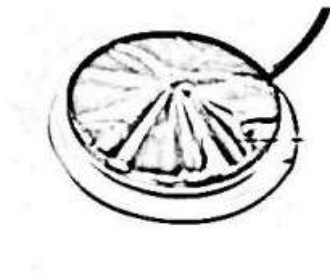
**Fig. 13**



### 3.4 USING THE FOOT CONTROL

Use of instruments

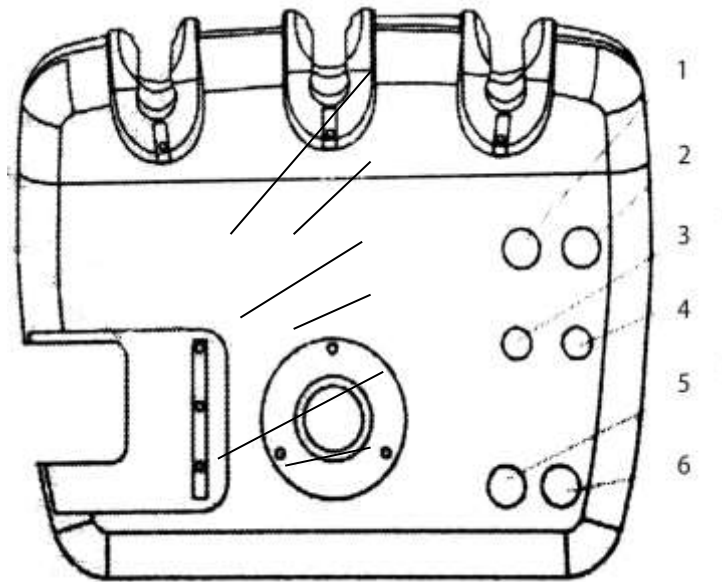
- Press and hold the foot control.  
The instruments will start working.
- Increase the force of pressing the foot control.  
The speed of operations will gradually increase.
- Decrease the force of pressing the foot control.  
The speed of operations will gradually decrease.
- Release the foot control.  
The instruments will stop working.



**Fig. 14**

### 3.5 PRESSURE ADJUSTMENT ON THE HANDPIECE BLOCK

- 1 - Channel I auxiliary air valve
- 2 - Channel I water regulator
- 3 - Channel I switch reversing the electric motor
- 4 - Channel I electric motor speed controller
- 5 - Channel II auxiliary air valve
- 6 - Channel II water regulator

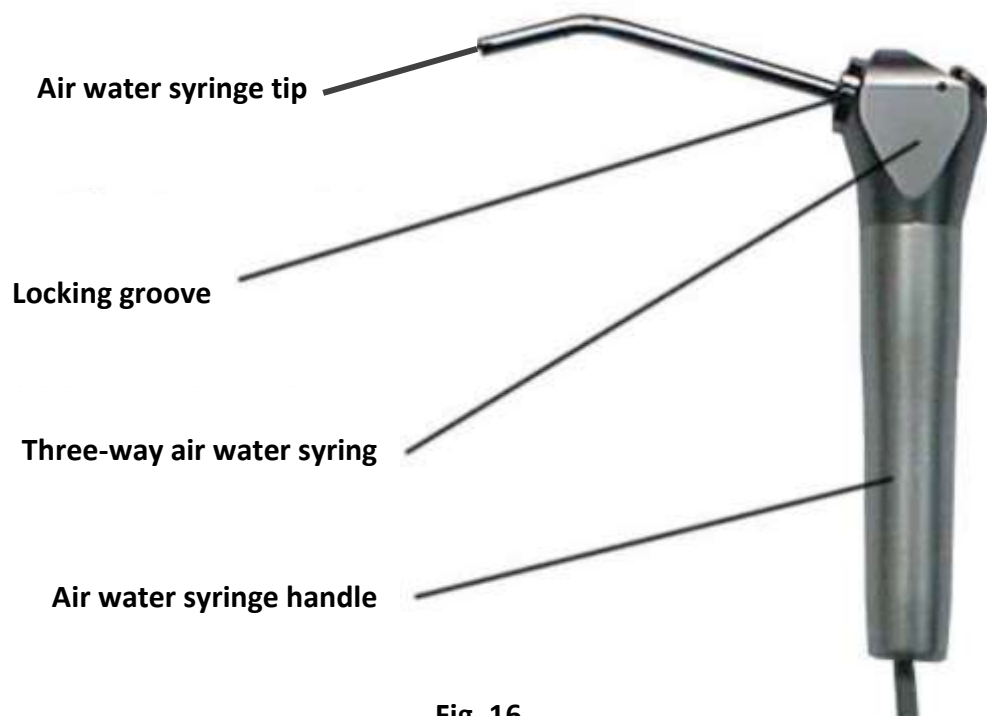


**Fig. 15**

### **3.6 SWITCHING ON A THREE-WAY AIR WATER SYRINGE**

Press the locking groove, insert the tip of the air water syringe, release the groove and the tip will be fixed.

#### **Three-way air water syringe (Fig. 16)**





**Fig. 16**

#### **ATTENTION!**

Make sure the water and air supply systems are connected properly (on the left for water and on the right for air); check the operation of the air/water syringe by pressing the functional buttons.

### 3.7 OPERATING A THREE-WAY AIR WATER SYRINGE

Switching on the water  or air  to the air water syringe is performed by pressing the control buttons on the body of the syringe; simultaneous pressing of all the buttons results in spraying (Fig. 17).

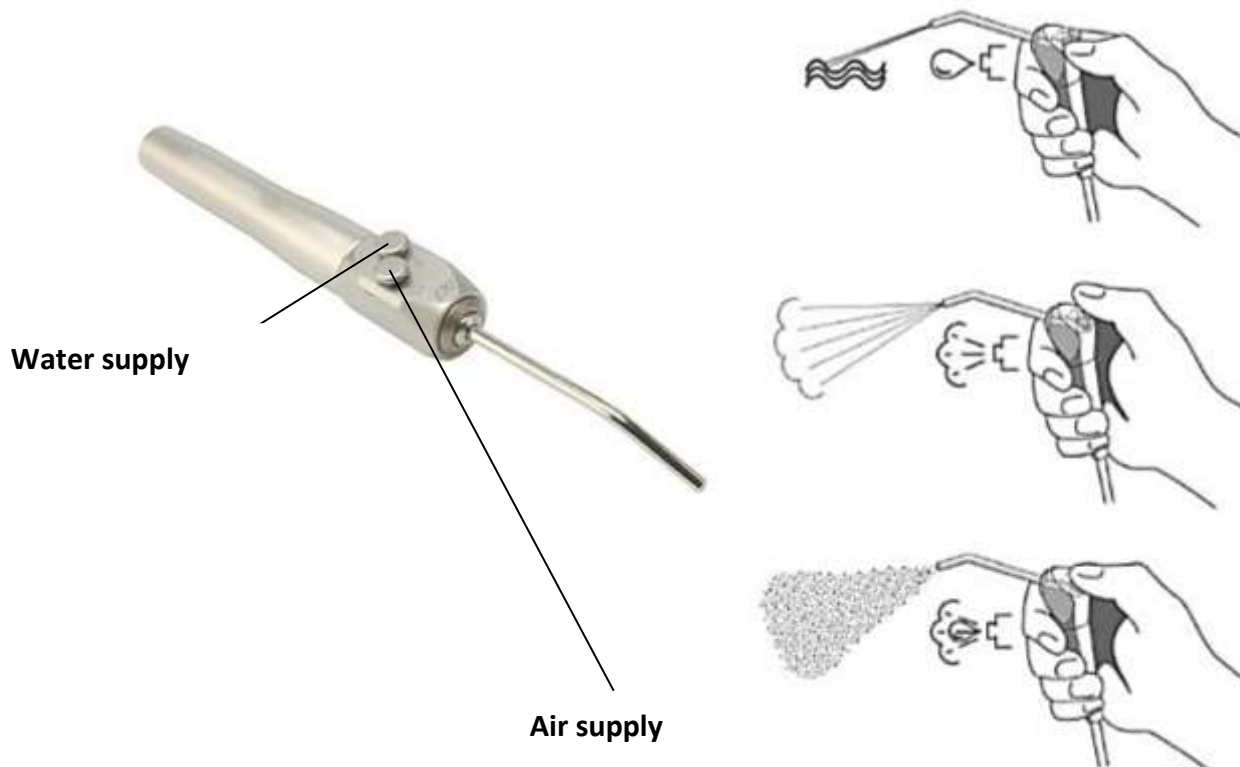


Fig. 17

### 3.8 OPERATING A HANDPIECE

**ATTENTION!** It is strictly forbidden to disassemble the handpieces or connect them under high pressure! (Fig. 18)



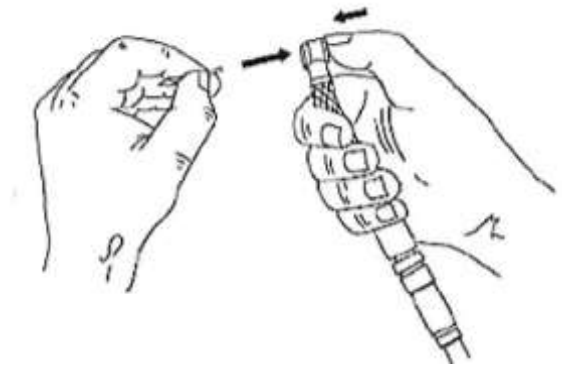
Fig. 18

## 4. MAINTENANCE

### 4.1 BUR REPLACEMENT

A handpiece with a button for bur replacement (Fig. 19):

1. Press the button on the head of the handpiece and remove the bur.
2. Press the button and insert the bur.



**Fig. 19**

### 4.2 REPLACEMENT OF A BUR ON A DISPOSABLE TURBINE HANDPIECE

The bur is replaced using a wrench for the bur removal (Fig. 20)



**Fig. 20**

Place a disposable turbine as shown and remove the bur (Fig. 21)



