MrTEEmothy®

Transesophageal Echocardiography Simulator

User Manual

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1. Preface

Transesophageal Echocardiography (TEE) is a frequently used clinical tool, providing important diagnostic information allowing to select a proper treatment strategy in cardiovascular disease. Moreover, it recently became a crucial tool in interventional cardiology and cardiac surgery, used to guide complicated procedures, many of them performed on a beating heart. However, the TEE exam is semi-invasive and very complex. It requires long training, which may frequently cause patients' discomfort or even harm due to excessive esophageal probe manipulation, prolonged examination time, etc. Understanding the three-dimensional anatomy of both healthy and diseased hearts is a crucial part of the training. However, the "TEE anatomy" is very specific. It requires understanding how the TEE views are obtained by complicated manipulation of the probe located in a limited space of a fragile esophagus. It varies from patient to patient, so it is not sufficient to be trained on an "idealistic" model but also on multiple real-life cases to importantly shorten the learning curve and to be able to perform high quality, well documented examination, minimizing the patients' risk.

The MrTEEmothy® simulator is an advanced educational tool created to provide the most realistic experience of TEE training. The clinical datasets used for virtual simulation are obtained from real, standard computed tomography (CT) studies of the heart, providing absolutely anatomically correct models. They can be used for TEE simulation due to complex transformation of the CT data. This is why MrTEEmothy is able to truly simulate not only 2D but also 3D images. Color Doppler flow maps are added to give an information of the blood flow as well. The number of cardiac CT exams is increasing worldwide. When clinically indicated they provide important clinical information but may in addition become a great source of educational material. TEE simulation can be used not only by beginners but also advanced echocardiographers to verify their understanding of "TEE anatomy" and prepare for complex interventions. It can also be used by non-medical personnel (engineers, technicians, proctors etc.) who may need to understand the examination strategy, advantages, and limitations.

This manual is intended to explain to new users, with some theoretical background in cardiac imaging, how to use MrTEEmothy in practice.

Disclaimer

1. None of the system components can be used in human beings for any purpose.

2. The system provides a simulation of how a TEE exam is performed. Exact angles and simulation details may differ from a real study. The manufacturer does not take any responsibility for the complications of the TEE studies/ procedures done in patients or inappropriate diagnoses made.

3. Datasets used for simulation are based on anonymized real patient CT scans performed for purely medical indications.

2. Components of the System

The MrTEEmothy simulation set consists of the following components:

- Dedicated laptop with preinstalled MrTEEmothy software
- Power adapter and power cord (US and Europe Schuko plug)
- Wireless mouse
- Phantom for TEE simulation
- TEE simulator probe
- Ultrasound control panel (optional)
- Transportation suitcase with handles and wheels (optional)
- Dedicated trolley stand for the PC, monitor, panel and keyboard (option)
- Dedicated “examination table” for the phantom (option)

Figure 1. The transportation case with all system components

Figure 2. Dell laptop with preinstalled software

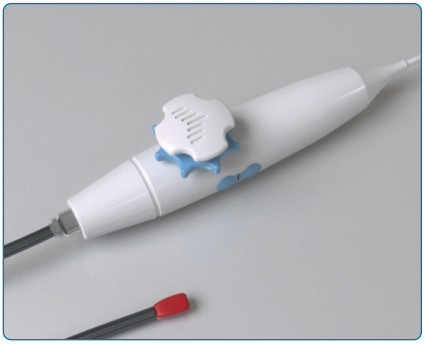


Figure 3. TEE simulator probe

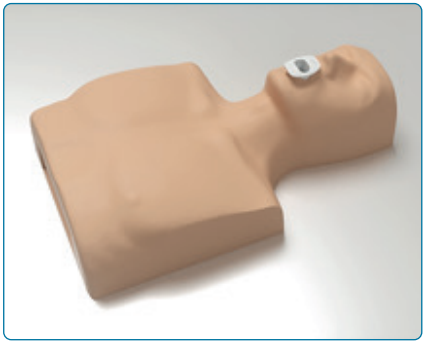


Figure 4. The Phantom

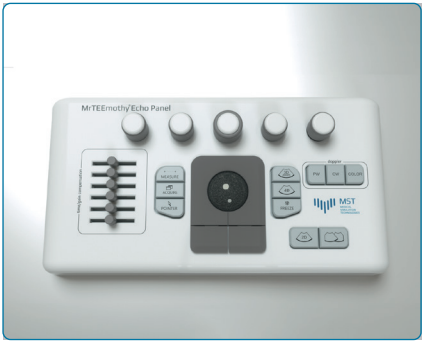


Figure 5. Ultrasound control panel (optional)

3. System setup

To set up the MrTEEmothy® Simulator, unpack the laptop (**1**), TEE probe (**2**), phantom (**3**), ultrasound control panel (**4**), power adapter (**5**) USB wireless mouse receiver (optional), and necessary wires. Use the USB cables to connect all components to the laptop. Connect the laptop to the power supply (**5**). All components except the wireless mouse are powered by the USB cables. The wireless mouse requires batteries that should be replaced every few months. If needed, the USB hub integrated in the phantom body may be used to connect additional USB devices.

The simplified connection diagram is shown in **Fig. 6**.

When all the wires are connected properly, turn the system on by pressing the power button on the laptop.

Note: The AC power adapter must be connected for appropriate system performance. Before connecting any wire, make sure the cable is not damaged to avoid short circuit. Do not use damaged cables.

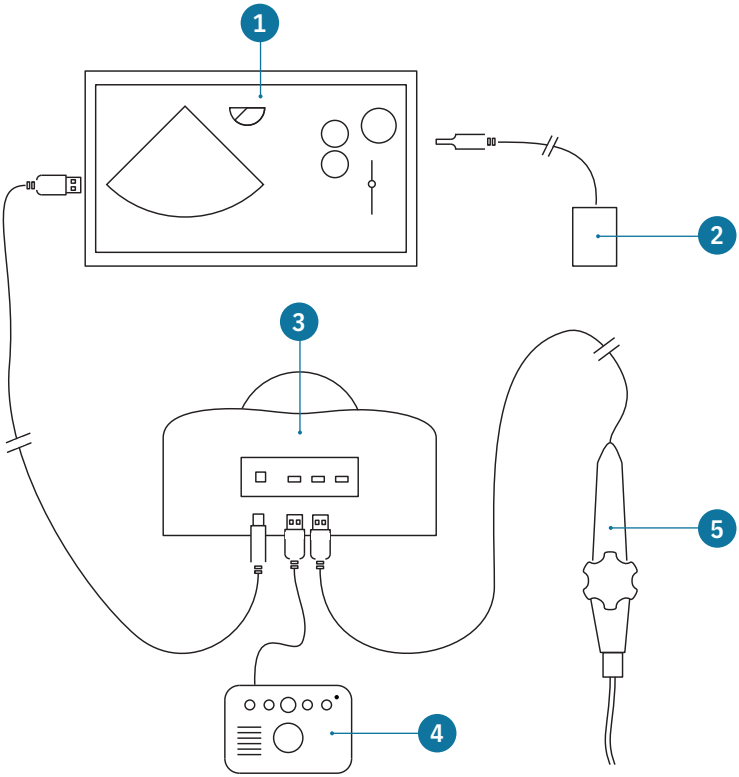


Figure 6. Simulation system wiring diagram: laptop with software (**1**), TEE probe (**2**), phantom (**3**), Ultrasound keyboard panel (**4**, optional), power supply (**5**). The number and location of the sockets may vary depending on the laptop model.

4. TEE Simulator Probe Use

The TEE probe simulator is not a medical device and can only be used for simulation purposes.

Insert the probe into the “mouth” of the phantom. After insertion, the distance between the mouth and probe tip is displayed in centimeters on the TEE control panel in the software.

It is important to note that manipulation of the TEE simulator probe is achieved through rotation of the probe handle and NOT rotation of the black rubber shaft at the mouth of the phantom. Once the probe has been inserted, the probe handle and NOT the probe shaft should be rotated to simulate rotation of the TEE simulator probe within the phantom. **Fig. 7** shows the correct and incorrect usage of the simulator probe.

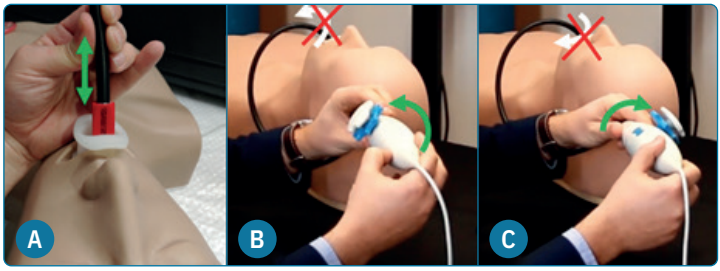


Figure 7. A – Insertion/withdrawal of probe shaft from phantom. **B-C** – Rotation of the probe shaft within the mouth of the phantom is incorrect (white arrows). Rotation of the probe handle is correct (green arrows).

5. Simulator Software

Once the initial setup of the simulator is complete and the system is fully powered on, the simulator software will activate automatically (**Fig. 8**). Clicking the Start icon opens a dialog window with simulator scenarios. Short descriptions of available cases are displayed below the thumbnails schematically illustrating the given pathology (**Fig. 9**).

