TimeBOMB: An Interactive Game Station Showcasing the History of Computer Games

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Figure 1: The TimeBOMB game station with its four faces.

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Abstract
We present TimeBOMB, an interactive game station that enables players to experience the history of computers and video game development. They compete with each other playing an adaption of the classic game *Bomberman*. As a novelty, each of the four sides of the station represents a different time period with corresponding input and output modalities. They consist of an oscilloscope interface with self-made, analogue control dials, a text-based interface controlled by a keyboard, a 2D arcade interface controlled by a joystick, and a 3D interface controlled by a gamepad. These four styles resemble iconic examples from the history of computer games. The game's art style also differs for each side accordingly.

Author Keywords
Interactive Exhibit; Game; History; Multi-user; Multi-display

CCS Concepts
•**Human-centered computing** → *Interaction devices; Collaborative and social computing; Collaborative interaction;*
•**Applied computing** → **Education;**

Introduction
The development of computer interfaces evolved from electron-beam tubes and punchcards to TFT monitors and key-boards and finally, high-resolution touch screens and gamepad

Figure 2: Rendering of the game stations digital 3D model.

prevalent today. As those modern interfaces differ drastically from the old technologies, it can be challenging to teach this development to laymen, especially kids. Instead of using descriptions, pictures or devices from specific periods, we integrate four important milestones into a single, interactive exhibit (see Fig. 1). This enables users to experience a particular point in history with direct comparison to older or more modern developments.

Therefore, we present TimeBOMB, an interactive game station which teaches the history of computer and video games in a joyful manner. Playing an adaptation of the competitive game *Bomberman*, up to four players experience four iconic time periods of video game development. All players compete with each other using the corresponding input and output modalities typical for the four time periods. As a single round is reasonably short, players can directly experience the change of interfaces with all their (dis-)advantages by switching to a different side or rather time period. TimeBOMB is aimed at laymen of every age, especially the ones that are too young to have personally experienced all the presented time periods.

Related Work

To develop an exhibit capable of teaching laymen the history of computers and video games, it needs to be appealing, fascinating and thought-provoking. To create a game is not only close to the topic but also an appropriate way to educate laymen, especially kids [2, 11]. Video games support learning by combining thinking, social interaction and technology [7]. A multiplayer exhibit that allows players to face each other fosters communication [8] and leads to a different social dynamic [10]. The presence of observing audience of an exhibition may lead to a better player experience and performance [3]. Additionally, social player's wellbeing increases when playing with strangers [9].

Concerning the game, *Bomberman* is an appropriate foundation for a derived adaption as there are many variations, e.g., suitable for large displays [5] or with body-driven interaction [4]. It is also suitable for easy automated opponents using statemachines [1] or AI [6].

TimeBOMB Game Station

Our exhibit TimeBOMB consists of a cuboid game station, which enables up to four players to compete with each other in an adaptation of the classic game *Bomberman*. The following sections describe in detail the significance of each represented time period and their respective input and output modalities.

Oscilloscope – 1950s

The first side is inspired by the iconic *Tennis for Two*, one of the oldest known video games, which was presented in 1958 in New York. It simulates a game of tennis on an old oscilloscope. TimeBOMB mimics the input and output conditions of this classic game. A small screen, housed in the body of a real oscilloscope, displays the game scene with monochrome green vector graphics and afterglow, typical for this time period (see Fig. 8a, right side). The input is strongly inspired by the original *Tennis for Two* controller and consists of two knobs to control vertical and horizonal movement, and a push button to place bombs (see Fig. 3). This creates an experience that strongly resembles the limited technical possibilities at that time.