**Fig. 21**

#### 4.3 REPLACEMENT OF A TIP OF THE AIR WATER SYRINGE

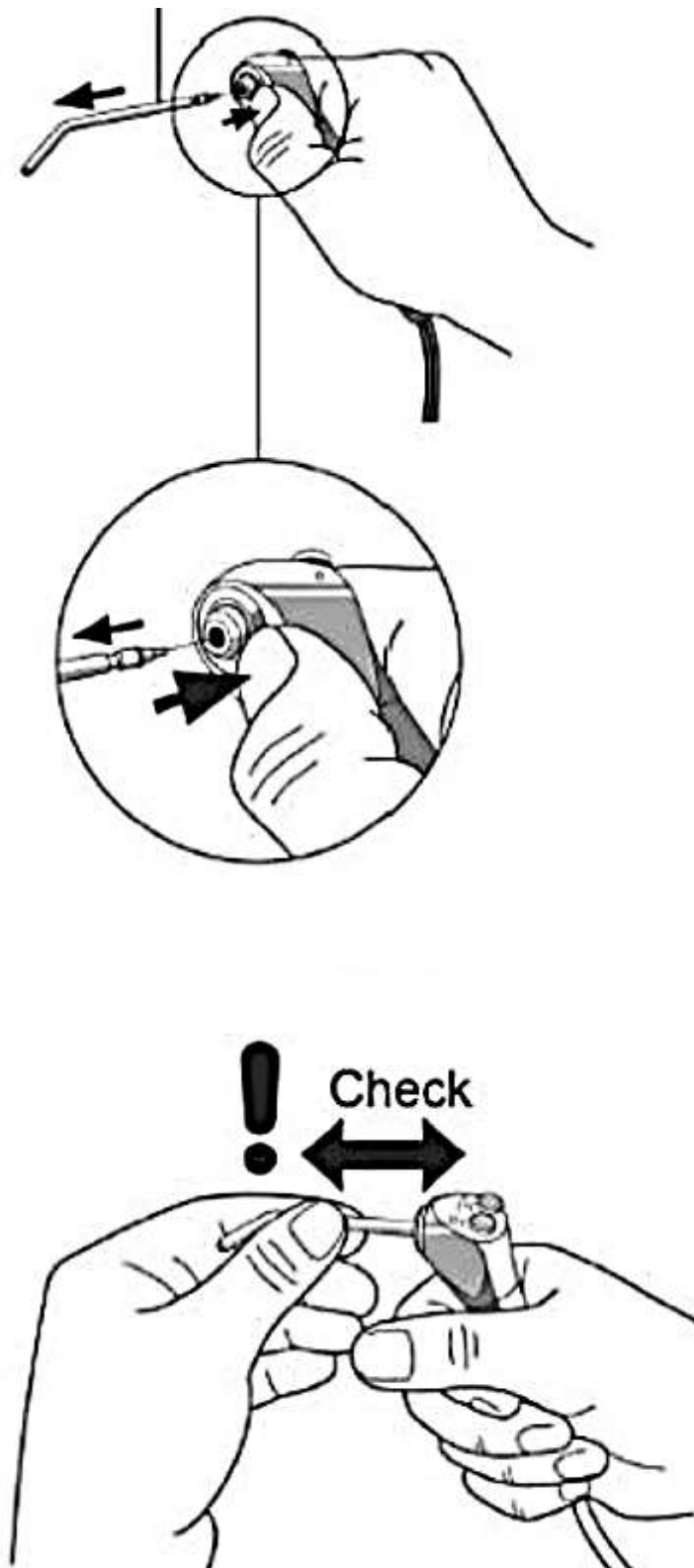
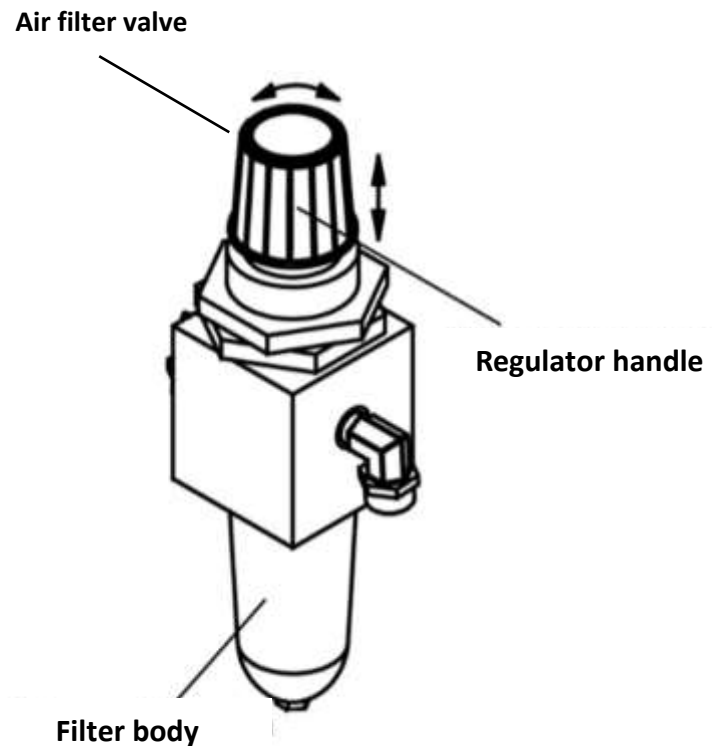


Fig. 22

#### 4.4 AIR FILTER VALVE



**Assembled air filter valve**

**Fig. 23**

As a result of filtration, moisture and contaminations that should be removed remain inside the filter; otherwise, it may affect the functioning of the device. You should generally remove and clean the filter if any of the following conditions are met:

- The filter has been used for more than a week.
- The filter body is filled with water by more than 2/3.
- The water inside the filter body has changed its color (the water is not transparent).

To remove the filter valve, unscrew it.

#### 4.5 SALIVA EJECTOR AND HIGH VOLUME EVACUATOR

In addition to maintaining external cleanliness, it is necessary to clean the internal system, the tubes of the saliva ejector and the high-volume evacuator. The internal cleaning of the suction system is carried out by rinsing with clean water (Fig. 24).



**Fig. 24**

Clean the evacuator filter regularly. To do this, unscrew the lid and remove the filter, clean it with a small brush, rinse with tap water and then put the filter back (Fig. 25).



**Fig. 25**

#### 4.6 WORK LIGHTING

Before using the surgical lighting system, please read the instructions contained in this manual.

- The dental surgical light is used to illuminate the patient's mouth; it should be used by medical personnel for this purpose only;
- the device must only be installed by authorized personnel;
- The dental surgical light should be installed in the respective holder;
- do not look at the lamp light;
- do not perform maintenance or cleaning operations on the lamp when it is switched on;



- do not place any objects in the ventilation holes of the lamp, since this may cause contact with the supply voltage;
- clean the surface of the lamp according to the instructions in this manual;
- do not close the ventilation holes of the lamp; clean and inspect these holes periodically to ensure adequate ventilation;
- do not leave the lamp unattended for a long time;
- avoid contact of the lamp body with sprays or vapors;
- never touch the led reflectors or LEDs. If necessary, clean them with warm air.

Clean the protective housing with a cloth using a non-abrasive disinfectant or a detergent. The handles of the device might be sterilized (we recommend a 121°C cycle).

#### **4.7 FUSE**

The fuse is located on the back of the simulator in the simulator power connector. Replacement of the fuse is performed as follows: disconnect the power supply, remove the power connector, then snap off the fuse cover and replace the fuse with a new one, then assemble everything in reverse order (Fig. 26).



**Fig. 26**

## 5. POSSIBLE MALFUNCTIONS AND WAYS TO ELIMINATE THEM

Table 3

NO	MALFUNCTION	POSSIBLE CAUSE	ELIMINATION
1	Insufficient power of the saliva ejector and high volume evacuator	1. The water filter is clogged	1. Clean the filter or replace it
		2. The pressure of the supplied compressed air is too low	2. Adjust the pressure to $0.5 \pm 0.02$ MPa
		3. A leak in the tube or pipes	3. Check the pipes and tubes
		4. There is malfunction of the locking mechanism	4. Replace it with a new one
2	There is no water supply from the handpiece	1. The handpiece water channel is clogged	1. Clean the channel
		2. The water supply on the controller is switched off	2. Switch on the water supply on the controller by turning the switcher to the right
		3. The regulator of the handpiece water supply is closed	3. Open and adjust the handpiece water supply
		4. The bottle for water supply is empty	4. Fill the bottle with water
3	The handpiece does not work or the handpiece power is insufficient	1. The handpiece working pressure is too low	1. Adjust the pressure on the controller
		2. The dental bur is worn out or incorrectly mounted	2. Replace the bur or mount it properly
		3. There is an air leak in the handpiece supply tube	3. Replace the handpiece tube
4	There is a leak in the air water syringe	1. The gasket is damaged	1. Replace the gasket and lubricate the connection with silicone grease

5	There is no water supply from the air water syringe	1. The water and air supply tubes are incorrectly connected	1. Connect the water and air supply tubes to the air water syringe
		2. The water pressure is too weak	2. Adjust the water supply
6	The hybrid dental simulator would not switch on	1. The power cable is not connected	1. Connect the cable
		2. The fuse does not work	2. Replace the fuse
7	The display would not switch on	1. The power cable is not connected	1. Connect the power cable
8	The keyboard and mouse would not work	1. The batteries are low	1. Replace the batteries

## **6. SHIPMENT**

Shipment of the stand should be carried out in a packed form by rail, road, air or sea (river) transport of the corresponding capacity and must comply with the rules of freight applicable for the selected mean of transport.

Before shipment, perform a visual inspection of the simulator and make sure there are no packaging damages and the labels are present.

Secure the simulator for shipment. To secure the simulator, use stretching, strapping, cable ties, wooden poles, sticks and shields that prevent from improper displacement and overturn. Loading and unloading operations should be carried out mechanically by means of lifting and transport equipment in compliance with safety standards and regulations.

### **6.1 PACKAGING**

The simulator should be packed into a bubble wrap according to GOST 16337-77 and a plywood box according to [GOST 30427-96](#).

## **7. OPERATING AND STORAGE CONDITIONS**

The simulator must be operated indoors under the following conditions:

- the average relative humidity in the wettest period is not more than 60% at plus 20°C;
- no pushes or hits;

The simulator must be stored indoors.

## **8. REQUIREMENTS FOR ENVIRONMENTAL PROTECTION WHILE USING THE DEVICE**

The products do not contain any materials or agents known to be toxic or irritating. The product does not pose any danger to the environment when used in accordance with the hybrid simulator user manual.

## **9. DISPOSAL**

After decommissioning of worn teeth, jaws, disposable turbines, they should be disposed of in accordance with GOST 12.3.030-83.

AA batteries are disposed of in accordance with GOST 12.3.031-83.

The drills are disposed of following their cleaning and disinfection according to national or local regulations.

Disposable turbines that are no longer valid to operate are not hazardous for the environment and human health and should be disposed of.

Decommissioned hybrid dental simulator should not be operated on and should be disposed of according to local regulatory requirements. The circuit boards and electric cables should be disposed of as waste products of electrical systems. Details made of aluminum, brass, iron and steel must be recycled as scrap metal. Air water gun, pipes for removal of dirty water from the air water gun should be handled as biologically contaminated materials. In the course of dismantling it is necessary to observe appropriate precautions. Any material that can't be recycled should be disposed of according to the relevant regulatory requirements.

## **10. SERVICE LIFE AND THE WARRANTY PROVIDED BY THE MANUFACTURER**

The warranty period of the simulator is 12 months from the date of putting the device into service but not more than 18 months from the date of shipping the device to the customer.

The product warranty repair is carried out by "GEOTAR Manufacturing", LLC and includes the elimination of the product defects on the premises of "GEOTAR Manufacturing", LLC or, if possible, in the customer's premises.

The manufacturer pledges to repair and replace defective details within the warranty period, provided that the consumer follows the operating and storage requirements.

The manufacturer is not responsible for damage to the simulator due to improper storage or operation. Post-warranty repair of the simulator is carried out by the manufacturer or a specialized enterprise at the expense of the customer.

The warranty does not cover replacement and wearing parts (jaws with gums and teeth, disposable turbine, drills) that require periodic replacement, equipment that has been modified without the permission of the manufacturer.

The warranty liability provided by the manufacturer terminate in the following cases:

- there are internal or external mechanical damages caused by careless operation, storage or shipping of the product, exposure to aggressive fluids, vapors and gases;
- there have been attempts of self-repair or update of the device;
- failure to follow the operating rules;
- unauthorized changes have been made (modification, reworking etc);
- contacts of fluids with the electrical part of the simulator.

## 11. SAFETY REQUIREMENTS WHEN OPERATING THE SIMULATOR

The hazard warning signs are shown in Figures below:



**Caution! High pressure!**



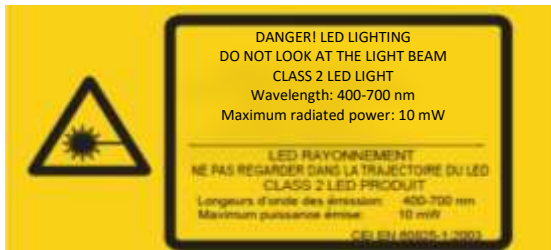
**Danger! Electric current**



**Work in safety glasses**



**Do not spray water**



### 11.1 SAFETY INSTRUCTIONS

Personal injury or equipment damage may be a result from the use of the simulator not according to its intended use.

