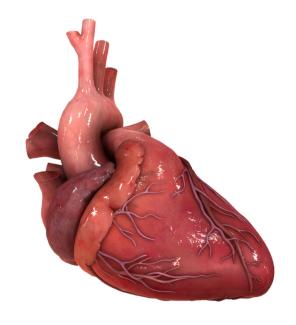




HeartWorks Virtual 3D Heart
Transesophageal Echocardiography Simulator
Transthoracic Echocardiography Simulator





Introduction

Inventive Medical Ltd. has developed HeartWorks over the past 5 years. At the core of the system is a computer-generated, animated 3D model of the normal human heart which has unrivalled qualities of accuracy and interactivity.

Progression from this point has led to high fidelity ultrasound simulation, both virtual and manikin-based, for transthoracic and transesophageal echocardiography.

With the addition of measurement tools and a student assessment package, HeartWorks will provide a comprehensive and effective teaching tool for all clinicians, from medical students to cardiologists, who share the need for an understanding of cardiac anatomy and echo imaging.

"It is exciting, one of the very best I have seen for some years. It shows the anatomy and function of the heart very accurately and is what you expect to see. This will have great impact on managing patients. This is just wonderful.."

Professor Sir Magdi Yacoub Professor of Cardiac Surgery





- Echocardiography Training Tool
- Developed by practising doctors
- Anatomically accurate 3D heart
- Real-time ultrasound simulation



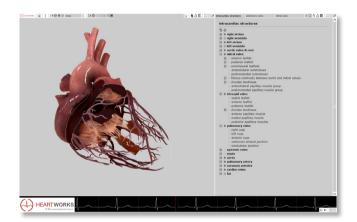
Anatomy Package

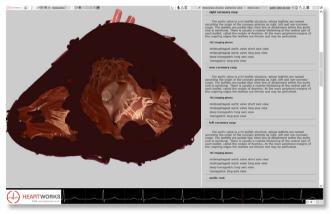
This product is a freely interactive computer generated model of the human heart with unprecedented anatomical detail and realism. The heart has been carefully animated to simulate the normal human cardiac cycle and is accurately synchronized to an EKG trace.

The beating heart is freely controlled by the computer keyboard and mouse; it can be viewed from any angle both internally and externally and through a range of zoom. It can be rotated around any axis and sliced in any plane to allow maximal flexibility in the display of cardiac structures.

Incorporated into the system is a comprehensive anatomy text with over 150 separate intracardiac structures labelled and described. Any selected structure can be simultaneously highlighted in the text and displayed within the 3D model. A number of predefined areas of the heart can be displayed separately or in combination to demonstrate anatomical relationships. The arrangement of the display windows on the screen can be adjusted by the operator according to personal preference.

Selected screen displays, still or animated, may be stored as slides, with impressive automatic transition between images within a slideshow. All image output can be displayed on the system monitor or relayed to an external projector to add a dramatic enhancement to lecture presentations.





"The animation of the heart is truly amazing, it's like working with the real thing. Exquisite."

Professor Robert Anderson

Emeritus Professor of Cardiac Morphology, Institute of Child Health, London



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Ultrasound Simulation Packages

Transesophageal echocardiography

This addition to the core anatomical model introduces the facility for real time TEE image simulation from the 3D virtual heart.

In the **Ultrasound Simulator Package** the on-screen introduction of a virtual TEE probe generates simulated ultrasound images that are derived directly and continuously from the 3D model. Ultrasound plane positioning is controlled using the computer keyboard and mouse via screen icons representing the standard flexion, rotation and angulation capabilities of a multiplane TEE probe.

In the **Manikin Simulator Package** a realistic TEE probe with authentic controls inserts into the mouth of a life-size upper-body manikin. With easy USB connection to the computer system, the hand held probe controls the position of the on-screen simulated TEE probe and ultrasound plane.

The 3D model can be set to display the 'cut surface' at the level of the TEE ultrasound plane to further clarify the plane orientation. This mode allows students of TEE to visualize clearly the relationship between the 2D TEE image represented on the screen and the underlying 3D anatomy of the heart. Any structure selected in the 3D model is highlighted in the simulated TEE image, and vice versa, so that the user can easily identify any intracardiac region.

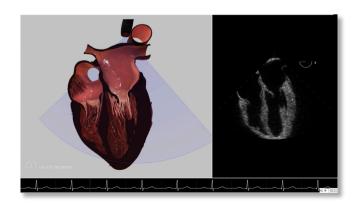
As with the core anatomy package, the arrangement of windows displaying the heart, the TEE image and descriptive text may be adjusted by the user. In this package the slideshow feature incorporates the ability to capture the simulated ultrasound images.