Text-based – 1970s

The next significant period TimeBOMB adresses is text-based interfaces, especially text-based games like the famous *Rogue*, which became an eponym for a whole genre. For this period, the display shows ASCII characters in a fixed grid, which have one of four colors. These characters are combined to form shapes resembling the player avatars

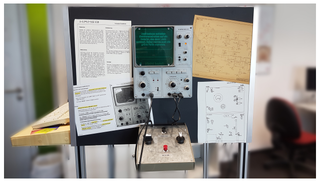


Figure 3: Oscilloscope - 1950s

Figure 4: Text-based - 1970s

Figure 5: Arcade - 1980s

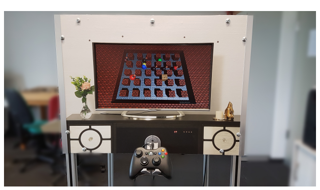


Figure 6: Modern - 2000s

and the environment. The display is housed in the frame of an old CRT-monitor (see Fig. 4). The game is controlled by keyboard, with four buttons dedicated to movement and one to placing bombs.

Arcade – 1980s
Another important period in the history of video games are arcade halls, dedicated stores filled with several coin-operated cabinets and a large variety of games. The third side of TimeBOMB is dedicated to closely resemble one of those cabinets (see Fig. 5). The game is presented in colored 2D sprites common for that time period. Each pixel is split into red, green, and blue channels and a scanline and a screen curvature effect are added to invoke the impression of an old CRT monitor. The input is handled by a large arcade joystick and push buttons, resembling typical arcade machine designs.

Modern – 2000s
The final side of the station is based on recent home entertainment systems, designed to resemble a living room TV setup (see Fig. 6). The display (aspect ratio 16:9) shows a full 3D representation of the game, including lighting, particle effects, and detailed textures. The game is controlled with a modern Xbox gamepad, using an analog stick for movement and one of the buttons to place bombs. This setup of TimeBOMB is most likely familiar to the players and demonstrates the tremendous development of computers and video games since their humble beginnings.

Construction and Development

The construction of the station was planned in a CAD application with millimeter precision. All required components and electronic devices were measured and transferred into the digital model. Finally, a metal section frame and wooden covers were designed to define the final shape and look of the station. This digital design process helped to ensure, that all components will fit into the station and how they needed to be arranged.
The station can be mounted at a height of either 140cm or 170cm to best fit the exhibition space and the expected audience. Three of the four faces have rectangular cutouts of various sizes to accommodate the corresponding screens. On the flat plywood boards elements, like the oscilloscope body, the CRT monitor frame, and the rest for the keyboard are attached. The arcade side is recessed into the cuboid to give the impression of a real arcade cabinet. The wooden body was primed white and laminated with plastic sheeting, designed to set the mood for each particular period.

Design Specifics
The oscilloscope used to represent the first time period is an original *Hameg HM 312* produced in Germany in the 1960s (see Fig. 3). Most of the oscilloscope's interior was removed but the original buttons, rotary-switches, and jacks on its front face are still articulated. The oscilloscope's body is surrounded by pages from the original manual and a circuit diagram of the inspirational *Tennis for Two*.
The *Text-based* period (see Fig. 4) is inspired by a typical desktop in the 1980s. An old *5170 IBM PC AT*, a membrane keyboard, and the frame of a CRT monitor completes the impression of a vintage office.
The side for the *Arcade* period (see Fig. 5) is laminated with sheeting that mimics the design of typical arcade cabinets. It uses the stylized variation of the in-game sprites and a TimeBOMB logo is placed prominently on top. Additionally, RGB LEDs and luminescent buttons illuminate the station, to invoke the atmosphere of a typical arcade store.
The *Modern* time period is represented by a flat TV placed on a living room shelf. Attached to the otherwise planar cover is a 3D printed mount for the tethered Xbox gamepad.

The classic *Bomberman*

Up to 4 players compete with each other starting in the corners of a rectangular game scene. Every other tile is either a thick wall or a destructible barrier. Each player can place a bomb which will destroy those field elements in the vertical and horizontal direction to create new paths for movement. If a barrier is destroyed by an explosion, it drops an item. Those allow a player to place more bombs at the same time, increase a bomb's explosion range, or add the ability to kick bombs in a straight line.
A player is eliminated if hit by an explosion until only one opponent remains.