- The simulator malfunctioning is possible if it is not used as indicated in the user manual.
- There is a serious danger if the device is malfunctioning or used improperly.
- Use only suitable instruments.
- Use the handpieces only at admissible rates.
- Follow the safety rules. Medical personnel should wear protective clothing:
  1. a dental gown;
  2. a surgical cap;
  3. a surgical mask;
  4. dental glasses;
  5. dental gloves. They are different from general medical gloves by the presence of special relief on the fingertips that prevent the instrument from slipping.

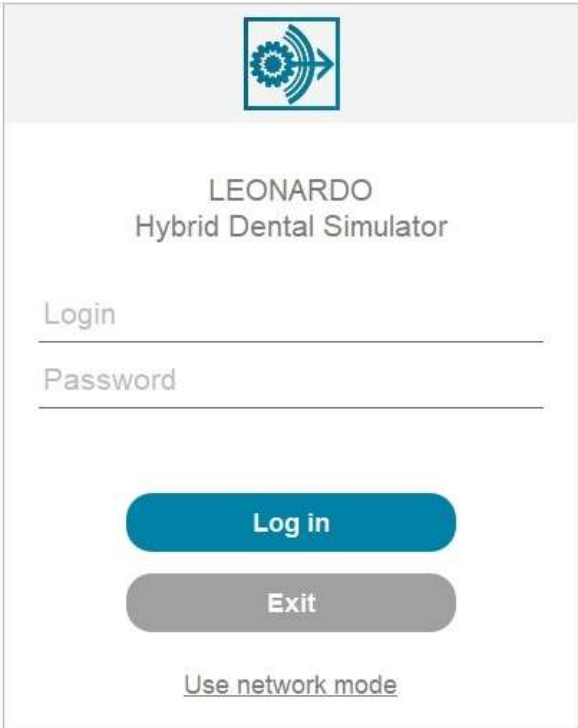
- Avoid wear, scratches or other damages.
- The water supply under pressure should always be filled with water.
- Before switching on the device, make sure that the water bottle under pressure is filled.
- The waste water bottle of the ejector should not be filled. Evacuation of water is impossible if this bottle is filled. Before switching on the device, make sure that this bottle is empty.
- There is a risk of injury by rotating instruments
- One can get injury as a result of waving hands. As a result of waving hands, the elements of the workplace of the dentist, assistant or the simulator of the dental patient can be destroyed or deformed. Move your hands carefully.

## 12. VIRTUAL PART OF THE SIMULATOR

### 12.1 HAVING A LESSON

#### LOGIN

Enter your login/password for authentication on the server. Go to a guest mode if you want to work locally. Authorization is on the Fig. 27.



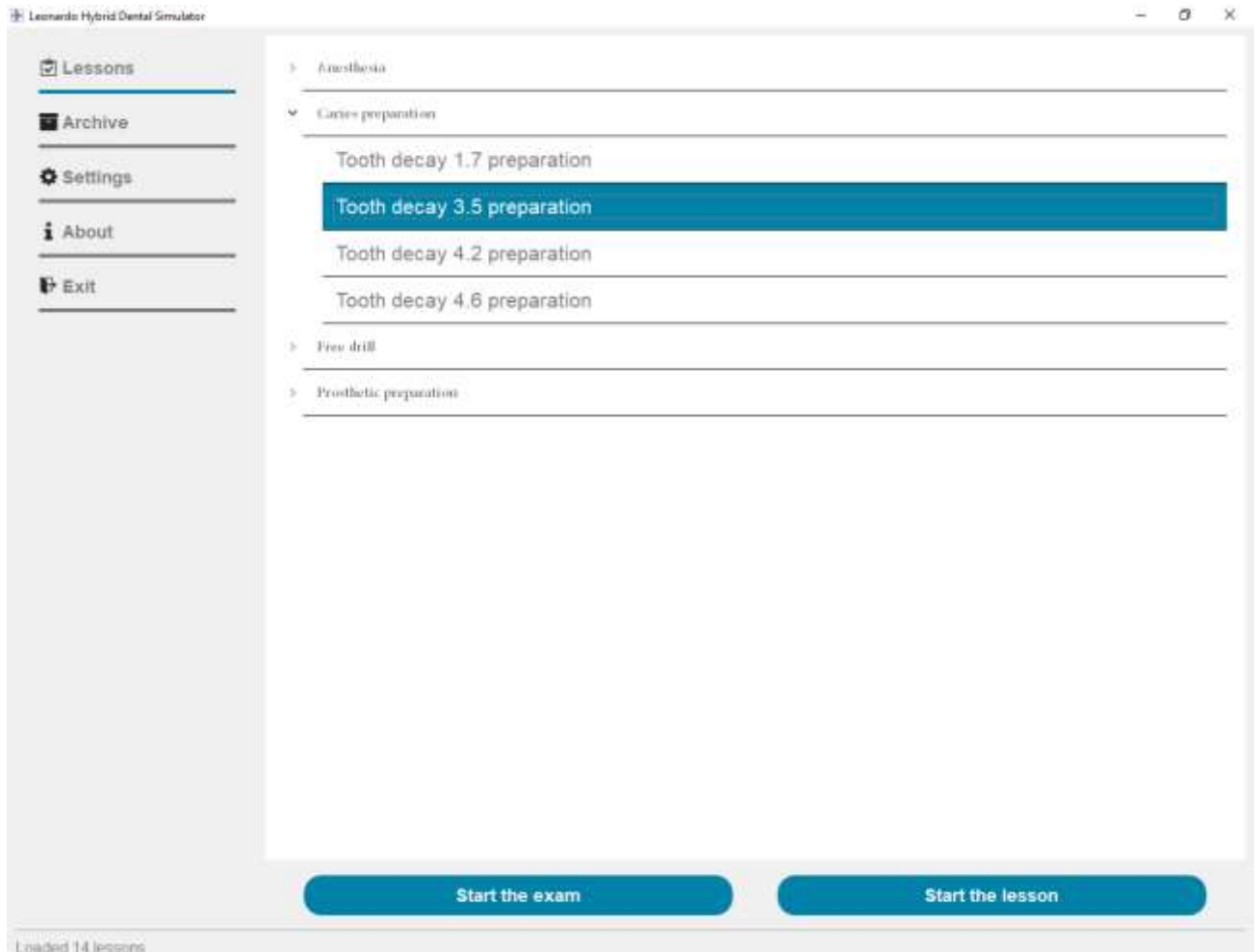
The screenshot shows the login interface for the LEONARDO Hybrid Dental Simulator. At the top, there is a logo consisting of a gear and an arrow. Below the logo, the text 'LEONARDO Hybrid Dental Simulator' is displayed. There are two input fields: 'Login' and 'Password'. Below these fields are two buttons: a blue 'Log in' button and a grey 'Exit' button. At the bottom, there is a link that says 'Use network mode'.

**Fig. 27**

## MAIN MENU

### Available tabs

- Lessons - a list of available lessons with their description
- Archive - a list of saved lessons and lessons taken earlier
- Settings - a menu of main software settings
- About the program - information about the software
- Exit - exit from the program



**Fig. 28. Main menu**

Begin taking a lesson from the list. Available lesson types:

- Dental anesthesia
- Orthodontics
- Dentin caries
- Free teeth preparation



## LESSON BRIEFING WINDOW

Read the lesson briefing (Fig. 29).

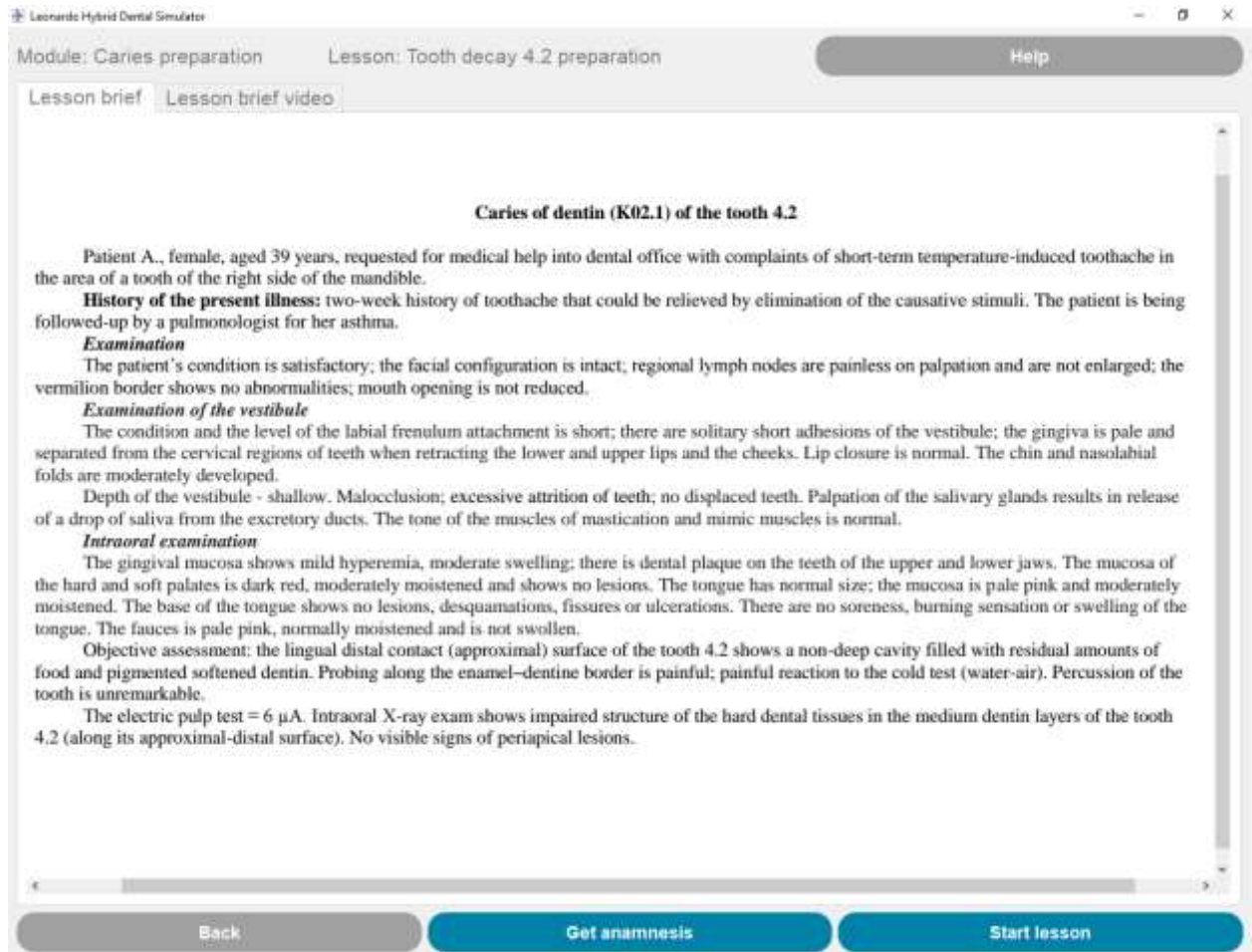


Fig. 29

LEONARDO HYBRID DENTAL SIMULATOR	
Lesson`s options	
Author: GEOTAR Title: Mandible Lesson: Dentin caries (K02.1) of the tooth 4.2	
Help	
Lesson briefing	
Video briefing	
<b>Dentin caries (K02.1) of the tooth 4.2</b> Patient A., female, aged 39 years, presented with complaints of short-term temperature-induced toothache in the area of a tooth of the right side of the mandible. <b>History of the present illness:</b> two-week history of toothache that could be relieved by elimination of the causative stimuli. The patient is being followed-up by a specialist in respiratory medicine for her asthma. <b>Examination</b> The patient's condition is satisfactory; the facial configuration is intact; regional lymph nodes are painless on palpation and are not enlarged; the vermilion border shows no abnormalities; mouth opening is not reduced. <b>Examination of the vestibule</b> The condition and the level of the labial frenulum attachment are unremarkable; there are no adhesions of the vestibule; there is no pallor or separation of the gingiva from the cervical regions of teeth when retracting the lower and upper lips and the cheeks. Lip closure is	

normal. The chin and nasolabial folds are moderately developed.