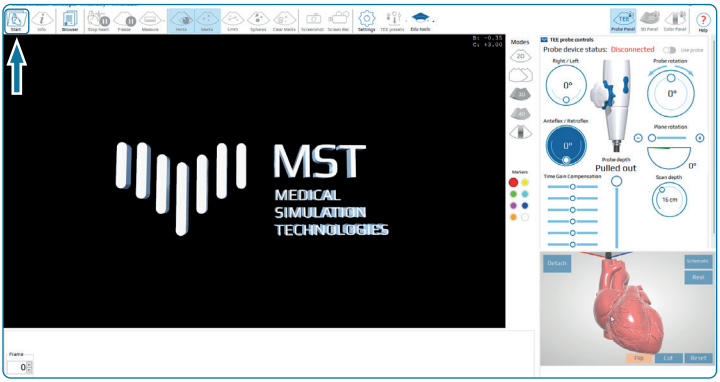


Figure 8. Initial screen of the software. The arrow indicates the Start icon

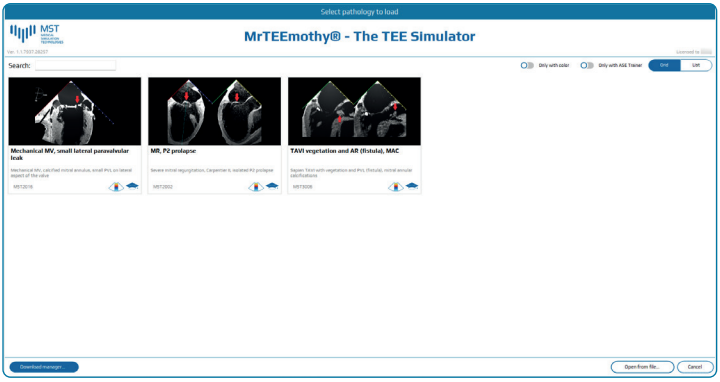


Figure 9. Case selection window. Clicking any of the cases with a left mouse button starts the simulation.

The user can start the simulation by selecting a case with a left mouse button (**Fig. 9**). Clicking on a thumbnail with a right mouse button opens a context menu which allows a user to change the order of cases on the list by moving them to the left, right, top or bottom. Cases can be temporarily removed from the list (**Fig. 10** – Remove option) or loaded again from the internal hard disk using Open from file option (**Fig. 9** bottom). The cases icons can be moved right, left or to the top or bottom of the list (**Fig. 10**).

Figure 10. Case selection window with the dialog box used to change the order of the cases on the list or remove case.

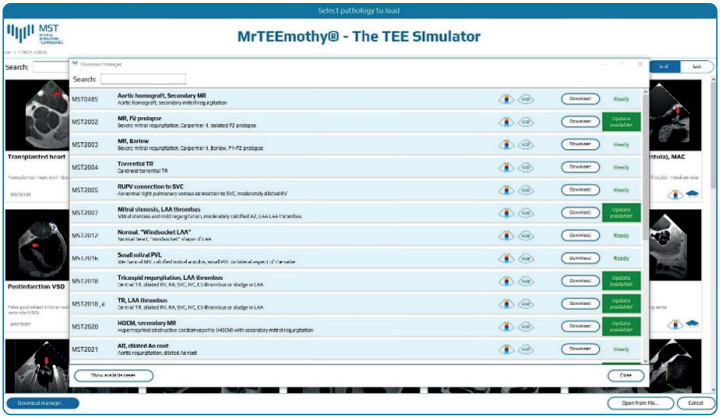


Figure 11. Download manager window.

The available cases differ, depending on the individual simulator license. The user can update the cases list remotely if the computer is connected to the internet via a LAN cable. After clicking the Download manager icon, the list of available cases will be displayed (**Fig. 11**).

“On server” means the case is ready for download. “Ready” means it is already downloaded on a local hard disk. After downloading, each case will automatically appear on cases list. If a new version of the case is available, it is marked as “Update available” and can be downloaded again (**Fig. 11**).

The simulation screen

Loading the case can take between 30 seconds and 3 minutes. The following image will appear on screen when the case is fully loaded (**Fig. 12**). The user interface window layout has 4 main sections (**Fig. 13**): Top main menu (**1**), TEE sector view (**2**), TEE probe control panel (**3**), heart visualization sector (**4**) the bottom bar (**5**) and the modes panel (**6**). If the ultrasound control panel is connected (optional, see pages 31–32), an additional bottom section is displayed (**7**).

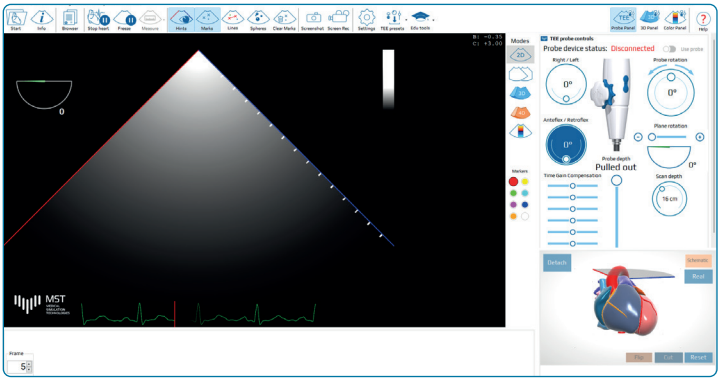


Figure 12. The simulation software interface

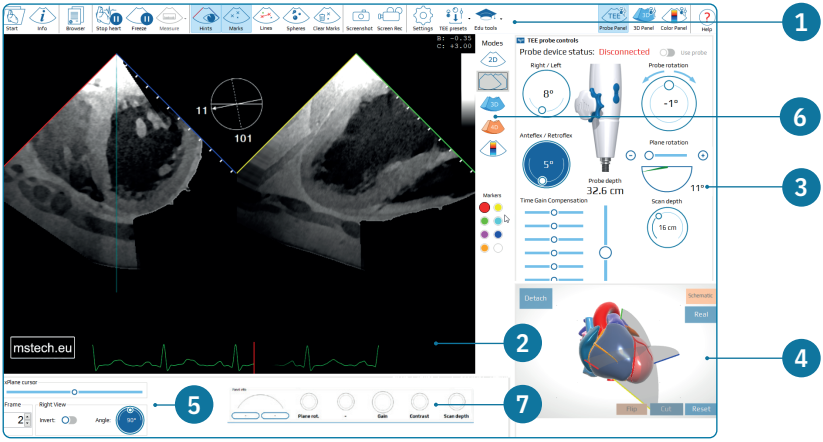


Figure 13. Window layout sections

Top bar

Figure 14. Top Main Menu Bar.

The main menu bar contains the following icons (**Fig. 14**):

Start – shows the case selection dialog window (allows the user to load a specific patient dataset for TEE imaging simulation).

Info – displays information about the pathology of the current case.

Browser – activates the interface used for browsing the recorded movies (AVI) or screenshots (PNG). It can also be used to copy selected files to an external USB memory stick. Files can be deleted.

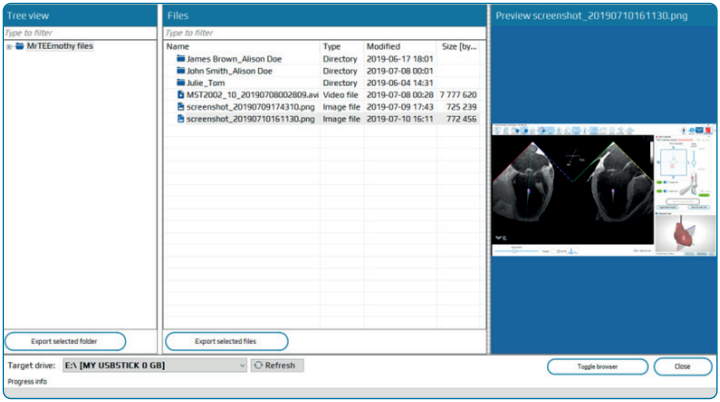


Figure 15. The "Browser" window is used to review or transfer files to a USB memory stick. Choose a folder (left panel) to view the Reports (pdf) and open or export them. Screenshot (png) or Video Capture file (avi) can be selected (right lower panel) and opened or exported.

Stop Heart – stops the beating of the heart but all manipulations of the TEE probe are still active. When the heartbeats are paused, the user can select a desired cardiac cycle  frame on the lower panel.

Freeze – stops the echo screen completely. When "Freeze" is selected, the user can select a desired cardiac cycle frame  on the lower panel. The "Freeze" function can also be activated by pressing the space bar on the PC keyboard or pressing FREEZE on the optional ultrasound control panel (see pages 31–32).

Measure – activates measurement mode (available in FREEZE mode). It can also be activated by the MEASURE button on the optional ultrasound control panel (see pages 31–32). Four measurement methods are available:

Distance

Multiple distance

Area

Elipse

Hints – activates or inactivates the color lines on the edges of the TEE sector(s) that help understand the orientation of the TEE views. The corresponding lines can be also seen on the virtual model of the heart in the right-lower panel of the screen.

Marks – activates the cross-type markers which can be placed in the 2D and 3D space of the heart by pointing to a selected location on the image and double clicking with the left mouse button. The markers are displayed only if the imaging 2D plane is close to them. Prior to clicking, the color of the marker may be selected in the color picker panel which is displayed in the control panel menu (**Fig. 16**). The color of the marker will automatically be switched after creating two markers to the next one in order when clicking on the 2D plane or in a 3D space.