"This powerful learning tool has greatly simplified the understanding of TEE anatomy and image orientation and has the potential to literally change the landscape of TEE training. It is a revolutionary advancement in the field of echocardiography with an enormous potential."



Beth Israel Deaconess Medical Centre Harvard Medical School, Boston







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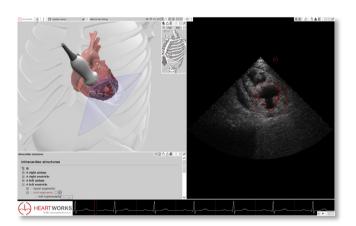
Transthoracic Echocardiography

This module allows real-time simulated TTE imaging of the virtual heart using a manikin. The life size manikin torso has soft skin with accurate, palpable anatomical landmarks to aid positioning of the handheld ultrasound probe.

The screen display allows the user to identify the position of the probe on the virtual chest as well as to see the orientation of the ultrasound plane.

The anatomy display includes a representation of the chest wall, ribs, sternum and spine as well as great vessels, lungs, pericardium, diaphragm and liver. These structures are displayed in the ultrasound view with realistic effects on cardiac imaging.

This package retains the virtual heart controls and features of the TEE and anatomy packages, along with the ability to generate 'slideshow' presentations.





"There is enormous demand for this type of skill in the field of intensive care, from cardiac physiology students to clinical practitioners. The inclusion of the HeartWorks simulation experience in our course will enable delegates to observe and safely practice skills for a day in a typical scenario before they go on to hone their skills in the peri-operative setting"

Dr Nick Fletcher

Consultant in Cardiothoracic Anaesthesia and Intensive Care Honorary Senior Lecturer at St Georges Hospital, London, UK



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Dual manikin package (TEE & TTE)

This package combines the anatomy, TEE and TTE packages with a single dual purpose manikin.

The TEE probe in this package is removable to enhance the realism of the simulated TEE procedure. The manikin may be positioned supine or at a 45° left lateral tilt to represent common scanning positions.







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Additional HeartWorks Products

'HeartWorks Plus' Extended Support

'HeartWorks Plus' offers an enhanced level of support at the expiry of the first year warranty period. Starting at the beginning of year 2 'HeartWorks Plus' can be extended to the end of year 5 and includes a scheduled 'on site' service and health check

HeartWorks Training

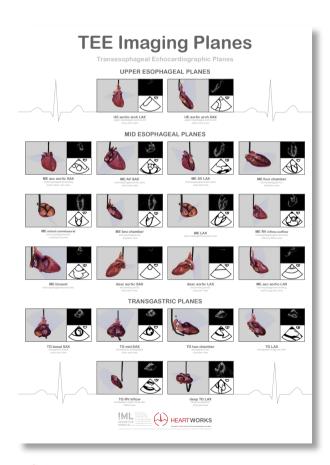
Additional training days can be delivered by qualified 'HeartWorks' staff at customer premises.

HeartWorks Images

High resolution still images of the HeartWorks virtual heart and simulated ultrasound are available for purchase on the HeartWorks website.

HeartWorks Video

High definition video clips of the animated heart and simulated ultrasound are also available on the HeartWorks website.



HeartWorks 'TEE Imaging Planes' Poster

A large poster (size B1, 1000mm X 707mm) of twenty standard TEE imaging planes is available on the website. The relative position of the probe to the heart, the corresponding ultrasound image and a line drawing of the TEE image are displayed for each imaging plane.



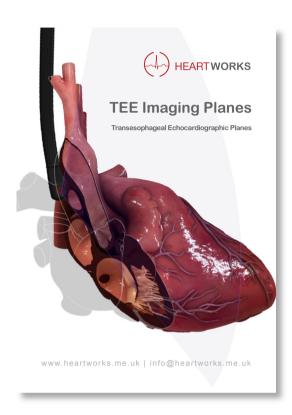
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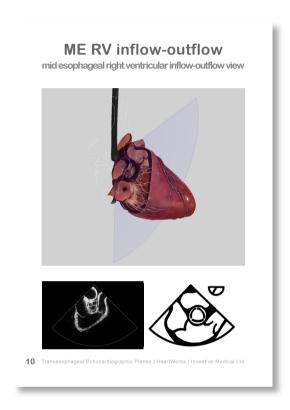


Additional HeartWorks Products cont...