Moderate depth of the vestibule. Malocclusion. Excessive attrition of teeth, no displaced teeth. Palpation of the salivary glands results in release of a drop of saliva from the excretory ducts. Normal tone of the muscles of mastication and mimic muscles.

#### **Intraoral examination**

The gingival mucosa shows mild hyperemia, moderate swelling; there is dental plaque on the teeth of the upper and lower jaws. The mucosa of the hard and soft palates is dark red, moderately moistened and shows no lesions. The tongue has normal size; the mucosa is pale pink and moderately moistened. The base of the tongue shows no lesions, desquamations, fissures or ulcerations. There are no soreness, burning sensation or swelling of the tongue. The fauces is pale pink, normally moistened and is not swollen.

*Objective assessment:* the lingual distal contact surface of the tooth 4.2 shows a non-deep carious lesion filled with residual amounts of food and pigmented softened dentin. Probing along the enamel–dentine border is painful; there is a painful reaction to the cold test (water-air). Percussion of the tooth is unremarkable.

The electric pulp test = 6  $\mu$ A. Intraoral X-ray exam shows impaired structure of the hard dental tissues in the medium dentin layers of the tooth 4.2 (along its approximal-distal surface). No visible signs of periapical lesions.

Back

Patient's history

Begin the lesson

### **WINDOW FOR TAKING A PATIENT'S HISTORY AND SELECTION OF ANESTHESIA**

Go to taking a history by pressing “**Patient's history**” (Fig. 30).

The screenshot displays the 'Leonardo Hybrid Dental Simulator' window. It features a 'Questions' section on the left with a list of medical history questions, and an 'Answer' section on the right. The questions are:

- Have you had any ulcerations in your mouth?
- Traumatic orofacial injuries
- Asthma
- Are you taking any medicines on a regular basis (tricyclic antidepressants such as amitriptylin, melipramine etc., nonselective beta-blockers such as propranolol, pindolol etc., thyroid replacement hormones)?
- For women: are you pregnant/are you a nursing mother?

The 'Answer' section shows the response 'No' for the first question. Below the questions, there are two buttons: 'Add question to the medical card' and 'Ask more questions'. The 'Medical card' section on the left shows a patient's profile with a cartoon illustration of a woman. The 'Added to the medical card questions number: 4' is displayed. The 'Medical card' section also shows the questions and answers for the first three questions.

At the bottom of the window, there are three buttons: 'Back', 'Local anesthesia', and 'Start lesson'.

**Fig. 30**

Ask the patient the questions from the list that you consider necessary. In the right window, you can see the patient's answer. Add the information to the medical record. If you want to ask additional questions, click "Ask more questions".

Go to selection of anesthesia parameters by clicking "**Local anesthesia**"(Fig. 31). You can change your selection before the injection. Having selected the required parameters, click "**Continue**".

Please select the right anesthesia parameters:

Anesthesia type	Anesthetic type	Vasoconstrictor concentration	Dental needle length
Not selected	Not selected	Not selected	Not selected
Infiltration	2% Lidocaine	1:100000	Medium
Intraseptal	3% Mepivacaine	1:200000	Long
Nerve block	4% Articaine	None	Short

Back Continue

Fig. 31

## BEGINNING OF A LESSON

Start taking a lesson by clicking "**Begin the lesson**".

## ANESTHESIA

Take a **Syringe** and select (if you have not done it earlier) the anesthesia parameters on the screen (Fig. 32). *By default, the program is set to auto-selection (can be turned off in the settings) of the instrument when you bring it to the patient's head.* Carry out anesthesia of the tooth. The injection site is shown in a darker color on the screen. During the injection, the syringe is highlighted in **red** ("missed"), **yellow** ("good") or **green** ("excellent"). With the help of the syringe sensors, the program tracks the accuracy of injection, the amount and time of the anesthetic administration and the number of punctures.

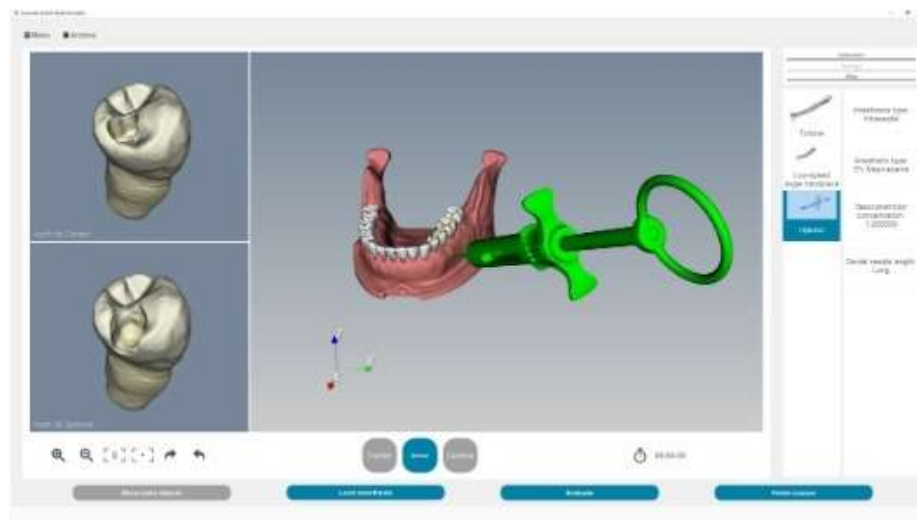


Fig. 32. Lesson screen. Injection

## BUTTONS:

Menu  
Archive  
Calibrate  
Settings  
Turbine  
Angular micromotor  
Syringe  
Anesthesia type: incisive block  
Anesthetic type: 3% mepivacaine  
Vasoconstrictor concentration:  
Injection needle length: short  
Tracker  
Sensor  
Camera  
Show additional objects  
Local anesthesia  
Finish the lesson

## CARIES REMOVAL

Select an appropriate instrument (a **turbine** or a **micromotor** with an angular handpiece) and set up a proper dental bur (Fig. 33). In the program, the bur is selected manually on the monitor screen.

Remove the carious tissues and click “**Finish the lesson**”.



Fig. 33. Lesson screen. Carious tissue removal

## RESULTS WINDOW

You can see your grades (0 to 12 points) and correctness of anesthesia selection, watch the video of the lesson (from the video camera and in a 3D mode, Fig. 35) and see the patient's medical record (Fig. 36) after the end of the lesson in the window (Fig. 34).



Fig. 34. End of the lesson Grades

### Statistical parameters and assessment:

- Carious tissue removal - % of the removed carious tissue of the total volume of carious tissue
- Healthy tissue removal - % of the removed healthy tissue of the tooth **0 points** = the entire tooth was removed. **12 points** = the minimum amount of healthy tissue was removed
- Pulp damage - % of affected pulp area. **0 points** - the entire pulp was affected. **12 points** - no pulp was affected
- Effective work time - % of useful bur work. **0 points** - the bur was always outside the tooth being operated. **12 points** - the bur worked only in the tooth being operated
- Injection accuracy - % of getting into the proper area during injection. **0 points** - 0% of getting into the area. **12 points** - 100% getting in the proper area. Not the number of hits, but the distance from the proper area is taken into account

- Damage to soft tissues **0 points** - there was a soft tissue damage **12 points** - the soft tissues were not affected by the working bur
- Damage to adjacent teeth **0 points** - there was a damage to adjacent teeth. **12 points** - the adjacent teeth were not affected by the working bur.

Local anesthesia result - shows correctness of selection of anesthesia parameters for this lesson.