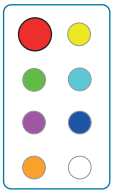


Figure 16. The color picker

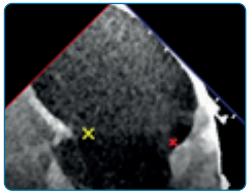


Figure 17. The markers

Each marker can be erased by double clicking it with the right mouse button. The crosses are bigger if the current TEE plane is positioned exactly on the cross (**Fig. 17** – yellow marker). If the imaging plane is close to the marker but not exactly on it, the size of the cross gets smaller (**Fig. 17** – red marker). In 3D space, the markers are represented as spheres.

Lines – shows the color lines between markers of the same color. In 3D/4D views the lines are projected on a heart model using markers and the probe tip positions.

Spheres – activates the spherical markers which can be placed in the 3D space of the simulated heart. Placing and deleting the colored spherical markers is analogous to the cross-type markers described above. Spherical markers are displayed always, even if the imaging 2D plane is far from the location of the marker. Enabling spheres may help a user to locate cross markers, if they disappeared from the view because of the manipulation of the probe. To reflect the position of the sphere, its size depends on the distance from the observer looking at the screen (the closer the marker, the bigger it appears) (**Fig. 18 B**). Both cross markers or spherical markers can be displayed also in 3D mode (**Fig. 18 C**).

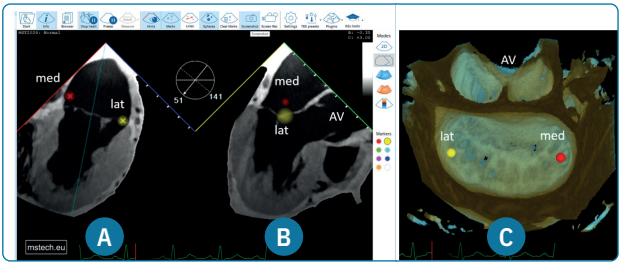


Figure 18. The spherical markers placed in medial and lateral aspect of the mitral annulus in orthogonal views (**A**, **B**). In the LVOT view (**B**), the yellow marker is bigger than the red marker because it is closer to the observer. Markers can be also displayed in 3D mode (**C**)

Clear marks – deletes all cross and spherical markers.

Screenshot – saves a screenshot (png) file, accessible in the “Browser” window (see above).

Screen Rec – starts/stops the recording of the screen and saves it as an avi file, accessible in the “Browser” window (see above). The record limit is 1 minute.

Settings – opens program screen settings window. TEE settings:

- **SEPIA MODE** – sepia coloring
- **TRANSGASTRIC MODE** – needed for additional anterior bend of the TEE probe used for transgastric views, should be ON
- **USE ULTRASOUND SHADOWS** – simulation of acoustic shadowing, should be ON
- **TEE NOISE** – simulation of noise signal making the exam more difficult, usually should be OFF
- Other options are used for MST service only

TEE presets – opens a drop-down menu that allows to save or load the position of the TEE probe.

Save TEE – saves current position of TEE probe (see below)

Load TEE – loads saved position of TEE probe – can be used only if the “Use Probe” button in the control panel is off

Plugins – drop down menu for plugins (optional)

Edu tools – drop-down menu for educational tools (see chapter 6).

Enhancements – Enhances the visibility of a tissue in certain cases.

ASE views trainer – Activates training tool used to learn, practice and test standard TEE views according to the America Society of Echocardiography recommendations.

CAMERA – Enables built-in camera for streaming or live screen presentation. The operator manipulating the probe can be seen on the screen.

Probe panel – toggle on/off the TEE manipulation indicators panel

3D panel – toggle on/off 3D Panel (available depending on license version). It can also be activated by the button on the optional ultrasound control panel.

Color – enables the Color Doppler mode (available depending on license version). It can also be activated by a button on the optional ultrasound control panel.

Brightness and contrast of the 2D TEE images can be adjusted by clicking on the TEE image and dragging up-down or left-right respectively. Alternatively, the Gain and Contrast knobs of the optional ultrasound control panel can be adjusted.

The TEE probe controls

The TEE probe controls shows the position and orientation of the TEE probe and imaging plane:

1. Right-left flexion of the probe tip (RIGHT / LEFT angle given in degrees).
2. Anterior – posterior flexion of the probe tip (ANTEFLEX / RETROFLEX angle given in degrees).
3. Probe depth in the esophagus. The indicator shows the distance of the probe from the teeth in cm.
4. Rotation of the probe in the esophagus (clockwise/ counterclockwise rotation given in degrees, related to anterior orientation.
5. TEE omniplane rotation angle given in degrees, can be changed with buttons on the TEE probe or mouse or using a dedicated knob of the optional ultrasound control panel.
6. Scan depth, can be changed with a mouse or dedicated knob of the optional ultrasound control panel.
7. Time gain compensation sliders, can be changed with a mouse or physical sliders of the optional ultrasound control panel.
8. If the USE PROBE switch is off each of the indicators can be manipulated by the mouse to change the virtual position of the imaging plane.

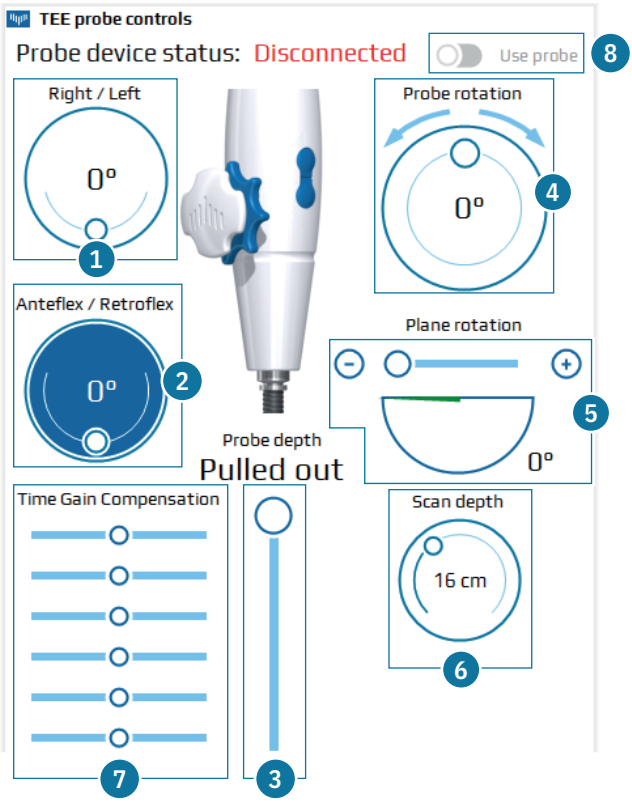


Figure 19. The TEE probe control panel.

Heart model

Below the TEE panel, the model of the heart with superimposed TEE imaging plane (or two orthogonal planes) is displayed. The model is individually created for each selected patient/case. The model can be rotated with the mouse and enlarged using the mouse wheel. The panel can be detached from the original position, moved with the mouse to the desired location on the screen and resized by dragging the edge/corner of the window. By clicking CUT the section of the model corresponding to the TEE plane orientation can be displayed. Clicking FLIP displays the opposite part of the section (**Fig. 20**).

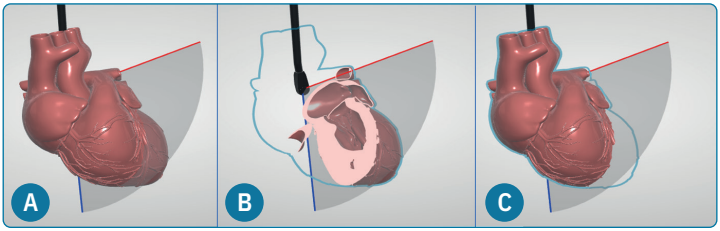


Figure 20. The heart cartoon (**A**) with activated CUT option (**B**) and FLIP option (**C**). The model and the esophagus trajectory are created individually, based on a CT scan of each selected patient. It can be rotated using a mouse,

Instead of the graphical model a real anatomy heart can be displayed with a section of the current TEE view to help understand the 3D orientation of the current TEE view. (**Fig. 21**).

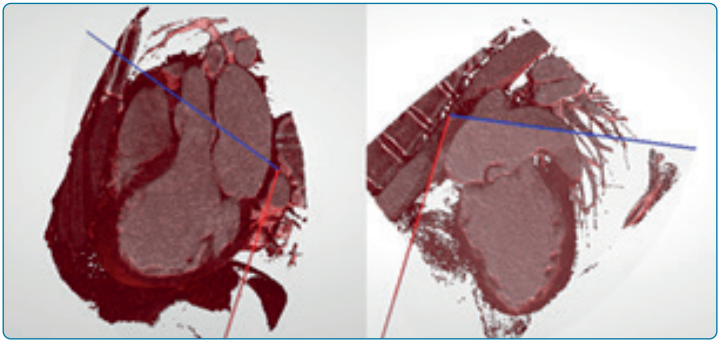


Figure 21. The real heart CT – derived 3D model sectioned according to the current position and orientation of the sector.

Imaging modes

The modes selection bar, located on the right-hand side of the TEE sector view, enables the user to switch between different imaging modes.

