INTERACTIVE LINAC MODELS IN MEDICAL EDUCATION

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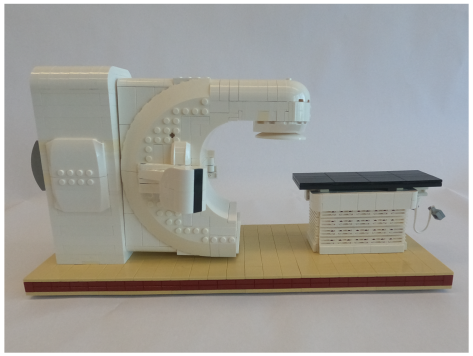
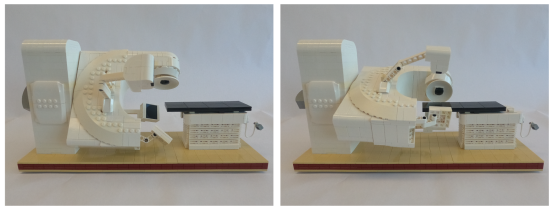
VAIDER LAB
Veterinary AI in Diagnostic Imaging and Radiotherapy

Interactive models and **gamification** in medical education **can improve learning outcomes**, enhance practical skills, and prepare trainees for the challenges of real life. This include **simulations**, **virtual reality** constructs, **board games**, role-playing and multi-player games, and puzzles. **We illustrate** how complex **electro-mechanical componentry** can be visualized and learning gamified.

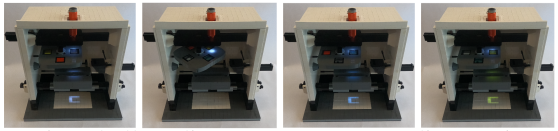




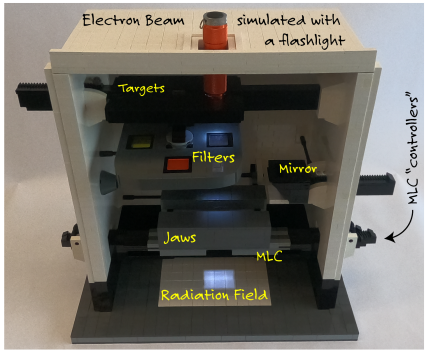
See it in multiple views

Maker toys such as Lego(c) offer engaging educational opportunities for learners due to their low cost, versatility, and hands-on nature. These tools provide visualization, abstraction, simplification of complex processes, and offers inviting ways to demystify complex systems. A linac model was created for educating the general public, and a more sophisticated one was developed for medical professionals. All models were created via collaboration with a world-renowned Lego(c) artist [1].

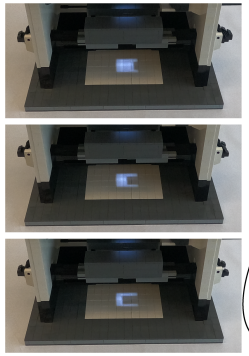
Below is a Lego(c) model for the essential components of the clinical linear accelerator head. These devices, used to deliver radiation to cancer patients, consist of complex machinery, electronics, and software. Electromechanical components of the linear accelerator head are simulated with moveable parts. The target, flattening filters, jaws, multi-leaf collimators, and light fields can move relative to each other, illustrating their co-dependencies. The model can highlight the need for quality assurance by demonstrating inter- and intra-leaf leakage and electron, target, and filter (mis) alignments.



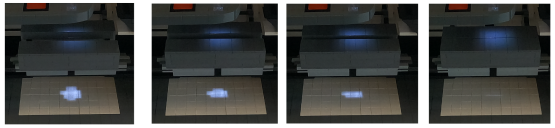
Simulation of different filters on a carriage, where each filter is visualized with colored Lego(c) windows. Handle that rotates the carriage not shown.



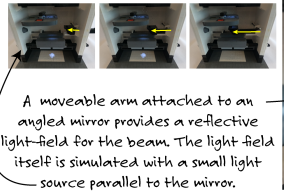
Linear Accelerator Head Model



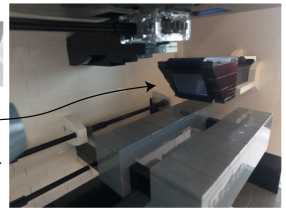
Simulation of Multi-leaf Collimation



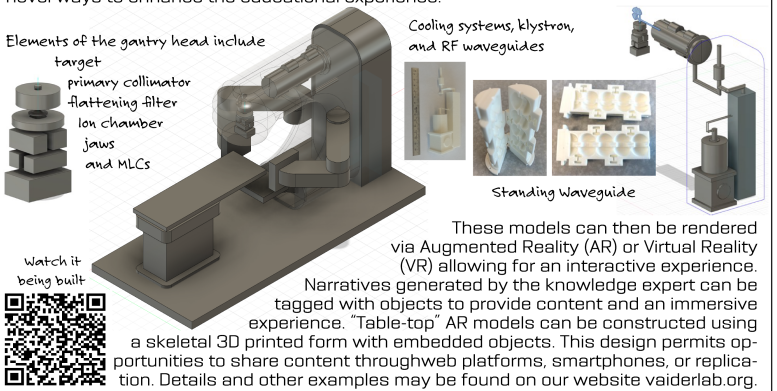
Lower Inplane jaws collimate the beam prior to MLC beam shaping.



A moveable arm attached to an angled mirror provides a reflective light-field for the beam. The light field itself is simulated with a small light source parallel to the mirror.



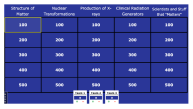
The adoption of 3D printing in medicine has improved the democratization, access, and efficacy of healthcare. Applications include surgical planning, custom prosthetics, and patient treatment and support devices. These technologies also offer limitless ways for enhancing medical education. A critical step in the 3D printing process is rendering and designing structures through computer-aided design (CAD) software. CAD models can facilitate the creation of Digital Twins. Both **form** and **function** of sophisticated electromechanical systems can be modeled using basic open-source software packages, offering novel ways to enhance the educational experience.



These models can then be rendered via Augmented Reality (AR) or Virtual Reality (VR) allowing for an interactive experience. Narratives generated by the knowledge expert can be tagged with objects to provide content and an immersive experience. "Table-top" AR models can be constructed using a skeletal 3D printed form with embedded objects. This design permits opportunities to share content throughweb platforms, smartphones, or replication. Details and other examples may be found on our website vaiderlab.org.

Medical education can be enhanced in simple forms as well. For example, interactive online tools, such as Jeopardylabs.com shown below, provide simple and fun ways for students to test knowledge retention, evaluate learning thorugh group review sessions, and allow individuals to review material at their own pace. Examples of freely accessible games aimed for different levels of expertise, ranging from gradudate level Radiation Oncology Physics to other medical professionals.

JeopardyLabs



Acknowledgements
1. **Paul Heatherington**: Instagram @paulhetheringtonartist
2. **Gregory Marzano & Hyun Maeng**, Biomedical Engineering, Cornell University.

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