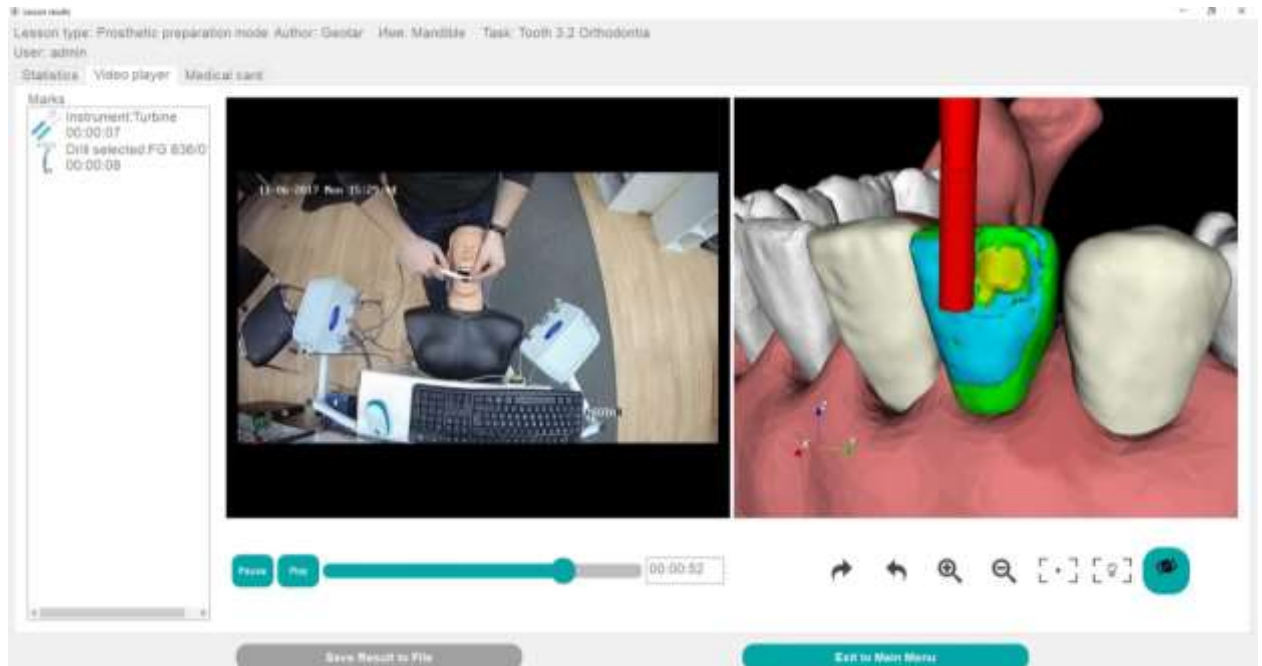


Fig. 35. End of the lesson Player

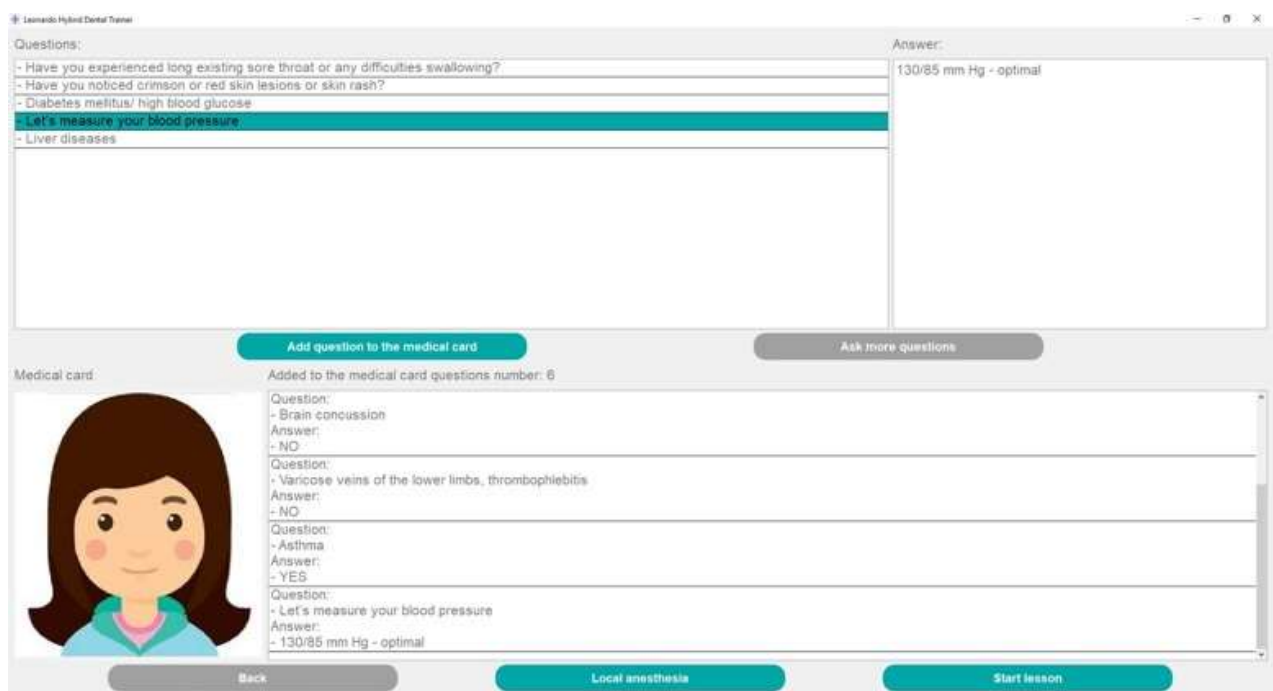


Fig. 36. End of the lesson Patient's medical record



After clicking the button “Go to main menu”, you will be asked to save the progress and the results of the lesson. Saved lessons will be available in the “**Archive**” of Main Menu.

## 12.2 OTHER LESSON TYPES

### DENTAL ANESTHESIA

The lesson is about anesthesia use only. Among the instruments, only a syringe is available (Fig. 37). Anesthesia is applied just as during other lessons. Assessment criteria were described in the previous lesson.

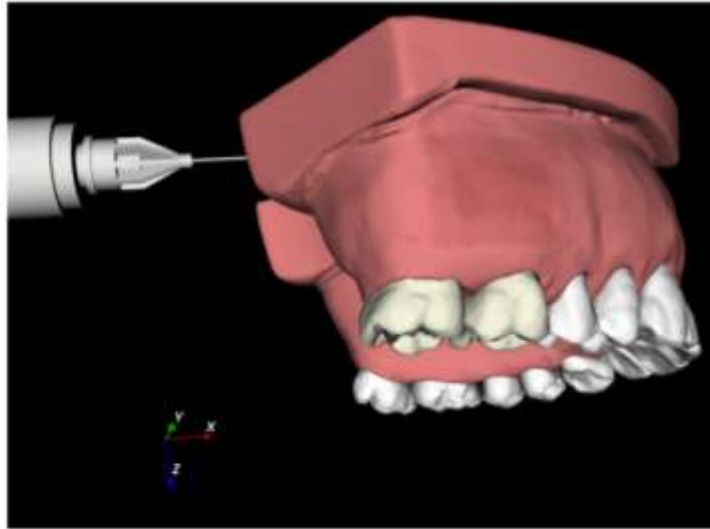



Fig. 37. Dental anesthesia

### ORTHODONTICS

In these lessons, there is a mode of color segmentation of the tooth being operated (Fig. 35 and 38). It can be turned on/off (switches to a single color mode) by clicking on the tooth image  in the bottom panel. The area to be removed is shown in **blue** on the tooth being operated. The ideal model of a prepared tooth is shown in **green**. The damaged healthy tissues inside the ideal model are shown in **yellow**.

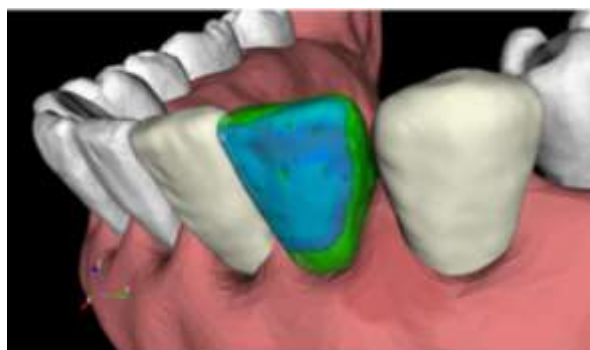


Fig. 38. Orthodontics color segmentation



**Fig. 39. Orthodontics Assessment Window**

Assessment criteria are described above in the lesson “Dentin caries”, except the following:

- Healthy tissue removal - % of the removed healthy tissue of the tooth (except for the area to be removed). **0 points** = the entire tooth was removed. **12 points** = the minimum amount of healthy tissue was removed
- Percentage of removed area to be prepared: % of the volume of removed tissue out of the proper area (shown in blue in the tooth color segmentation mode). **0 points** - the proper area has not been removed at all; **12 points** - the proper area has been completely removed.

### FREE TEETH PREPARATION

In this mode, any tooth of the mandible may be prepared by putting the bur close to it for 5 seconds. No statistics parameters are recorded.



## 12.3 PROGRAM INTERFACE

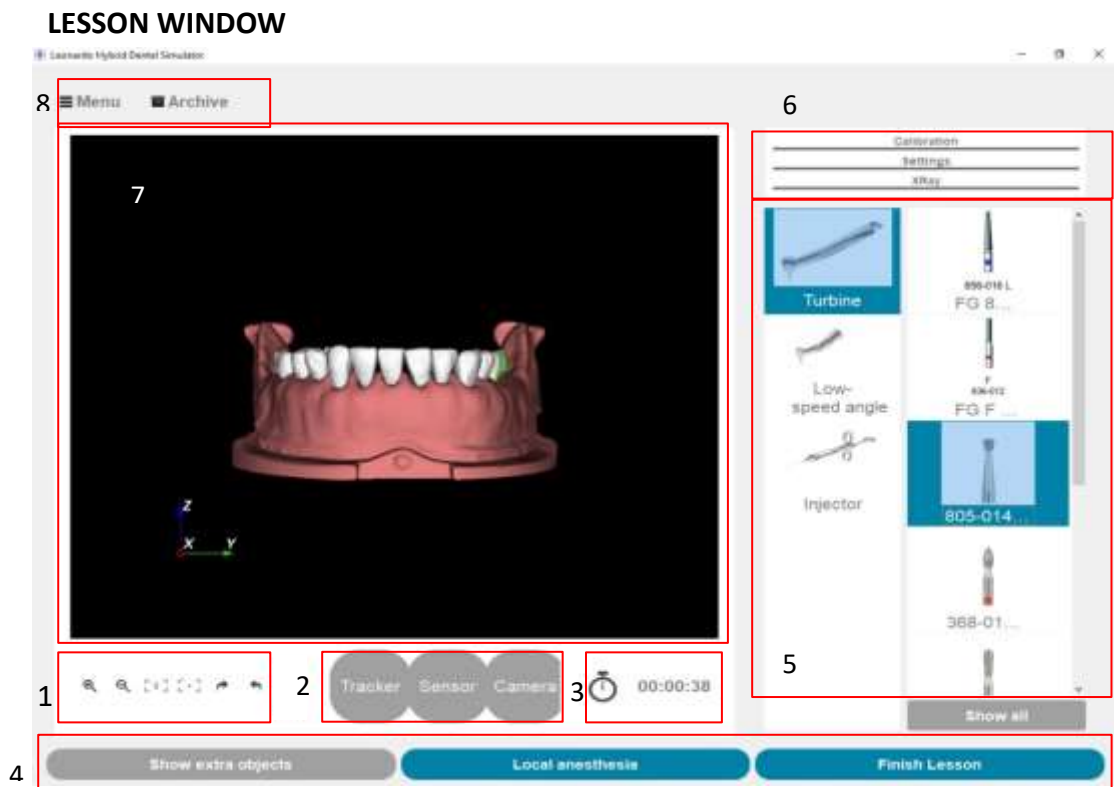


Fig. 40. Lesson window interface

Leonardo Hybrid Dental Trainer	
1	Camera handling
2	Camera
	Sensor
	Tracker
3	Time indicators
4	Finish the lesson
5	Angular micromotor
	Local anesthesia
	Syringe
	Turbine
6	Calibrate
	Settings
	X-Ray
7	3D model
8	Archive
	Menu

Camera view in the working window with 3D objects (Fig. 35) can be changed using the buttons on the bottom panel, the mouse (left mouse button+offset, wheel+offset) or the touchpad of the display.

#### CAMERA HANDLING (Fig. 41):



Fig. 41

- Zoom in/zoom out
- Show the tooth being operated
- Put the camera in the central position - front view of a jaw
- Rotate the camera clockwise and counterclockwise (similar to pressing CTRL + left mouse button)

#### CONNECTION INDICATORS (Fig. 42):

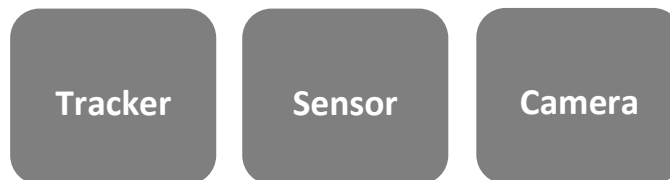


Fig. 42

- Tracker - demonstrates whether the tracker is connected
- Sensor - demonstrates whether the foot control sensor is connected
- Camera - demonstrates whether the video camera is connected

Clicking on the corresponding indicator causes an attempt to reconnect the device.