2D imaging is the default mode. Whenever the 2D button/icon is depressed all other modes are turned off and 2D is activated again.
The user has to adjust 2D gain and contrast using the dedicated knobs of the panel or dragging the mouse up-down and left-right on the imaging sector. The time gain compensation (TGC) sliders are also available, similar to the ECHO machine.

In the **xPlane** mode, the crossing of the planes is determined by the line visible on the left (primary) sector, marked with blue and red edges. A second, orthogonal plane is displayed on the right (marked with yellow and green edges). The line can be moved left-right using a slider at the bottom of the screen using a mouse or the trackball of the optional ultrasound control panel.

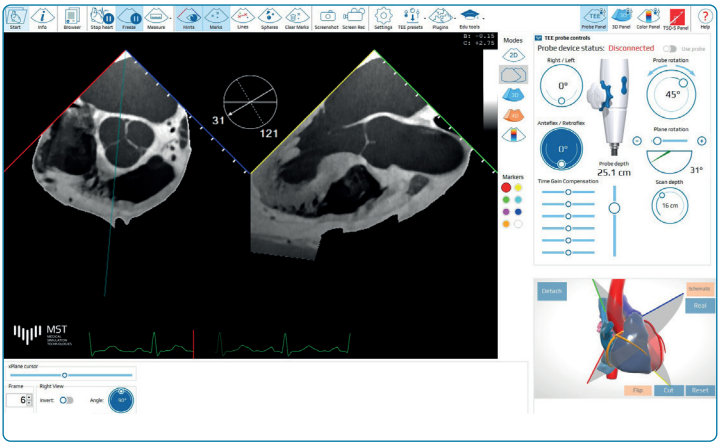


Figure 22. The xPlane mode. The two perpendicular planes are shown on a model of the heart. The lower panel contains the xPlane slider and a Right invert button.

Two perpendicular planes are also displayed on the virtual model of the heart in the right-lower panel of the screen (**Fig. 22**).
The RIGHT INVERT button is located on the right part of the lower panel. Selection of this button will cause the right panel to flip (mirror image). This button may be needed if the plane angle on the right panel exceeds 180 deg. The angle between the planes can be adjusted using an ANGLE icon at the bottom of the screen (default 90 deg.).

Once the **Color Doppler** mode is activated, the Doppler window is visible on the screen. It allows adjustments of scale, baseline and low velocities filter. The parameters can be changed using the mouse or context knobs of the optional ultrasound control panel.
If the Color Compare mode icon is clicked both the 2D image and 2D Color image are displayed side by side allowing simultaneous interpretation.

Clicking the **3D** button once activates two boxes that let the user select the region of interest (ROI) on the xPlane views. The ROI can be moved by dragging the mouse on the left sector with a left mouse button depressed. Dragging with a right mouse button depressed changes the box size.

The ROI elevation depth can be modified by dragging the mouse over the right view with the right mouse depressed.

Using the optional ultrasound control panel, the 3D mode is activated by a 3D button and the trackball is ready to set the position of the yellow box on the left xPlane sector.

- The left trackball button is used to adjust left yellow box. It toggles between width/height and position modes.
- The right trackball button is used to adjust the right yellow box, corresponding to the 3D ROI elevation depth.

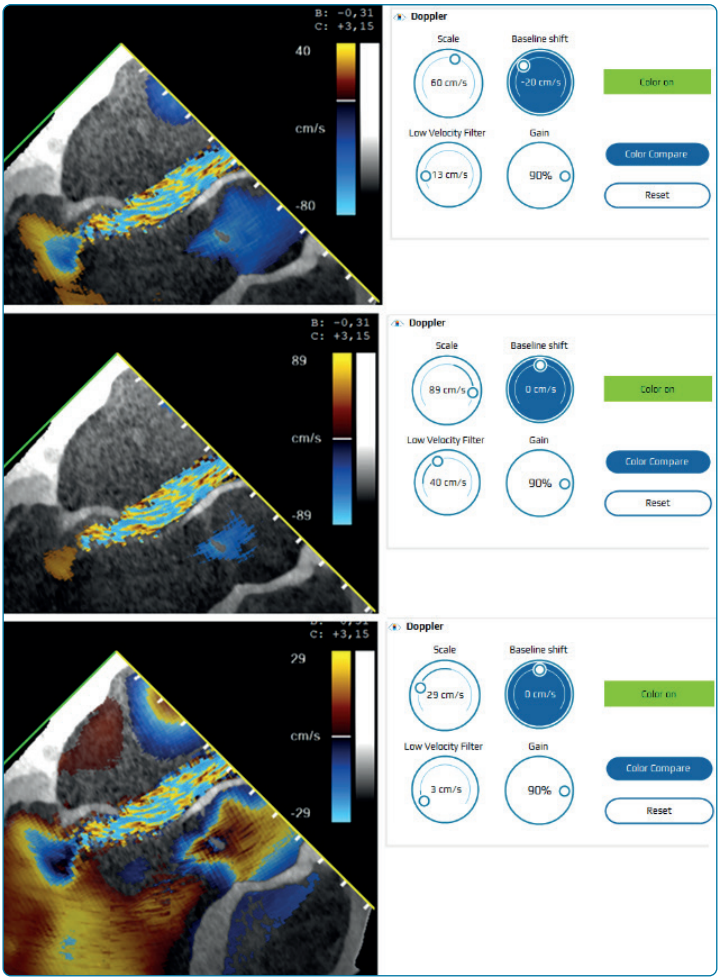


Figure 23. The Doppler settings and their influence on the color display

The second click on the 3D zoom button (using mouse or physical button on the optional ultrasound control panel) switches on the 3D rendering function. The 3D volume can be rotated (X and Y axes) by dragging the mouse (or using the trackball of the optional ultrasound control panel). The Gain should be adjusted (usually, initially significantly decreased – similarly to a real ECHO machine), to optimally visualize the cardiac

structures. Z rotation is used to rotate the model on the screen (Z axis perpendicular to the screen). Both Gain and Z-rotate functions can be set by the mouse or the knobs of the optional ultrasound control panel (see pages 31–32).

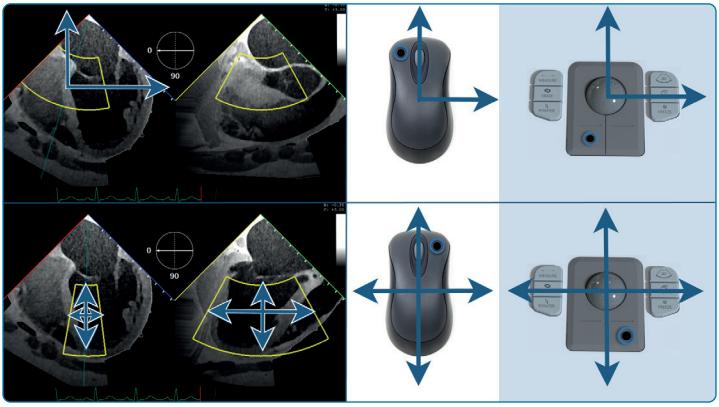


Figure 24. Preparing for 3D imaging by selecting the region of interest using the mouse or the optional ultrasound control panel.

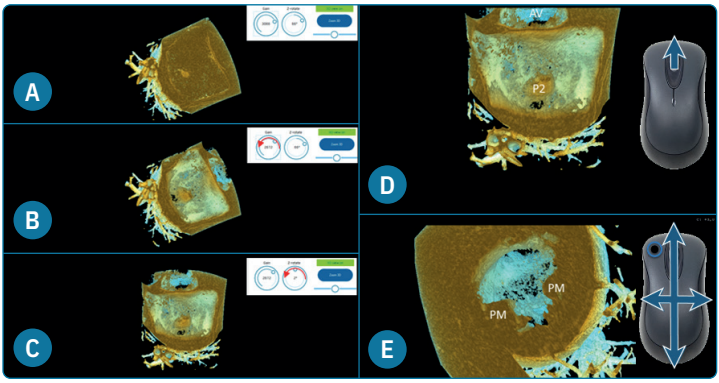
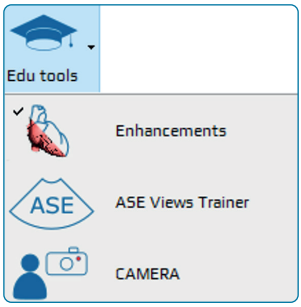


Figure 25. 3D volume settings. Gain adjustment (**A** → **B**), Z-rotation to obtain a surgical MV view with aorta on top (**B** → **C**), zooming in (**C** → **D**), obtaining the view from the left ventricle by rotating the volume (**D** → **E**). Using the optional ultrasound control panel the same manipulations may be achieved by rotation of dedicated knobs (**A** → **D**) and a trackball (**D** → **E**).

When 2D mode is displayed the **4D** mode can be activated simultaneously. It is a “real time” 3D image showing the same section as the original 2D image with added depth called elevation. On a 4D window the elevation position (back, center or front buttons) and elevation depth (slider) can be adjusted. The 3D volume can be rotated by the mouse or trackball. The photorealistic mode can also be activated (light slider) and modified (SSS slider). The light position can be moved using a mouse. The quality can be changed (high can cause scattered motion due to high processor workload).

6. Educational Tools

The MrTEEmothy simulator is equipped with Educational Tools helping to teach, learn, practice and test the TEE skills. The options are listed under the EDU TOOLS icon in the top bar. Each option can be activated or disactivated by a mouse click.



