Heartwood Inc.

Air Flow Simulation

28th July 2020 (updates in orange 8th August 2020)

1. OVERVIEW

An interactive simulation of the air flow through a locomotive and rail car air system from engine start to engine shutdown. This is a tool that will allow users to manipulate objects related to the air system, showing realistic feedback to their inputs.

2. TRAINING GOALS

1. Understand how air flows through the air system of a locomotive and 10 car consist.
2. Identify air system components on locomotive and rail cars.
3. Manipulate simulated controls to gain a better understanding of how these adjustments affect the air system.
4. Speed up learning and improve understanding of the air system without requiring hands-on training.

3. SPECIFICATIONS

This air simulation will be based off of the 26L Air Brake system for the locomotive and a single standard type of air brake system on each car will be the same.

4. MILESTONES

4.1 Preliminary Design

The Heartwood development team embarks on a deep dive into the subject matter of the project to fully understand and identify the problems that need to be solved. During this research, the project design is created, iterated on and finalized. The end result of the Preliminary Design phase will consist of two items, a Project Design Document alongside a set of comprehensive interactive mockups. When both are combined it will give the customer a clear understanding of Heartwood's vision of the final product.

4.2 Project Design Document

Heartwood presents to the customer a completed Project Design Document outlining in detail the project development goals and details. Customer signs off on design, features and final scope of work.

4.3 Project Development

The Heartwood development team begins development using the agreed upon Project Design Proposal. Development will consist of 2 week sprints, where major project goals are worked on. At the end of each 2 week sprint, the current progress of the application is presented to the customer for feedback. This feedback will be incorporated into the next 2 week sprint along with continued development. The cycle continues for the duration of the project development schedule until the project is completed. Some design changes can be made during the project development cycle but any scope changes or design shifts requested can result in cost overruns, budget adjustments, and development schedule changes.

4.4 Final Delivery

After completion of the Project Development cycle, Heartwood will submit for review a Final Delivery of the Application. There should be no significant changes to the application design or content at this point, and is used to finalize any outstanding feedback that has been received from the customer. If any changes need to be made to this version of the application, extremely clear feedback must be outlined by the customer and agreed upon by Heartwood.

4.5 Deployment

The final version of the application will be distributed to the customer on all formats. All application formats must be tested by the customer and signed off as working as intended.

Deployment Targets

- PC
- iOS
- SCORM Package for LMS

5. PROJECT DESIGN DOCUMENT

5.1 Splash Screens

The opening phase of the application processes loading tasks while displaying Heartwood and Customer Logos.

5.2 Menu

- Introductory information about the application and its features
- Begin Simulation button
- Exit application button and confirmation window

5.3 Simulation

The core function of the application, the air flow simulation. When the simulation has started the user will see an overhead view of the lead locomotive graphic. The application will simulate the 26L air brake system and car components to an accuracy level that will allow all core functions of the brake system to be replicated and visualized within a reasonable limit. The simulation may not replicate the influence of internal or external environmental conditions 100%.

Visualization

The simulation is viewed from an overhead perspective. The user sees the locomotive and cars as if they are above the tracks looking down. From this perspective the air system components are laid out in a semi-realistic fashion that mimics where these components would be located on real life equipment. This is not meant to be a visually lifelike simulation in terms of graphics, but a stylized map of where these components are located to help the student understand the positional relationship of components to their locomotive or car during the simulation.