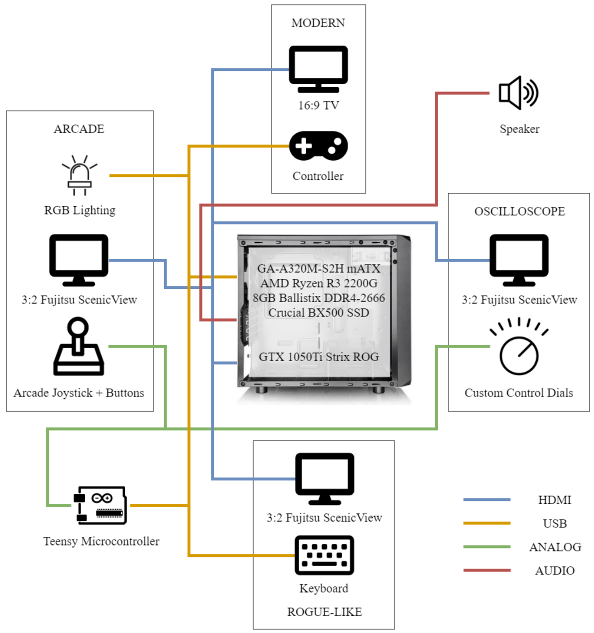


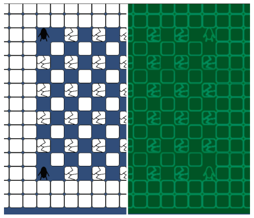
Figure 7: Internal wiring of all electric components of TimeBOMB.

Electronics
A single PC occupies the interior of the game station with a GPU (GTX 1050Ti Strix ROG) capable of controlling 4 individual monitors. Other technical specifications can be found in Figure 7. There are three monitors (aspect ratio 3:2) and one TV (aspect ratio 16:9) placed behind the four faces visible from the outside to emulate the different displays from each epoch. The keyboard and a Xbox gamepad are directly connected to the PC via USB. The custom rotary controls, the arcade joystick, and the buttons from the *Oscilloscope* or *Arcade* side are wired to a *Teensy 3.6* microcontroller board. This Arduino based board can be wired to a PC via USB and emulate a Human Interface Device. The incoming analog signals are mapped to the buttons of a virtual gamepad which the game engine can interpret. Speakers were added to play the in-game music.

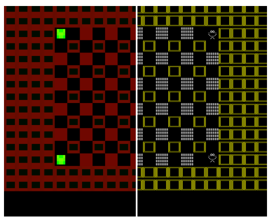
TimeBOMB Game
The TimeBOMB game is closely related to the famous *Bomberman* games (see sidebar). Figure 10 shows some of the game elements like the player, bombs, and dropped items and how they differ on each time period.
Ninety seconds after a round started, the game scene begins to shrink in a spiral pattern and players touching the new walls will be eliminated. This leads to a maximum time per round of around 2 minutes.
In addition to the classic *Bomberman* items, we introduced a special "virus" item. It triggers a negative effect for one random opponent once collected by a player which is typical for their epoch. On the *Oscilloscope*, the image starts to obliterate, as the afterglow effect, which is typical for the former electron-beam tubes, intensifies. On the *Text-based* period, ASCII characters and colors are flipped to form skull and crossbones. The *Arcade* side shows a distortion effect as if a strong magnet is held to the side of the CRT screen when it receives the virus. On the *Modern* period, players suffer from a reduced framerate, resembling lag resulting from a bad internet connection. The negative effects disappear after 10 seconds.

Game Development

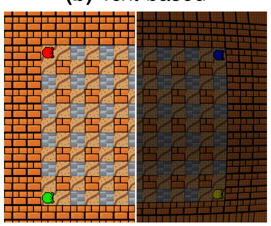
The software for TimeBOMB was developed using the Unity game engine. A single application provides the views for the displays of all four time periods. The views are synchronized with each other. Therefore, no networking is required. The main challenge in developing the application was to achieve the visual look typical for each individual time period. This includes mimicking the technical characteristics