Enhancements

In selected cases the important elements can be enhanced using color display (**Fig. 26**).

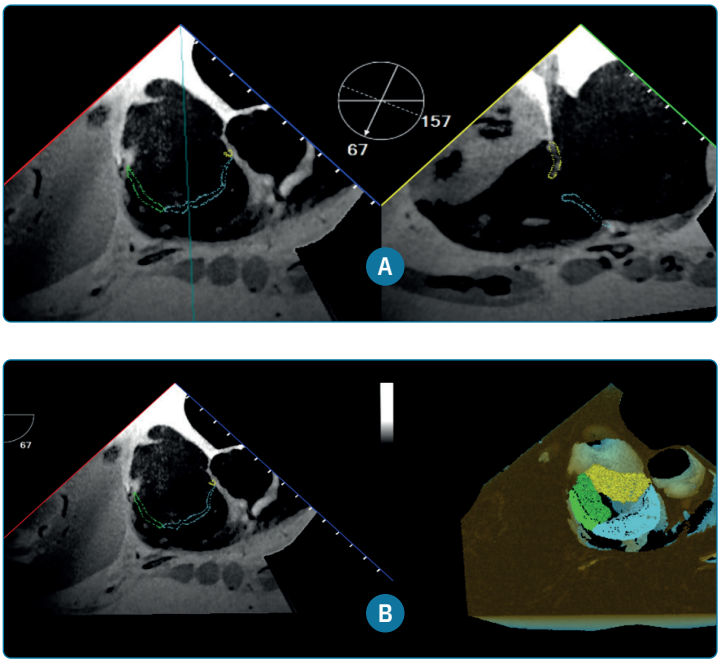


Figure 26. An example of tricuspid valve leaflets displayed in xPlane mode (**A**) and in 4D view (**B**). The leaflets are shown in colors: yellow (septal leaflet), blue (anterior leaflet) and green (posterior leaflet). It is very helpful in studying the anatomy of the leaflets and the anatomical landmarks of the tricuspid valve in three-dimensional space.

Automatic trainer of the standard TEE views

According to medical societies, particularly the American Society of Echocardiography, the comprehensive TEE examination should be performed and documented using standard views*. The probe has to be manipulated in five degrees of freedom, based on the US image pattern observed by the operator. General rules of the probe manipulation apply, however they have to be modified according to individual anatomy of the heart and esophagus.

The ASE views trainer is an advanced tool demonstrating and helping to teach propper views in individual simulated cases. The skills can be also tested and the metrics can be stored in a pdf report file.

To activate the ASE Views Trainer for a currently loaded case select the Edu Tools icon from the top panel and select the ASE Views Trainer

The ASE views Trainer window will be displayed in the ceter of the screen (**Fig. 27 A**). The trainee name (for example John Brown) can be optionally entered and it will be used in the test report, otherwise ANONYMUS name will be displayed.

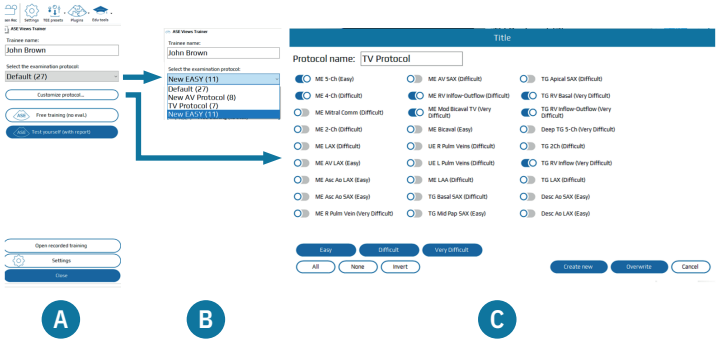


Figure 27. The main ASE Views Trainer menu is displayed at the centre of the screen (**A**). The trainee name (here John Brown) can be entered and later used in the report. One can use DEFAULT protocol with all 27 ASE standard TEE views or select a subset of views grouped in the preprogrammed protocols (**B**). By clicking CUSTOMIZE PROTOCOL one can edit or create own protocols activating or disactivating each view (**C**).

The user can select the protocol (selection of TEE views) from the list. They may be factory-defined or user–defined. By default there is usually total of 27 views available. The protocol name is followed with the numer of views in brackets (**Fig. 27 B**)

The user can modify or create the training/test protocol by clicking the CUSTOMIZE PROTOCOL button (**Fig. 27 A** and **C**). Each view (named according to the ASE standard) can be activated or disactivated. The difficulty of each view is defined as EASY, MODERATE or DIFFICULT and they can be applied for trainees at different stages of training. The user can name, create new or overwrite existing protocol using the protocol name field and appropriate buttons on the lower right corner of the window (**Fig. 27 C**).

Settings can be used to make the training or test easier or more demanding (**Fig. 28**).

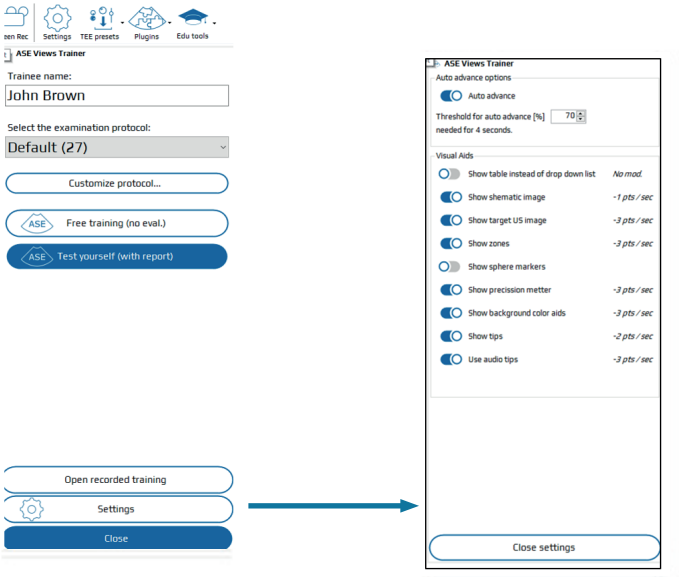
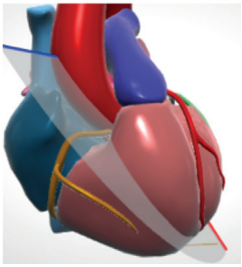


Figure 28. Entering to settings allows the user to modify the training/test support and difficulty options (see text for details).

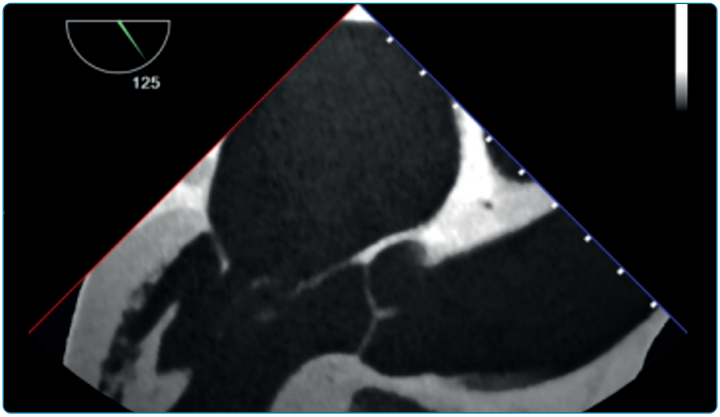
AUTO ADVANCE – if it is OFF, the user has to click SCREENSHOT or push ACQUIRE on an optional panel to store the best achieved view. If it is ON, the computer will accept the view automatically and after a BEEP it will go to the next view.

THRESHOLD FOR AUTO ADVANCE – is a level of accuracy of a given view plane compared to the ideal. If the view is kept stable for over 4 seconds and the accuracy is above the threshold the view will be accepted as correct and computer will go to a next view.

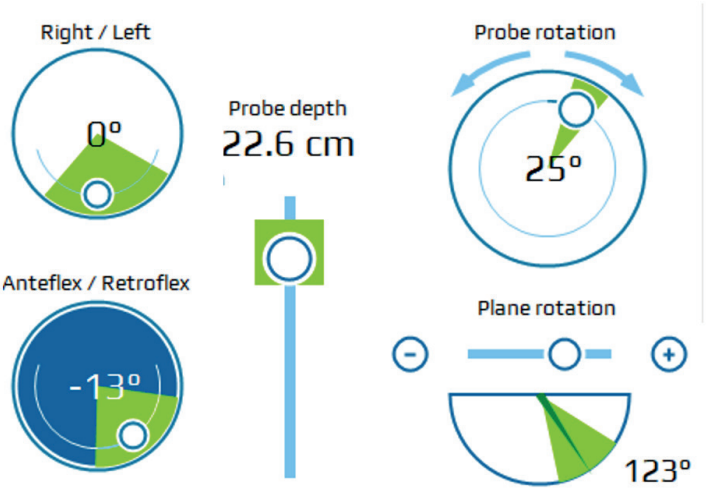
SHOW SCHEMATIC IMAGE – displays the view of the desired plane in the relation to a cartoon 3D model of the heart – the user may use it as a reference to manipulate the current view.



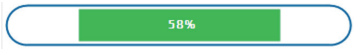
SHOW TARGET US IMAGE – displays the TEE image of the desired view – the user may use it as a reference to manipulate the current view.