LOCOMOTIVE - 26L EQUIPPED
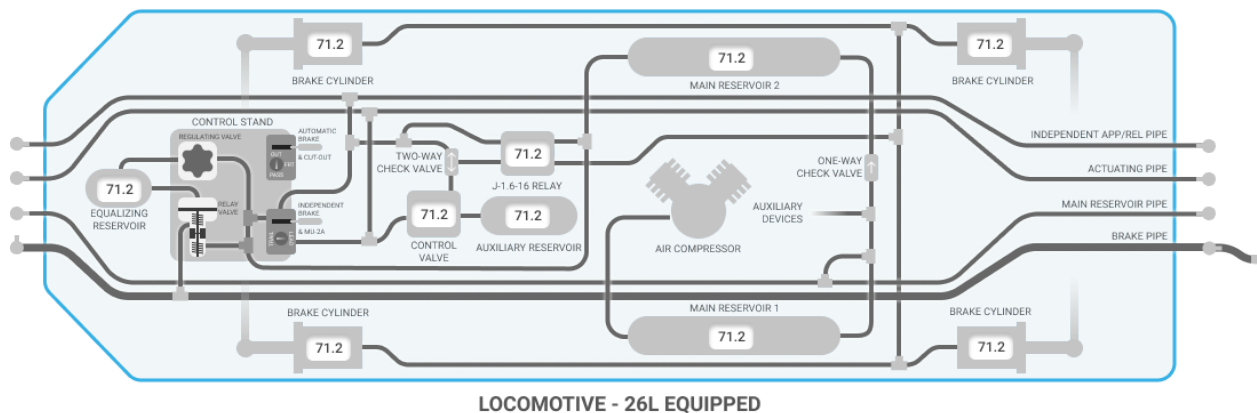
In this stylized view of the simulation the user will see graphical representations of each component and the piping that connects them. The layout of the piping and positions of components will generally reflect the air system layout in a way that promotes clarity and user understanding of the system.

Navigation

Walking the train. The user will be able to navigate through the Air Simulation by horizontally scrolling the length of the train. Click/touch on a locomotive/car then drag left or right to move the view. This will move the train across the screen allowing the user to glide along the train following air lines and equipment.

- PC/WebGL (Click + Drag)
- iOS (Touch + Drag)
- Universal (On screen minimap)

In addition to these inputs, users can also select a train car from the minimap version of the train. Selecting a locomotive or car icon from this minimap will jump the view to the select piece of equipment. See the image below, the blue car has been selected and the main simulation view would be centered on the air system of this car.

Zooming In and out. To see smaller details of the air system, the user can zoom in and out as needed. In addition to traditional input methods (scroll wheel, touch pinch), there will be separate zoom in and zoom out buttons on screen that allows the zoom level to be incrementally adjusted.

- PC/WebGL (Mouse Scroll Wheel)
- iOS (Pinch)
- Universal (On screen controls)

Reset View Button - When pressed, this button automatically zooms out the view and centers the view onto the nearest car or locomotive. The purpose is to give a shortcut to the user to continue navigating down the train after zooming in to inspect smaller components as well as an easy way to reset to the default view settings.

Air Pressures and Flow

Main Reservoir Pipe (MR), Equalizing Reservoir (ER), Brake Pipe (BP) and Brake Cylinder (BC) and Air Flow Meter
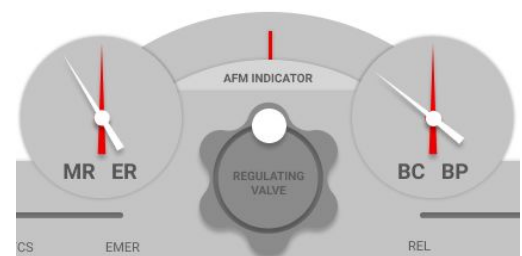
Indicator (AFM) will all be displayed along with the user input controls, mimicking the control stand inside a locomotive. The user will be able to see the gauges change in real time.

Overlaid on top of the components and piping will be colored directional arrows that indicate the flow of air and the pressure change that is happening to this area of the system triggered from events such as charging, brake application, pressure releases, and recharging of the system. As pressure flows from one area to another the arrows will animate, following the piping. If the pressure increases, the arrow color will begin to fade towards red. If the pressure decreases, the arrow color will fade towards blue. Arrows will fade away completely when there is no flow.

For components that store air or react to pressure changes, a digital numeric readout will overlay on top of that component, indicating its current air pressure. This value will update in real time as the air system changes state. See Main Reservoir 1 in the above image.

Interactive Air System Components

These objects will be how the user can manipulate the air system. As these controls are adjusted by the user, the simulation will show the effects of these adjustments in real time, visualizing the changes on screen. There are two types of interactive components. Primary controls are Control Stand components that are used during normal operation of the locomotive. These are located at the bottom of the simulation screen and give more precise input control using a slider style input method. The user will select and drag the white circular handle on a primary control to adjust its position, in turn affecting the simulation.