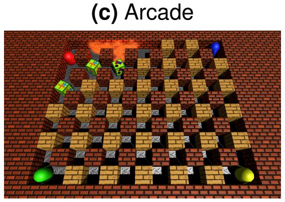
(a) Oscilloscope



(b) Text-based



(c) Arcade



(d) Modern

Figure 8: Different shaders for each side are creating the style typical for each epoch.

of oscilloscopes and CRT monitors and emulating similar computational capabilities common for these time periods like text-based interfaces or 2D sprites with limited resolution. All effects are achieved by dedicated post-processing shaders which are applied to the individual views.
To mimic an oscilloscope is challenging as it is not pixel-based like today's monitors. Thus, transitions between neighbouring pixels need to be smooth and pixelated edges should be avoided. Additionally, the whole image needs to consist of lines with even thickness to look like it is being constantly drawn by a single electron beam. We achieve this with the following steps: A Sobel filter detects the horizontal and vertical borders of the image. The previous frame is weighted into the current frame to achieve the afterglow effect. Afterwards, the image is blurred to prevent pixelated borders. Finally, faded horizontal lines are added to the image to imitate the moving electron beam. 2D sprites with little details and high contrast are required as a foundation for this shader to work properly (Figure 8a).
The *Text-based* period also incorporates a post-processing shader which ensures the placement of ASCII characters in a fixed grid layout. The screen is subdivided into 8×12 pixels which contain a single character (see Fig. 8b). The center pixel's green color channel determines which character is shown and its red channel determines the corresponding color. The available colors are identical with the *Microsoft Windows default 16-color palette*.
To accomodate for the much smaller pixel density on early CRT displays the post-processing shader on the *Arcade* side divides pixels into groups of nine. The pixels on the first two rows represent the red, green, and blue channels. The third row is darkened to imitate scanlines (see Fig. 9). Finally, the whole image is warped to mimic the curvature of a glass display (see Fig. 8c).
For the *Modern* side, no post-processing shader was used, because the aspired style is common for today's game engines like Unity (Figure 8d).
On top of the visual output, self-composed 8-bit music was added to the game. It is a medley of iconic melodies from the video game history.

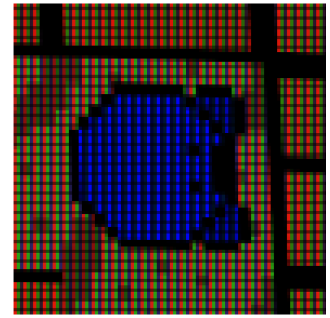


Figure 9: To mimic a low resolution CRT monitor 9 pixels are grouped and the result gets split into its color components.

The final game runs on the MS Windows 10 OS on the computer inside the game station. All input devices are connected to it and inputs are assigned to the corresponding side. When the station is plugged in, the game is started automatically after booting. Common hot keys were disabled to prevent users from closing the game or running other applications.

Conclusion

We presented TimeBOMB, a stand alone game station that teaches the history of computers and video games in a joyful manner. TimeBOMB was presented at several public events, like the *50 year anniversary of computer science education* in Dresden, and the exhibition on video games in the Technische Sammlungen Dresden. The ease of learn-

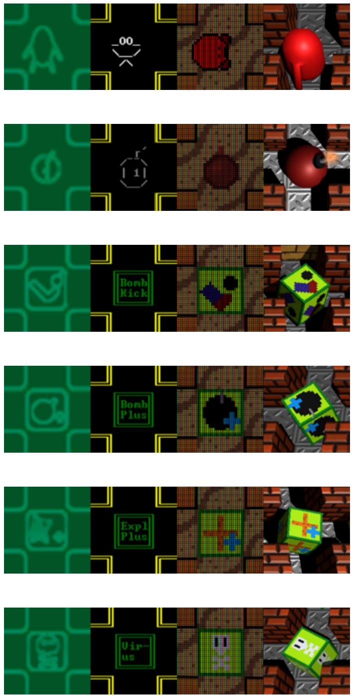


Figure 10: Elements of the TimeBOMB game in the different applied styles.

ing the game as well as the extraordinary appearance reliably managed to draw in large crowds. TimeBOMB was enjoyed by children and adults alike and sparked many curious conversations about the history of computers and video games.

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