#### TIME INDICATORS (Fig. 43):



Fig. 43

- Lesson duration - time from the beginning of the lesson
- Effective time - time of the bur work in the area of the tooth being operated

#### BUTTONS (Fig. 44):

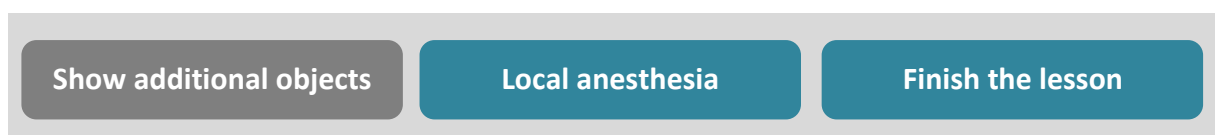
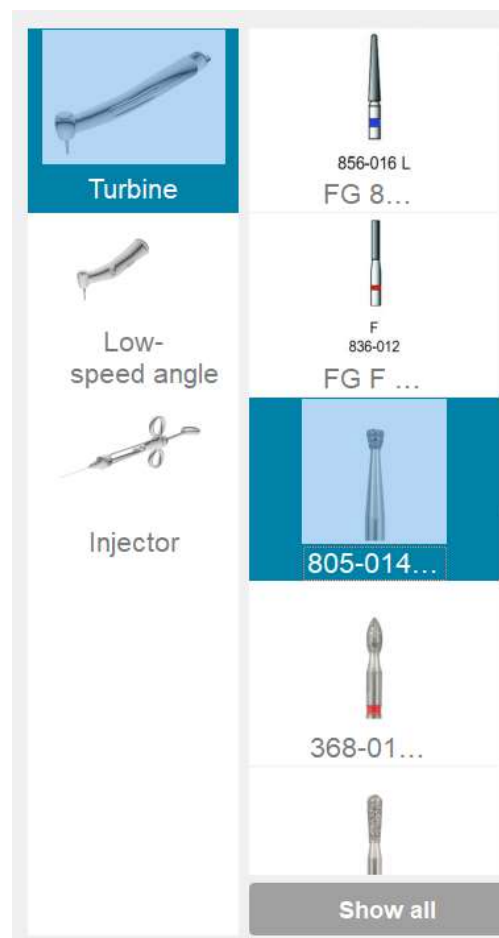


Fig. 44

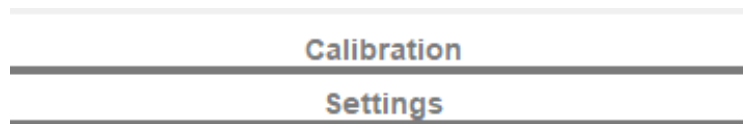
- The button "Show additional objects" enables/disables the display of the second jaw and a translucent head
- Local anesthesia - opens the window of anesthesia parameter selection (Fig. 31). Available before the first injection is made
- Finish the lesson - end of the lesson You will be offered to save the lesson record

**INSTRUMENT SELECTION PANEL (Fig. 45)** In the left column there are available instruments, in the right one - available burs. For the syringe, the selected injection parameters are displayed in the right column. **Important! The instrument selection can be performed automatically when the function is enabled in the settings, but the selection of the bur is ALWAYS done manually.**



**Fig. 45**

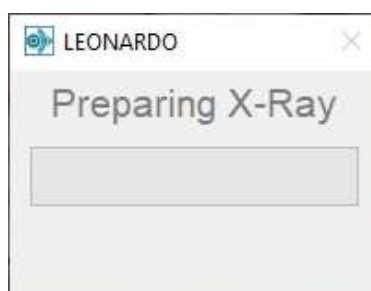
**THE "CALIBRATION" AND "SETTINGS" BUTTONS** (Fig. 46) open the calibration and program settings Windows over the lesson window. They are described below.



**Fig. 46**

## **X-RAY**

The X-ray button includes the X-ray tool, which allows you to take a picture of the teeth of the working jaw. After the button is pressed, a status window opens, which informs the user about the preparation status, taking into account the deformations of the working tooth.



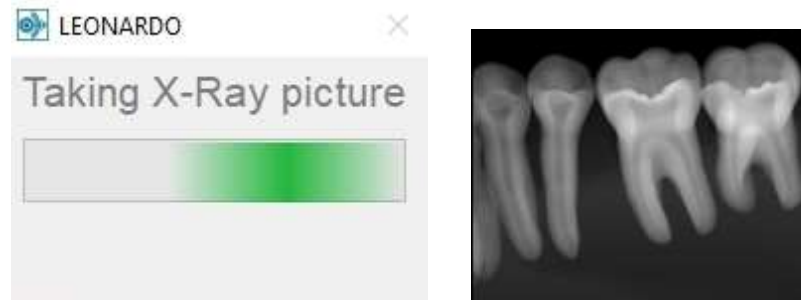
**Fig. 47. X-ray preparation indicator**

After preparing the X-ray the area for saving X-ray images will become available on the right side of the screen.



**Fig. 48. X-ray window**

Place the X-ray unit plate in the mouth of the mannequin and click the “Take Image” button.



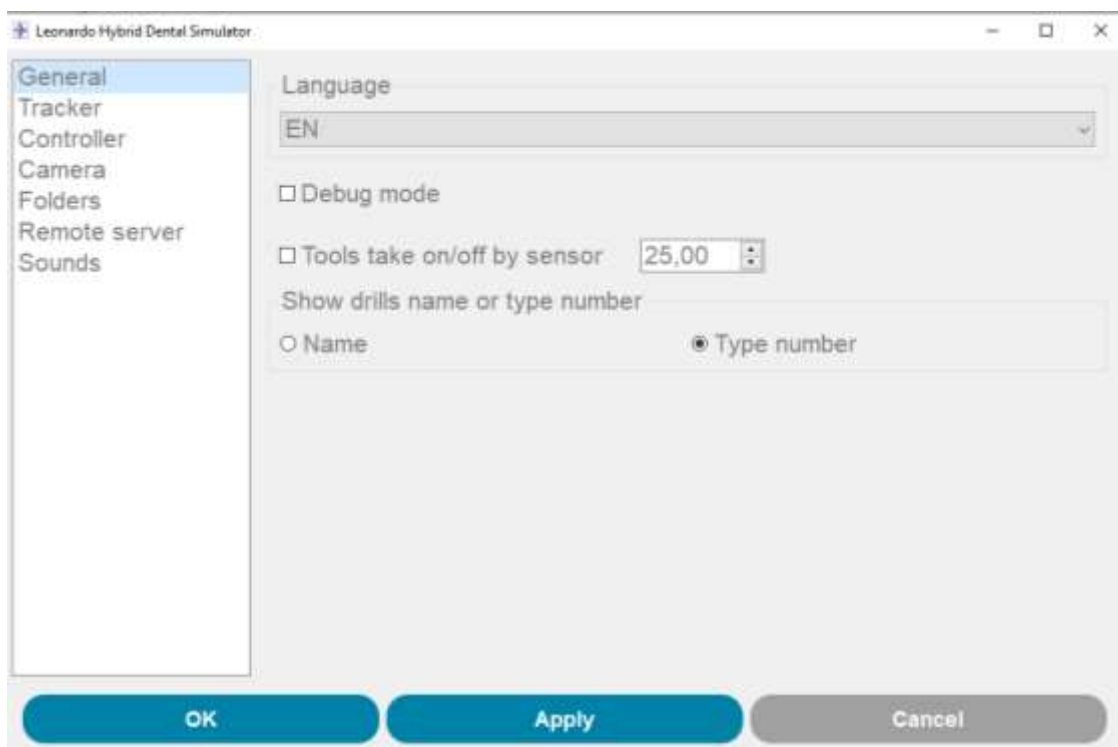
**Fig. 49. Created X-ray Pictures**

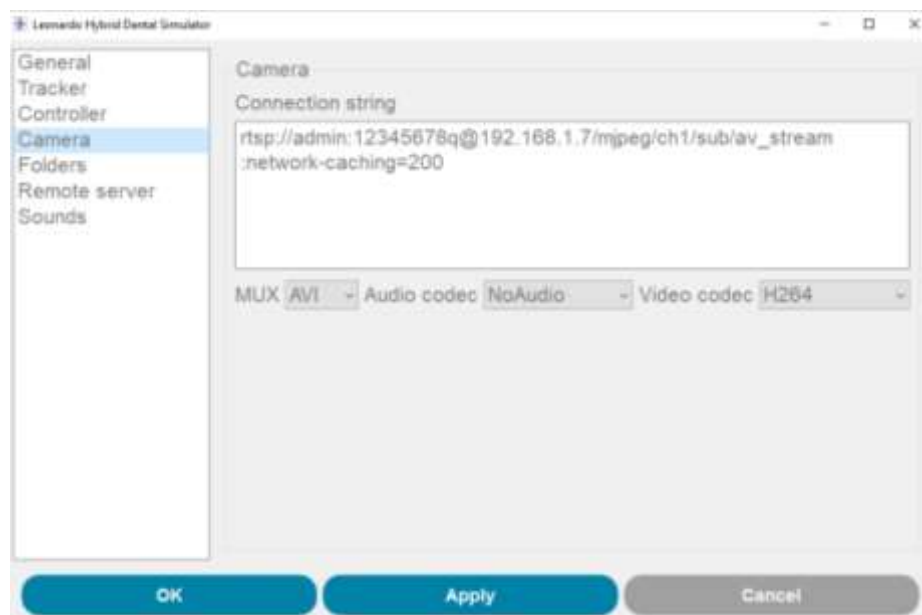
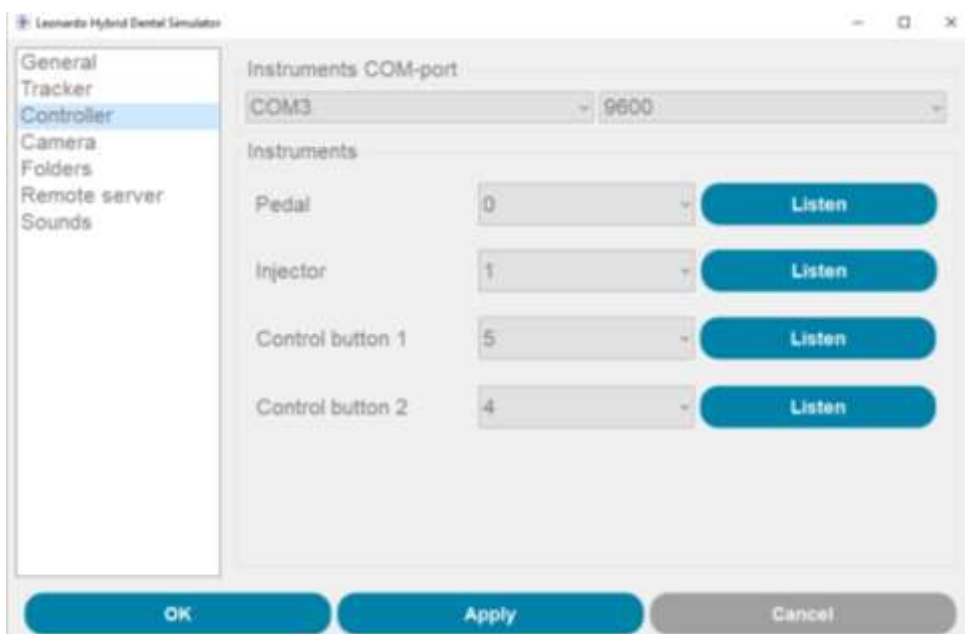
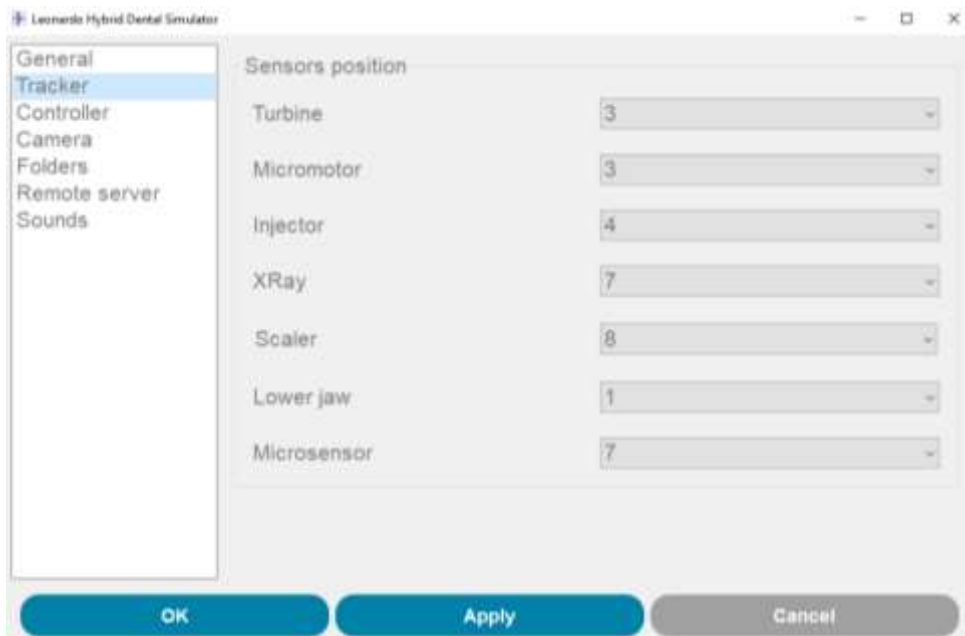
You can take several pictures placing the plate of the X-ray apparatus in different positions in the mouth of the mannequin. Pictures will be available for viewing in the lesson window.