HeartWorks 'TEE Imaging Planes' Booklet

Twenty TEE imaging planes, along with corresponding ultrasound images and line drawings, are also presented in an A6 (105mm X 148mm) booklet, providing students with a handy pocket size reference tool





HeartWorks Laptop Computer

Existing owners of HeartWorks desktop systems can complement their HeartWorks facilities with a laptop version of the HeartWorks software. With the ability to display the HeartWorks image output via the laptop monitor or via an external screen projector, this addition greatly enhances the system's potential to support educational activities and lecture presentations at distant locations.

HeartWorks Travel Cases

Customised travel cases are available for the manikin, computer and screen. The cases have a lightweight and durable outer lining with fitted sponge inner lining. All cases have integrated wheels for easy transportation.



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Detailed specifications

Anatomy Package

Hardware:

- · High specification desktop computer with Intel based processor
- · High-end graphics card
- · Keyboard and mouse
- DVD+/-RW Drive
- High resolution (1920 x 1200) 24" Widescreen monitor

Software:

- · HeartWorks freely manipulable virtual heart model with labels
- · Anatomy textbook
- User manual

Transesophageal Echocardiography Package

Hardware:

- Includes Anatomy package hardware, plus:
- Fibreglass and soft rubber, latex free, torso manikin -80cm x 48cm x 28cm
- · Removable simulation TEE probe

Software:

- · HeartWorks freely manipulable virtual heart model with labels
- · Anatomy textbook
- · User manual, plus:
- Ultrasound simulation package with both manikin, keyboard and mouse controlled TEE functions.

Transthoracic Echocardiography Package

Hardware:

- · Includes Anatomy package hardware, plus:
- Fibreglass and soft rubber, latex free, torso manikin -80cm x 48cm x 28cm
- Removable soft skin area and left lateral tilt mechanism
- · Simulation TTE probe

Software:

- · HeartWorks freely manipulable virtual heart model with labels
- · Anatomy textbook
- · User manual, plus:
- Ultrasound simulation package with manikin control of TTE functions

Transesophageal and Transthoracic Echocardiography combined Dual Manikin Package

Hardware:

- Includes Anatomy package hardware, plus:
- Fibreglass and soft rubber, latex free, torso manikin -80cm x 48cm x 28cm
- · Removable soft skin area and left lateral tilt mechanism
- · Removable simulation TEE probe
- Simulation TTE probe

Software:

- · HeartWorks freely manipulable virtual heart model with labels
- · Anatomy textbook
- · User manual, plus:
- Ultrasound simulation programme supporting both TEE and TTE functions.



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Benefits of Purchasing and Using HeartWorks®

This document outlines some of the benefits that have been realised by customers from implementing the HeartWorks system.

Financial

- · More efficient use of training resources
- Reduced training time
- · Time-effective use of training facilities
- · Ability to teach larger groups
- · Ability to generate income from teaching/training using HeartWorks based training programs

Educational

- Improved learning and understanding of:
 - Echocardiography
 - Relationship between anatomy & echocardiography¹
- Improved practical skills acquisition¹
- Accelerated learning:
 - Reduced time to achieving competence¹
 - Reduced time demand on tutors
 - Improved ability to offer self-directed learning
- · No dependence on operating schedule & clinical material availability:
 - Improved efficiency of training time usage
 - Improved ability to schedule training time
- · Ability to create bespoke slideshows and teaching modules
 - Applicable to students at any level of training
 - Applicable to a broad spectrum of disciplines (medical, nursing, paramedical, technical, schoolchildren...)

Clinical

- · Better informed clinical practice
 - Improved diagnostic ability of clinicians
 - Improved quality of patient care
- · Ability to schedule training away from clinical area
- · More clinical time spent 'patient' focussed rather than 'training' focussed

Risk

- · Reduced risk of trauma to patient by unskilled practitioner
- · Reduced patient complaint
- · Reduced risk of distraction in clinical area (during teaching)
- Reduced infection risk (fewer personnel in clinical environment)

Additional

- · Prestige with using innovative teaching methods & materials
- · Enhancement of existing simulation facilities
- · Enhanced institutional profile
- · Increased attraction to potential student and tutor applicants
- · Ability to access continued developments and upgrades in HeartWorks software & hardware

1 Smith LA, Bhan A, Paul M, Monaghan MJ. Expert evaluation of a novel transoesophageal echocardiography simulator. Eur J Echocardiogr 2010, 11 (Suppl 2): P898





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