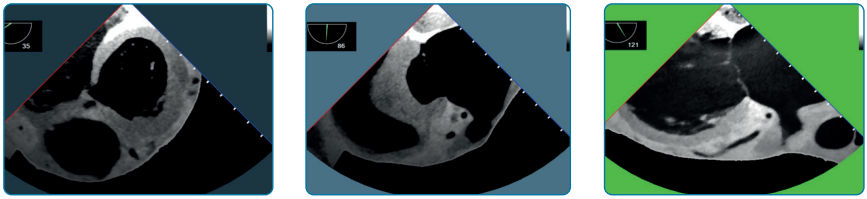
SHOW ZONES – displays the green zones on each element of probe manipulation. The user can easily get to an optimal position and orientation of the imaging plane.



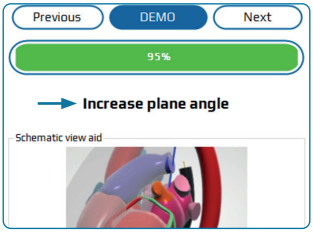
SHOW PRECISION METER – displays the green bar informing how close to ideal the current imaging plane is.



SHOW BACKGROUND COLOR AIDS – displays the color background depending on how close to ideal the current imaging plane is – shades of blue when the plane is approaching the threshold accuracy, green when the view is acceptable.



SHOW TIPS – displays text messages suggesting the proper movements of the probe.

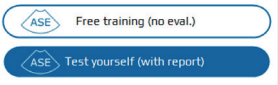


USE AUDIO TIPS – plays audio messages suggesting the proper movements of the probe.

Activation of any help tool assigns negative points for each second of the test. They are used when generating the final score in the report. However the exam may be passed regardless of the score achieved, if proper images are obtained.

Performing automatic ASE views training or test

Free training (without evaluation) or a test (with a report) can be selected.



In both options the interface will appear with more or less options depending on settings (**Fig. 29**).

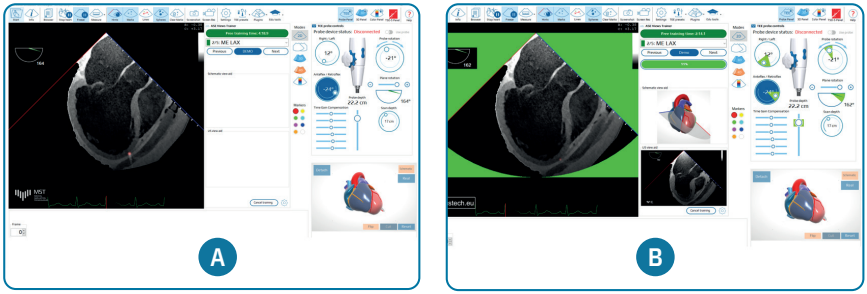
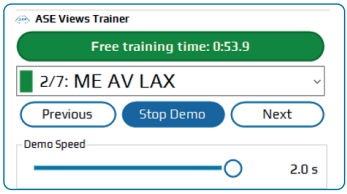
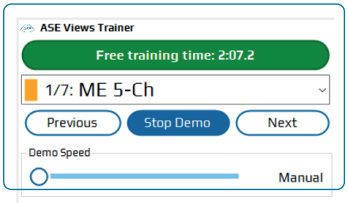


Figure 29. Depending on the settings, the ASE views trainer interface will appear with less (**A**) or more (**B**) helping tools (see text for an explanation).

In **FREE TRAINING** mode additional presenting the "ideal" views is available. The computer automatically shows the view with respective probe position indicators and a schematic model with the current imaging plane. During the DEMO operation the physical TEE probe is turned off.

After clicking DEMO a button, all views will be automatically presented by the computer, starting from the view previously selected in a dropdown menu. The views will be automatically shown in a sequence. The display time can be set between 2 and 11 seconds. Maximal left slider position enters manual mode – the views are advanced by clicking next/previous buttons.





After reviewing the demo, the user may start the training from any view of the previously selected protocol.

If test mode is selected the test starts automatically using the selected protocol and settings (see above).

For each view the following metrics are recorded: time, view % accuracy comparing to “ideal”, manipulation errors (risk of esophagus perforation caused by pushing a flexed probe or abrupt random probe motions).

The test can be completed by acquisition of all views in the selected protocol or terminated by the user. A report is created and displayed automatically (**Fig. 30**). It is also stored and accessible in the **Browser** (see page 14) for future review or export to a USB stick. The report contains the name of the trainee (if previously entered – see above).

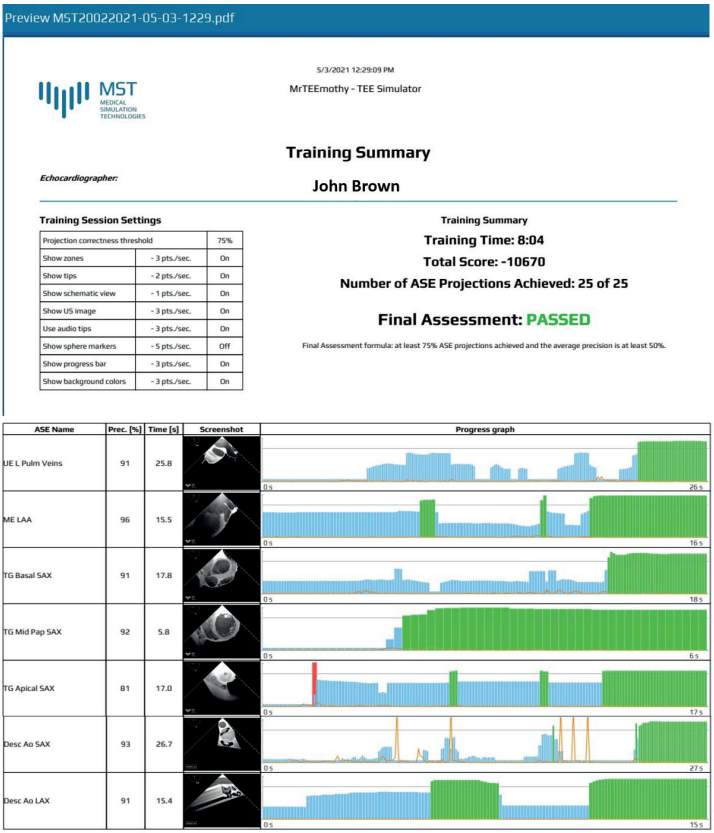


Figure 30. A fragment of a sample test report. The top table shows the help tools used. The exam is passed – all 25 views were achieved with acceptable accuracy. The time and precision of each view acquisition is shown in the main table, together with a screenshot of the view and graph showing progress of the manipulations. Blue bars represent approaching the accuracy threshold and green shows acceptable accuracy. The red bar documents pushing the flexed probe and orange lines – the amplitude of probe motions – peaks show rapid movements (potentially harmful for patients).

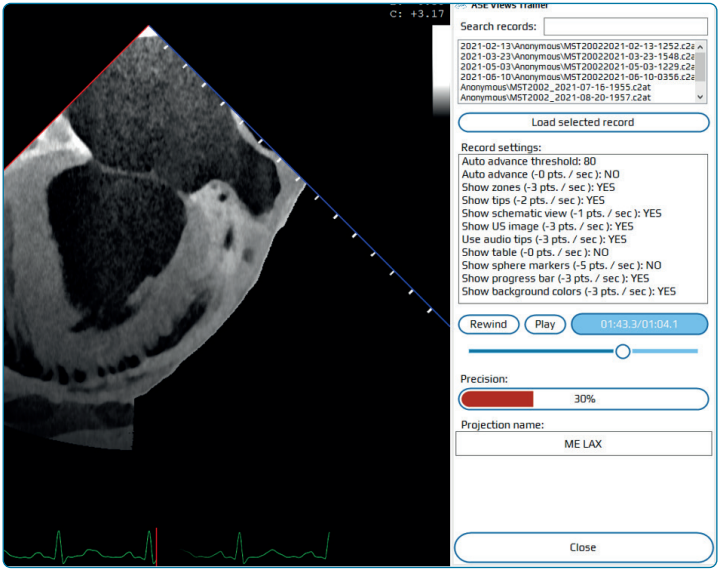


Figure 31. The test can be reviewed step by step using an OPEN RECORDED TRAINING button.

The test is automatically digitally recorded and can be played for detailed analysis by clicking

Built-in camera display

The laptop camera image can be displayed on a simulator screen for a conferences or internet streaming (**Fig. 32**). The camera mode is activated using the EDU TOOLS and then the CAMERA button.

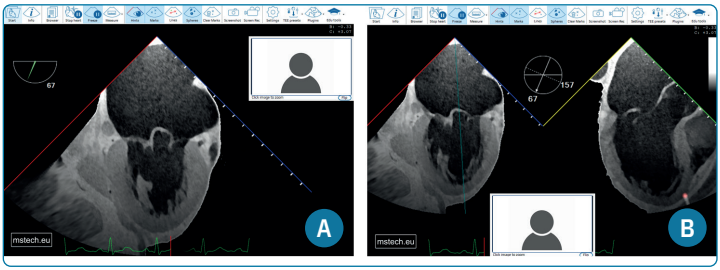


Figure 32. The built-in laptop camera can be used for live conference presentations using the HDMI port and a projector, showing the teacher presenting the probe manipulations. An optional HDMI streaming device can also be used for internet meetings. The image is automatically positioned in a free space on the screen – examples of 2D (**A**) and xPlane (**B**) modes used. The image can be enlarged or flipped if needed.