The “Turn off X-ray” button turns off the X-ray mode and returns the toolbar to select other tools.

### **SETTINGS PANEL**

You can call the settings panel (Fig. 50) both from the main menu and during the lesson.





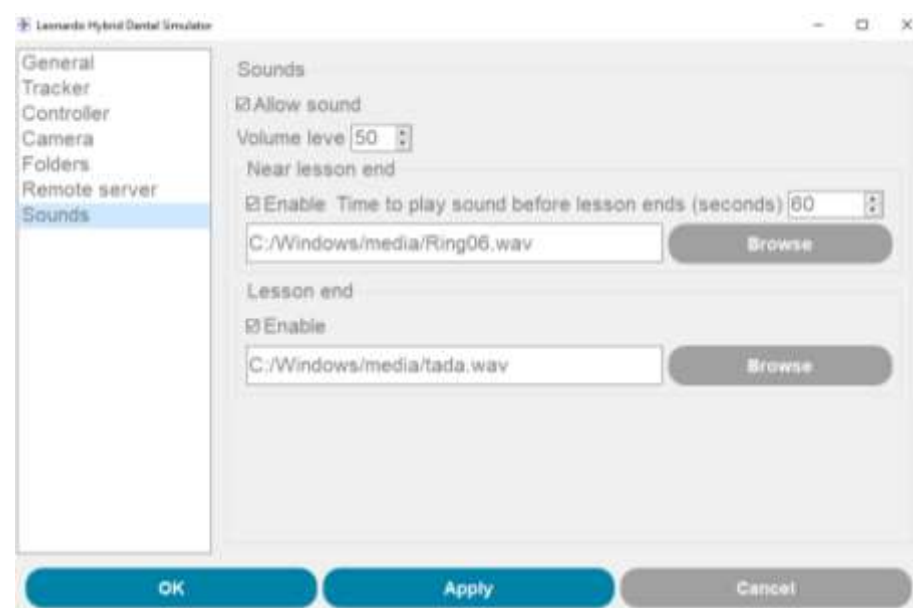
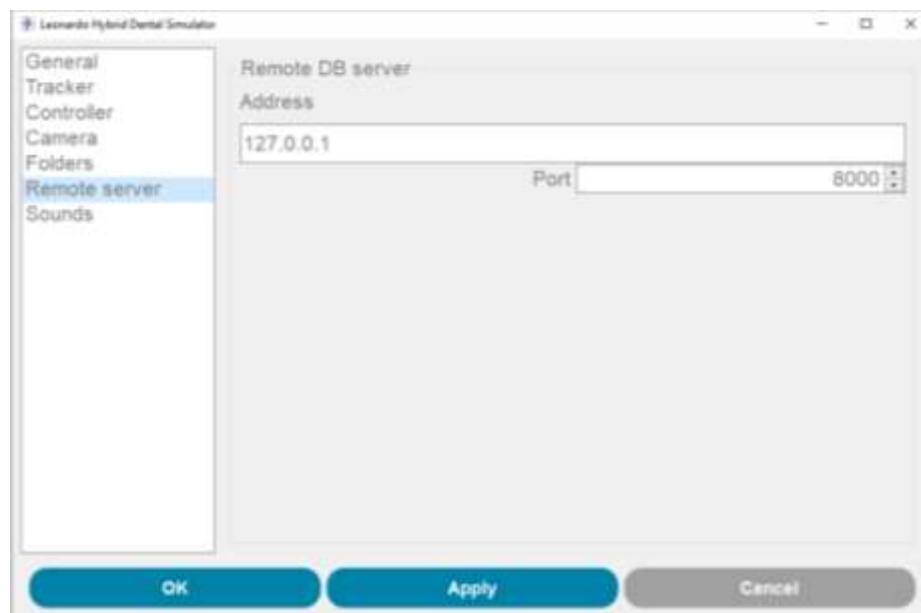
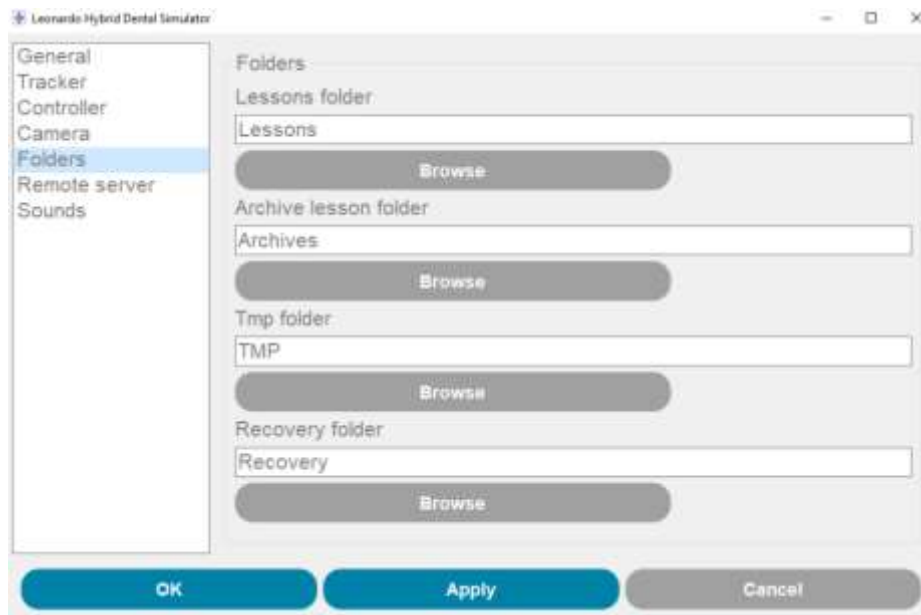


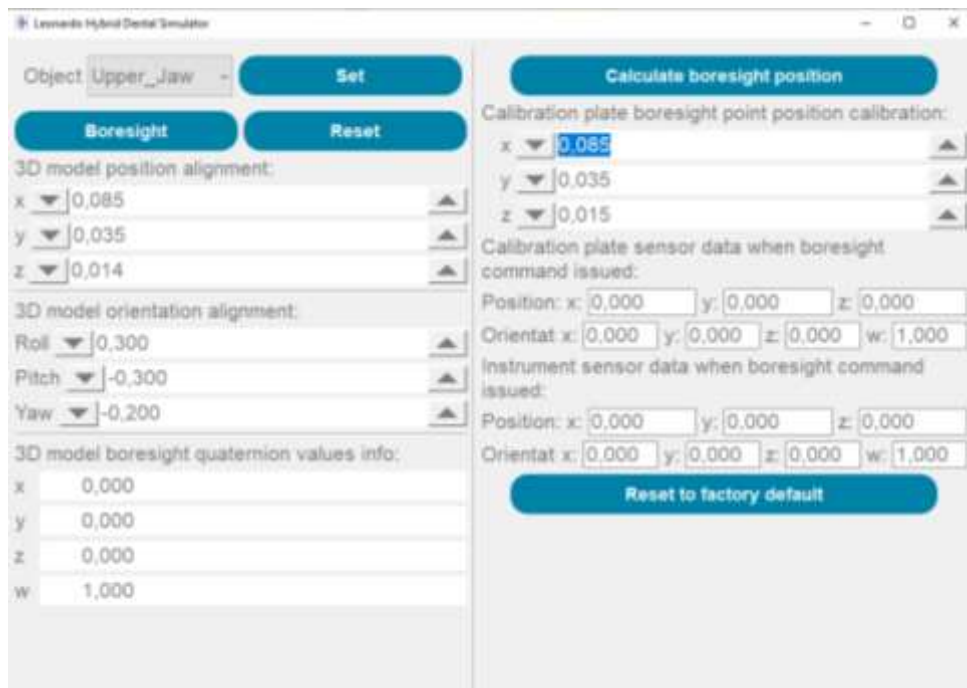
Fig. 50

- Language - select of the lesson language and the program interface
- Instrument COM port - selection of the number and rate of the COM port (9600 on default) for connection of instrument sensors
- Instruments - selection of the number of the sensors of the foot control and the syringe plunger (for injection control)
- Server address - selection of the IP address and the port of a remote or a local server used for authorization
- Adjustment mode - switching on/off the adjustment mode for displaying the additional information and troubleshooting
- Remove the instrument with a sensor - switching on/off of automatic instrument selection when putting it near the manikin head to a distance of less than the specified one (25 cm). **Important! For correct operation of this function it is not necessary to bring several instruments at the same time or to carry out the instruments further than the holder.**
- Turbine, Micromotor, Syringe, Calibration plate, Lower jaw, Upper jaw - installation of sequence numbers of the instrument positioning sensors
- Lesson folder – place of lesson storage
- Lesson archive folder - place of lesson archive storage
- Temporary folder - temporary folder for storage of information about the lesson.
- Recovery folder – place to store information for program recovery after an abnormal program termination. **Important! You have to have access rights to all folders in the program.**
- Camera - line to establish a connection with the IP camera. *Format on page* `rtsp://admin:12345678q@192.168.1.7/mjpeg/ch1/sub/av_stream:network-caching=200`, with login: **admin**, password **12345678q**, IP camera address **192.168.1.7**
- MUX, Audio codec, Video codec– Camera recording settings. On default: AVI, no sound, H.264. IP camera settings are described in the “**Camera Settings**”.

## CALIBRATION WINDOW

The calibration window (Fig. 51) is called during the lesson by clicking on the “Calibrate” button in the right upper corner. **Important! For each lesson, the calibration is performed and stored separately.**