Primary Controls

- Automatic Brake
- Independent Brake
- Regulating Valve
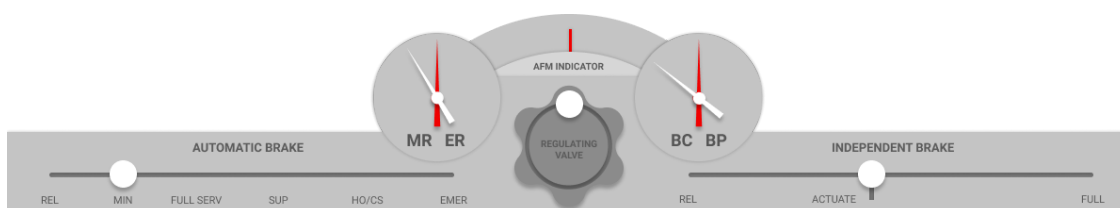
Secondary Controls allow adjustment to accessory features of the simulation using a button press style input method. These allow the user to change the state of objects within the air system like valves and toggles. When the user selects a component that has Secondary Controls that can be manipulated in the air system, a context menu will open showing the control options for that component. When the user selects a control open in the menu, it will change the state of the selected object to the selected control option and the menu will close.

Secondary Controls

- Air Compressor (ON, OFF)
- Angle Cock (CUT IN, CUT OUT)
- Automatic Brake Cutout (CUT OUT, FREIGHT, PASSENGER)
- Cutout Cock (CUT IN, CUT OUT)
- MU-2A Valve (TRAIL, LEAD)
- Retaining Valve (EX, HP, SD)
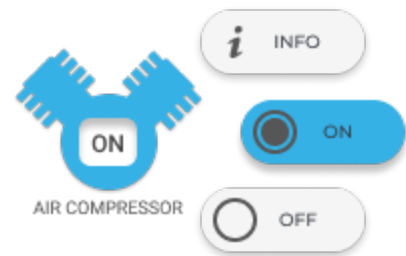
Animated Components

Some components of the air system will display their state change using animation to help visualize to the user that their actions have had an effect on the system. The user will be able to see valves/dials rotate and pistons extend. These can be either a direct result of the user interacting with that component, or a byproduct of an air system change they have made.

Quick Charge

This is a button that appears on screen during the simulation and allows the user to speed up time. When pressed the air system will fill to the fully charged state much more quickly. This is intended to help instructors and students skip past slow charge times when desired to make better use of their training time.

Pause/Play Simulation

Pressing this pause button holds the simulation and all animations and air flow at the point in time it was pressed. The pause button will disappear and a Play button
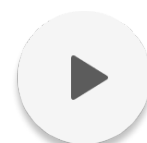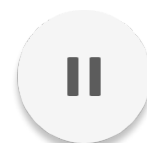
Component Identification

Every component that is visualized in the application will be selectable by the user. When selected the component will colorize blue and a small information popup button will appear. The user can select the popup button to learn more about the component. This will open the Component List.

Component List

All visualized components of the air simulation in this application will be available within this list. It serves as a searchable reference guide that users can easily access to get more information on components. It will contain a description about the component and its purpose within the air system. If a component is selected within the list, the information area will expand to display a list of components that is connected to the selected component, see Main Reservoir 1 in the image below. These connected components behave as buttons, when pressed it will update the component list, showing the information for the recently selected component.

Visualized Locomotive Components

Actuating Pipe	Independent App/Rel Pipe
Air Compressor	Independent Brake
Angle Cock	J-1.6-16 Relay
Automatic Brake	Main Reservoir Pipe
Auxiliar Devices	Main Reservoir 1
Auxiliary Reservoir	Main Reservoir 2
Brake Cylinder	MU2A Valve
Brake Pipe	One Way Check Valve
Control Stand	Two Way Check Valve
Control Valve	Regulating Valve
Cut Out	Relay Valve
Equalizing Reservoir	

Visualized Railcar Components

Angle Cock

Retaining Valve

Auxiliary Reservoir

Service Piston

Brake Cylinder
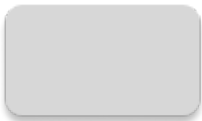
Strainer

Brake Pipe

Vent Protector

Charging Choke

Vent Valve

Check Valve

Control Valve

Cutout Cock

Dirt Collector

Emergency Piston

Emergency Reservoir

Quick Action Volume