Selected references:

- Hahn RT, Abraham T, Adams MS, et al.: Guidelines for Performing a Comprehensive Transesophageal Echocardiographic Examination: Recommendations from the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists. J Am Soc Echocardiogr 2013;26:921-64
- Hahn RT, Saric M, Faletra FF, et al.: Recommended Standards for the Echocardiographic Screening for Structural Heart Intervention: From the American Society of Echocardiography. J Am Soc Echocardiogr 2013, in press. https://doi.org/10.1016/j.echo.2021.07.006.
- Shanewise JS, Cheung AT, Aronson S, et al. ASE/SCA guidelines for performing a comprehensive intraoperative multiplane transesophageal echocardiography examination: recommendations of the American Society of Echocardiography Council for Intraoperative Echocardiography and the Society of Cardiovascular Anesthesiologists Task Force for Certification in Perioperative Transesophageal Echocardiography. Anesth Analg. 1999 Oct;89(4):870-84.
- Reeves ST, Finley AC, Skubas NJ, et al. Council on Perioperative Echocardiography of the American Society of Echocardiography; Society of Cardiovascular Anesthesiologists. Basic perioperative transesophageal echocardiography examination: a consensus statement of the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists. J Am Soc Echocardiogr. 2013 May; 26(5):443-56.

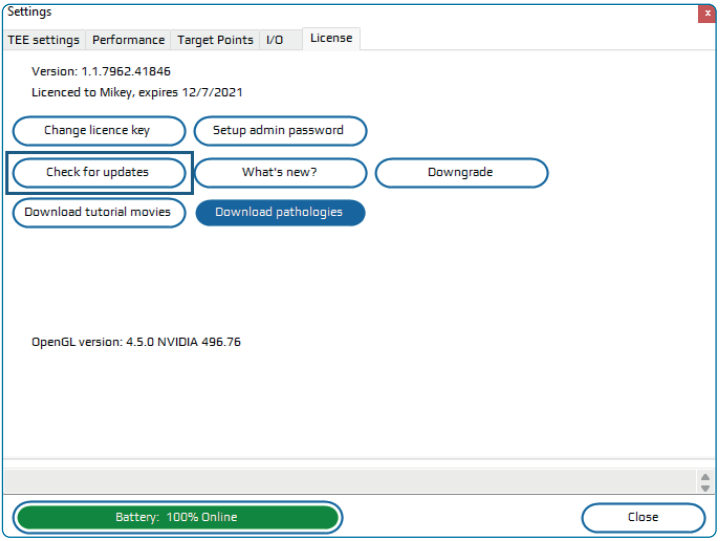
7. Updates & License

Updating MrTEEmothy

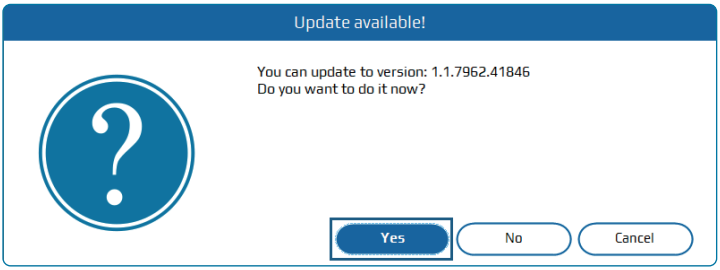
To ensure the best experience, MrTEEmothy automatically checks for updates on startup, provided that an Internet connection is available.

To install the update manually, provided that the update is available on the server, follow the steps below:

1. Connect the computer to the Internet using the supplied LAN cable.
2. Turn on the computer.
   a. If the Internet is accessible and the update is available, the message box will appear just before the simulator starts.
   b. You can also manually check for updates to the main program by accessing the MrTEEmothy settings.



3. Click “Yes” to update.



4. The progress bar will appear. Note that the time required for downloading depends on the type of Internet connection. Check the table below.

5. The newest version of simulator should start automatically after the update process finishes.

Connection type	Download speed	Download time
Modem	56,6 kbit/s	20:48:18
ADSL	256 kbit/s	04:33:04
ADSL	1 Mbit/s	01:09:54
ADSL	24 Mbit/s	00:02:54
LAN	10 Mbit/s	00:06:59
LAN	100 Mbit/s	00:00:41
Fiber	300 Mbit/s	00:00:13

License

MrTEEmothy checks for the validity of your license. 60 days prior the expiration date, the warning dialog box starts to be displayed (**Fig. 27**).

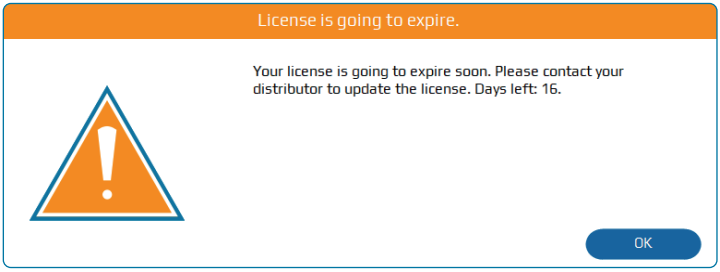


Figure 27. The license expiration warning.

8. Using the ultrasound control panel

All functions are accessible by on-screen controls, however some settings can also be adjusted using the dedicated ultrasound control panel. The arrangement of ultrasound control panel buttons and knobs is shown in **Fig. 28**.

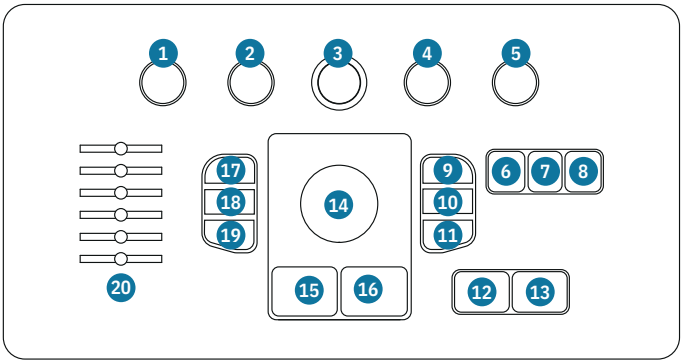


Figure 28. Ultrasound control panel

1. Knob 1: Plane rotation – Adjust TEE omni plane angle (the same function as the buttons located on the TEE probe)
2. Knob 2: Not used in the primary mode, for Doppler and 3D modes see section below
3. Knob 3: Gain – Adjust image gain
4. Knob 4: Contrast – Adjust image contrast, for 3D mode see section below
5. Knob 5: Scan depth – Adjust imaging depth
6. PW: not active yet
7. CW: not active yet
8. Color: activate Color Doppler mode (depending on the license)
9. 3D: activate 3D Zoom mode
10. 4D: activate 4D mode (adding 3D depth to a current 2D section)
11. Freeze: Freeze image
12. 2D: reset the imaging mode to 2D
13. xPlane: Activate xPlane mode

14. Trackball: In X-plane mode – set the X-plane angle, in freeze mode operate cine, in measure mode – set the caliper measurement, for 3D mode see section below
15. Left button: Approve selections, for 3D mode see section below
16. Right button: Erase points in measure mode, for 3D mode see section below
17. Measure: Activate measurement mode
18. Acquire: Store current screenshot
19. Pointer: Toggle between Cine, Mouse cursor and X-plane angle modes.
20. Time-gain compensation: Slide potentiometers for TGC settings

Note: Some functions depend on activated mode (context functions). The following functions are specific to use in either color doppler mode or 3D view mode.

- Color Doppler mode
  - Knob 2 – Set Doppler scale
  - Knob 4 – Set baseline
- 3D view mode
  - Trackball – Select image scope/rotate 3D view
  - Left button – Set the trackball to adjust the lateral width and height of the 3D sector
  - Right button – Set the trackball to adjust the elevation depth of the 3D sector
  - Knob 2 – 3D Zoom
  - Knob 3 – 3D Gain
  - Knob 4 – Z-axis rotation of the 3D image

Depending on the current imaging mode, the context function of each knob of the Echo Panel is displayed on an additional section of the screen interface (**Fig. 29**).

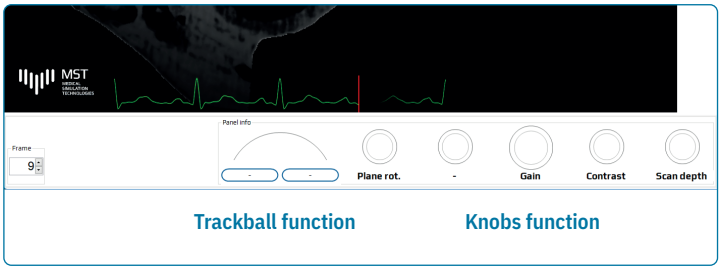


Figure 29. The context indicators of the knobs and trackball functions.

To the right of the knobs icons there is a symbol representing the current trackball function (Cine / Mouse cursor / xPlane line angle). The trackball function changes automatically depending on the current imaging mode or may be toggled with a Pointer button (19 on **Fig. 28**).

9. Troubleshooting

Question: The laptop is not turning on.