**Fig. 51. Calibration window**

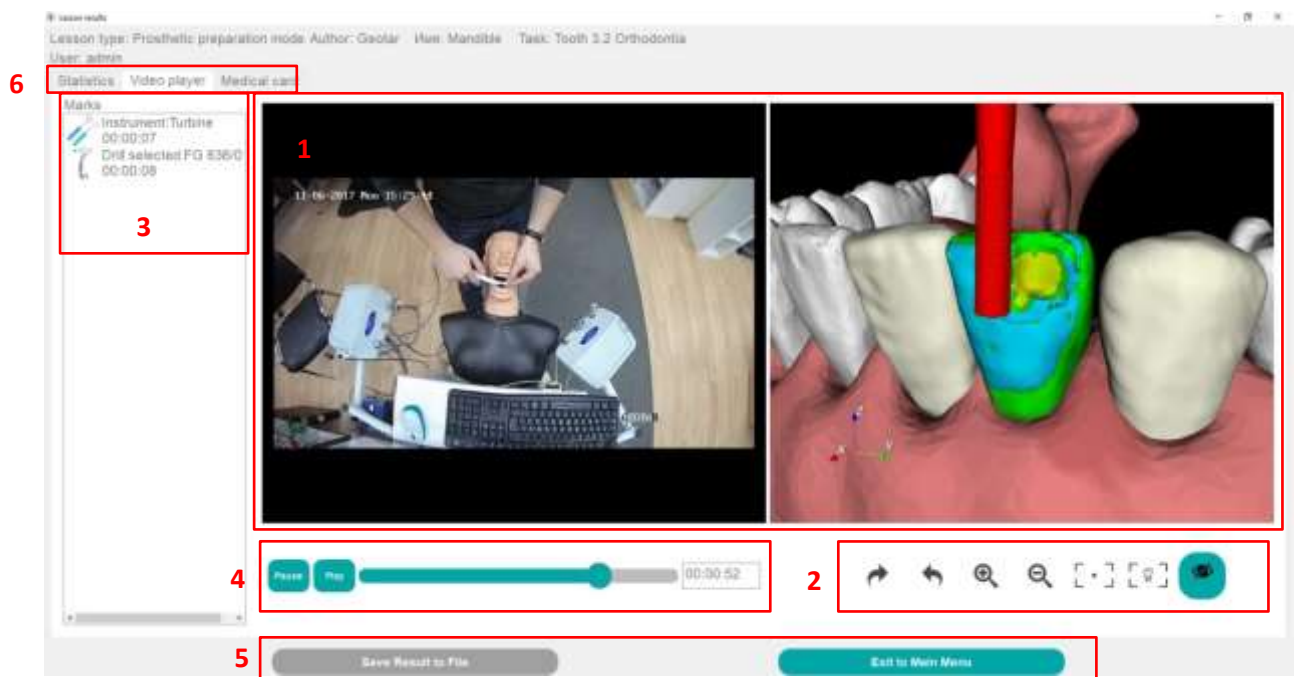
- Supporting jaw - fixed jaw (upper/lower), relative to which other objects move. The supporting jaw is the jaw with the tooth being operated. Set - confirm your choice
- Object - calibrated object (jaws and instruments). Set - save the calibration of the object for the current lesson
- Set a target - move the instrument to the specified point on the calibration plate. After targeting, you can calibrate the object within the current session of the lesson. After restarting, you must repeat the targeting
- 3D model position shift - position shift of the target by XYZ (measured in cm) after calibration application
- 3D model turn - object rotation by bias, slope and deflection (measured in degrees)
- Targeting point position calibration on the calibration plate - position shift of the target by XYZ relative to zero of the sensor plate. Carried out by clicking the button "Calculate the position of the targeting point".

**Calibration process:**

1. Secure the instrument in its slot on the calibration plate
2. Fix the plate with the instrument near the manikin head (preferably on the jaws)
3. Initiate the lesson (! For each lesson, the calibration is performed separately)
4. Click the "Calibrate" button. The calibration window opens (Fig. 51) and the 3D model of the plate appears
5. Select the supporting jaw ("Supporting jaw") you are working with in this lesson, and click "Set"
6. Select the object to calibrate and the working instrument from the right panel, as well as the bur to it
7. Place the instrument in the appropriate slot on the calibration plate and press
8. Set the targeting point in Targeting point position calibration on the calibration plate. Holding the tool, click the "Set a target" button
9. The 3D model of the instrument should stand on the plate identical to the real one
10. Place the bur tip into one of the holes of the calibration plate. Check the movement deflections by rotating the instrument relative to the bur axis. Adjust the instrument position by smooth or abrupt (holding CTRL) changes in the X, Y, Z settings in the left part and the 3D model rotation. Click "Set" button for saving the settings
11. Having calibrated the instrument, set the bur tip on the tooth of the working jaw of the manikin. Select the jaw by the calibration object
12. Move the jaw relative to the actual position of the bur tip, smoothly changing the angles of inclination (Bias, Slope, Deflection) and the X, Y, Z shift. Click "Set" button for saving the settings.

**END OF THE LESSON WINDOW**

After the end of the lesson, three tabs are available: Statistics (shows statistics and assessment of the lesson), Video player (Fig. 52) and Medical record completed earlier.



**Fig. 52. End of lesson window interface**

LESSON RESULTS INFORMATION	
Lesson type	Prosthetic preparation mode
Title	Mandible
Task	Tooth 3.2 Orthodontia
Author	GEOTAR
User	admin
Marks	Frame 3
Lesson duration	Frame 4
Video and 3D model of jaws	Frame 1
Statistics, Video player, Medical record	Frame 6
Instrument	Turbine
Bur selected	FG 836
Camera control panel	Figure 2
Instrument	Syringe
Pause	Frame 4
Play	
Save results to file	Frame 5
Exit to main menu	

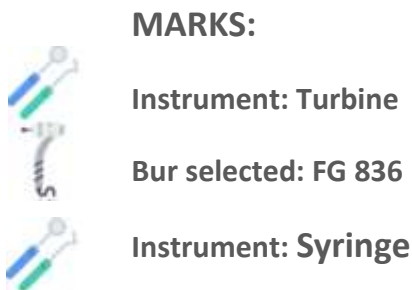
Fig. 52 - There are two screens here. On the left screen, the video from the IP camera is played; on the right one - the recording of actions in 3D is played. The right screen is interactive, the camera may be rotated. The left screen may be switched off in the lesson file settings.

**Fig. 50 – Camera control panel. Described earlier in the lesson window interface.**

The button  hides unnecessary objects leaving only the tooth being operated



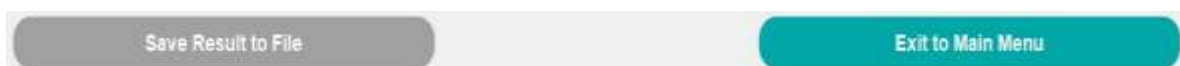
**Fig. 53 - The panel displays the main events during the lesson. Click on the event icon to rewind the recording to the place you need.**



**Fig. 54 - The record playing is controlled by the buttons: "Pause", "Play", moving the time slider and selecting an event from the list. Current time is shown on the right.**



**Fig. 55 - Record statistics and exit buttons:**



Save Result to File - save the user grades in a separate CSV file.

Exit to Main Menu - close the window and go to Main Menu. **The user will be offered to save the lesson record.** This record will be available in the Lesson Archive.

## CAMERA SETTINGS

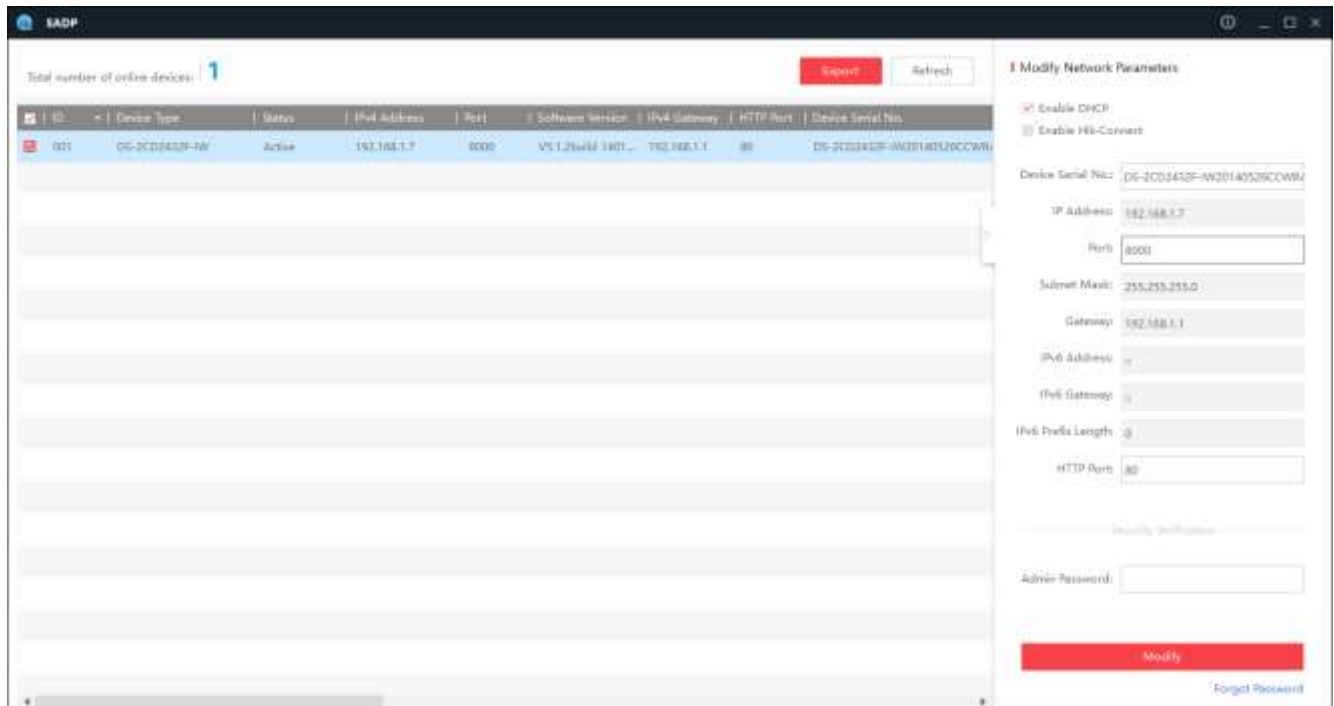
IP video camera is used to record video during the lesson. A proprietary SADPTool software (Fig. 56) is used to connect HikVision cameras.

Example of computer network settings:

- Set the computer IP address: **192.168.1.1**, gateway: **192.168.1.1**, subnet mask **255.255.255**.
- Set the camera IP address: **192.168.1.7**, gateway: **192.168.1.1**, subnet mask **255.255.255.0**

Example of HikVision camera parameter settings:

- Go the camera web interface (Fig. 55) at the specified IP address **192.168.1.7**.
- Login: **admin** Password: **12345**



**Fig. 56. HikVision camera settings in SADPTool**

SADP
Total number of online devices, Export, Refresh
ID, Device Type, Status, IPv4 Address, Port, Software Version, IPv4 Gateway, HTTP Port, Device Serial No.
DS-2CD-2432F-IW, Active, V5.1.2build, DS-2CD2432F-IW20140526CCWR
Modify Network Parameters
Enable DHCP
Enable Hik-Connect
Device Serial No: DS-2CD2432F-IW20140526CCWR
IP Address:
Port:
Subnet Mask:
Gateway:
IPv6 Address:
IPv6 Gateway:
IPv6 Prefix Length:
HTTP Port:
Security Verification
Admin Password:
Modify
Forgot Password

## Parameter settings in the camera web interface (Fig. 57):

The screenshot shows the HikVision camera web interface. At the top, there are tabs for 'Live View', 'Playback', 'Log', and 'Configuration'. The 'Configuration' tab is active. On the left, there is a sidebar with a tree view containing 'Local Configuration', 'Basic Configuration', and 'Advanced Configuration'. Under 'Basic Configuration', 'Video/Audio' is selected. The main area displays the 'Video' settings. The settings are as follows:

Setting	Value
Stream Type	Main Stream(Normal)
Video Type	Video&Audio
Resolution	1920*1080P
Bitrate Type	Constant
Video Quality	Medium
Frame Rate	25
Max. Bitrate	4096 Kbps
Video Encoding	H.264
Profile	Main Profile
I Frame Interval	50
SVC	OFF

A 'Save' button is located at the bottom right of the settings area.

**Fig. 57. HikVision camera parameter settings in the web interface**

HIKVISION, DS-22CD2432F-IW
View, Archive, Journal, Settings admin, Exit
Local settings
Main configuration
System
Network
Video/Audio
image
safety
Extended configuration
Video, audio
Current type, main current (normal mode)
Video type, Video and Audio
Resolution, 1280*720P
Bitrate type, Alternate
Video quality: medium
Frame rate
Maximum bitrate, Kbps
Video coding, H 264
Profile, Main profile
One frame interval
SVC, ON
Save
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## **PROGRAM RECOVERY**

When starting the program after an emergency shutdown, the user will be offered to restore the last session of the lesson. If you click OK, the program tries to restore the lesson from the last saved state.