Answer: Make sure the power adapter is connected and there is power in selected socket.

Question: The "Update is available..." dialog box does not appear before simulator starts.

Answer:

1. The update is not available at this time.
2. Make sure that the Internet is available (cable is connected, no firewall blocks the connection). Test the connection using different device or contact your network administrator.
3. Restart the computer a few times with the Internet cable connected in advance.
4. In some network configurations, it may take a long time to receive an IP address from the router. Then, one should try these steps:
   a. Start simulator as usual
   b. Press Alt+Ctrl+Del simultaneously.
   c. Click "Sign out".
   d. Try to log in again using regular user account. If Internet connection is up, the simulator should check for updates.

Question: I can't see the "Download Manager" button.

Answer: The software was not updated. Please, update the software first.

Question: The "Download manager" appears, but the list of pathologies is empty.

Answer: Make sure the Internet cable is connected and the Internet is available. Also, make sure that the probe is connected to the computer.

Question:

The “Your license does not include this pathology. (...)” error is displayed after clicking “Download”.

Answer:

Please contact your distributor to order more pathologies. You can also request your own CT data to be translated into Mr. TEEmothy’s format.

In case of any problem, please contact MST IT support: +48 793 737 171

10. System specification

Laptop computer	
Processor	Intel Core i5
Graphic card	NVIDIA GeForce
RAM	8 GB
Hard Disk	256GB (SSD)
Size	335 x 229 x 23 mm
Weight	1.70 kg
Voltage	100 ~ 240 V AC, 50 ~ 60 Hz
Screen dimension	15.0”
Number of USB ports	4
Accessories supplied	Power adapter

Training Phantom	
Size	610 x 368 x 160 mm
Weight	5.1 kg
Voltage	5 V, USB standard
Current	500 mA max, 50mA average
Operating temperature	5 ~ 40°C (41 ~ 104°F)
Storage temperature	-24 ~ 49°C (-11 ~ 120°F)
Operating humidity	40 ~ 80% RH
Storage humidity	0 ~ 90% RH

MST TEE probe simulator	
Depth sensing accuracy	3 mm
Anteflex/retroflex rotation angle	±25°
Left/right rotation angle	±25°
Size	Handle 260 x 52 mm, 1 m flexible tube
Weight	0.5 kg
Voltage	5 V, USB standard
Current	500 mA max, 130 mA average

Ultrasound control panel (optional)	
Size	300 x 160 x 44 mm
Weight	0.5 kg
Voltage	5 V, USB standard
Current	500 mA max, 10 mA average

English Medical Simulation Technologies hereby declares that this device is in compliance with the essential requirements and other relevant provisions of CE Directives. Please see the CE Declaration of Conformity for more details.

Français Medical Simulation Technologies déclare par la présente que cet appareil est conforme aux critères essentiels et autres clauses pertinentes des directives européennes. Veuillez consulter la déclaration de conformité CE pour plus d'informations.

Deutsch Medical Simulation Technologies erklärt hiermit, dass dieses Gerät mit den wesentlichen Anforderungen und anderen relevanten Bestimmungen der CE-Richtlinien übereinstimmt. Weitere Einzelheiten entnehmen Sie bitte der CE-Konformitätserklärung.

Italiano Medical Simulation Technologies con la presente dichiara che questo dispositivo è conforme ai requisiti essenziali e alle altre disposizioni pertinenti alle direttive CE. Per maggiori informazioni fate riferimento alla dichiarazione di conformità CE.

Компания Medical Simulation Technologies заявляет, что это устройство соответствует основным требованиям и другим соответствующим условиям европейских директив. Подробную информацию, пожалуйста, смотрите в декларации соответствия.

Български С настоящото Medical Simulation Technologies декларира, че това устройство е в съответствие със съществените изисквания и другите приложими постановления на директивите CE. Вижте CE декларацията за съвместимост за повече информация.

Hrvatski Medical Simulation Technologies ovim izjavljuje da je ovaj uređaj sukladan s bitnim zahtjevima i ostalim odgovarajućim odredbama CE direktiva. Više pojedinosti potražite u CE izjavi o sukladnosti. Čeština Společnost Medical Simulation Technologies tímto prohlašuje, že toto zařízení splňuje základní požadavky a další příslušná ustanovení směrnic CE. Další podrobnosti viz Prohlášení o shodě CE.

Dansk Medical Simulation Technologies Erklærer hermed, at denne enhed er i overensstemmelse med hovedkravene and andre relevante bestemmelser iCE-direktiverne. Du kan læse mere i CE-overensstemmelseserklæring.

Nederlands Medical Simulation Technologies verklaart hierbij dat dit apparaat compatibel is met de essentiële vereisten en andere relevante bepalingen van CE-richtlijnen. Raadpleeg de CE-verklaring van conformiteit voor meer details.

Eesti Käesolevaga kinnitab Medical Simulation Technologies, et see seade vastab CE direktiivide oluliste nõuetele ja teistele asjakohastele sätetele. Vt üksikasju CE vastavusdeklaratsioonist.

Suomi Medical Simulation Technologies vakuuttaa täten, että tämä laite on CE-direktiivien olennaisten vaatimusten ja muiden asiaan kuuluvien lisäysten mukainen. Katso lisätietoja CE-vaatimustenmukaisuusvakuutuksesta.

Ελληνικά Με το παρόν, η Medical Simulation Technologies Δηλώνει ότι αυτή η συσκευή συμμορφώνεται με τις θεμελιώδεις απαιτήσεις και άλλες σχετικές διατάξεις των Οδηγιών της ΕΕ. Για περισσότερες λεπτομέρειες ανατρέξτε στην Δήλωση Συμμόρφωσης ΕΕ.

Magyar Az Medical Simulation Technologies ezennel kijelenti, hogy a készülék megfelel a CE-irányelvek alapvető követelményeinek és ide vonatkozó egyéb rendelkezéseinek. További részletekért tekintse meg a CE-megfelelőségi nyilatkozatot.

Latviski Līdz ar šo Medical Simulation Technologies paziņo, ka šī ierīce atbilst būtiskajām prasībām un citiem saistošajiem nosacījumiem, kas norādīti CE direktīvā. Lai uzzinātu vairāk, skatiet CE Atbilstības deklarāciju.

Lietuvių Šiuo dokumentu bendrovė „Medical Simulation Technologies" pareiškia, kad šis įrenginys atitinka pagrindinius CE direktyvų reikalavimus ir kitas susijusias nuostatas. Daugiau informacijos rasite CE atitikties deklaracijoje.

Norsk Medical Simulation Technologies erklærer herved at denne enheten er i samsvar med hovedsaklige krav og andre relevante forskrifter i CE-direktiver. Du finner mer informasjon i CE-samsvarserklæringen.

Polski Niniejszym Medical Simulation Technologies deklaruje, że to urządzenie jest zgodne z istotnymi wymaganiami oraz innymi powiązanymi zaleceniami Dyrektyw CE. W celu uzyskania szczegółów, sprawdź Deklarację zgodności CE.

Português A Medical Simulation Technologies declara que este dispositivo está em conformidade com os requisitos essenciais e outras disposições relevantes das Diretivas da CE. Para mais detalhes, consulte a Declaração de Conformidade CE.

Română Prin prezenta, Medical Simulation Technologies declară faptul că acest dispozitiv respectă cerinţele esenţiale şi alte prevederi relevante ale directivelor CE. Pentru mai multe detalii, consultaţi declaraţia de conformitate CE.

Srpski Medical Simulation Technologies ovim izjavljuje da je ovaj uređaj u saglasnosti sa ključnim zahtevima i drugim relevantnim odredbama CE Direktiva. Molimo vas, pogledajte CE Deklaraciju o usklađenosti za više detalja.

Slovensky Spoločnosť Medical Simulation Technologies týmto prehlasuje, že toto zariadenie vyhovuje príslušným požiadavkám a ďalším súvisiacim ustanoveniam smerníc ES. Viac podrobností si pozrite v prehlásení o zhode ES.

Slovenščina Medical Simulation Technologies tukaj izjavlja, da je ta naprava skladna s temeljnimi zahtevami in drugimi relevantnimi določili direktiv CE. Za več informacij glejte Izjavo CE o skladnosti.

Español Por la presente, Medical Simulation Technologies declara que este dispositivo cumple los requisitos básicos y otras disposiciones relevantes de las directivas de la CE. Consulte la Declaración de conformidad de la CE para obtener más detalles.

Svenska Medical Simulation Technologies förklarar härmed att denna enhet är i överensstämmelse med de grundläggande kraven och andra relevanta bestämmelser i CE-direktiven. Se CE-försäkran om överensstämmelse för mer information.

Українська Medical Simulation Technologies заявляє, що цей пристрій відповідає основним вимогам відповідних Директив ЄС. Будь ласка, див. більше подробиць у Декларації відповідності нормам ЄС.

Türkçe Medical Simulation Technologies, bu aygıtın temel gereksinimlerle ve CE Yönergelerinin diğer ilgili koşullarıyla uyumlu olduğunu beyan eder. Daha fazla ayrıntı için lütfen CE Uygunluk Beyanına bakın.

Bosanski Medical Simulation Technologies ovim potvrđuje da je ovaj uređaj usklađen s osnovnim zahtjevima i drugim relevantnim propisima Direktiva EK. Za više informacija molimo pogledajte Deklaraciju o usklađenosti EK