

Vortex Rough Terrain Mobile Crane Training Module 2016a: Product Specification

This document provides an overview of the Rough Terrain Mobile Crane Training Module as delivered with the 2016a release. Consult the relevant manuals for specific details.

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1 VORTEX ROUGH TERRAIN MOBILE CRANE TRAINING MODULE

1.1 Rough Terrain Crane Machine

The Vortex Rough Terrain (RT) Crane is a generic 40-ton RT crane with a 9.8–31 meter, four-section telescopic boom. It features the standard capabilities that are available on a wide range of OEM products and that would feel familiar to most experienced operators.



From the seat the operator has a view that accurately matches the view from inside a real RT crane.

1.1.1 Engine and Hydraulic Systems

The simulated engine supplies power to the hydraulic systems. The power and torque delivered depend on the engine RPM and are modelled on generic curves found on similar 40-ton cranes. The operator will notice an RPM performance drop when lifting heavy loads if the throttle is not set correctly.

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1.1.2 Outriggers

The crane outriggers are controlled through the crane HMI. The operator can set the outrigger beams to three positions recognized by the HMI: Fully extended, 50% extended, or retracted. The operator will then need to level the crane by deploying the outrigger jacks. It is possible to set outrigger pads under the jacks provided that the outriggers are not touching the ground.

1.1.3 Boom

The boom is composed of four parts: the basic boom and three telescoping sections. The telescoping sections deploy together when increasing the cranes range. The length detector will update the boom position on the HMI.

As the boom increases in length the likelihood of boom deflection increases. The operator must compensate for boom deflection when picking up heavy loads.

The main hook is controlled by the boom and can be used to pick up selected objects at any time. Should the operator need to change the rope reeving, the line configuration of the crane can be changed during operation to up to seven parts of line. If selected, the operator will need to ensure that the crane is in a safe configuration before the lines are deployed, by following the on-screen instructions.

The anti-two-block is visible to the operator and fully functional.

1.1.4 Jib

The crane is equipped with a stow-away jib that can be deployed and re-stowed at any time during the operation. The operator will need to ensure that the crane is in a safe configuration before proceeding, by following the on-screen instructions.

1.1.5 Boom tip camera

The crane is fitted with a boom tip camera that supplies the view from the tip of the main boom downward toward the main hook. The camera feed can be turned on or off at any time to facilitate operations.

1.1.6 Controls

The following controls are simulated through the hardware:

- Main hook hoist/lower
- Auxiliary hook hoist/lower
- Boom up/down
- Swing left/right
- Boom tip camera zoom
- General stop (Emergency power off)
- Engine start/stop
- Hoisting Gear slow/fast
- Horn
- Hook button
- Swing brake pedal
- Telescopic Boom in/out

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- Throttle

1.2 Cabin and Human Machine Interface (HMI)



Through the HMI the operator has visibility or control of the various functions of the crane, environment and simulator.

Outrigger Control – Full control of the placement of the outriggers. By default, the crane starts fully packed. The operator must level the crane before conducting any operations.

Swing Brake – Manually set the swing brake of the crane. This switch, when on, will override the hardware pedal swing brake.

Crane Gauges – Simulated outputs of the following: Oil Pressure, RPM, Fuel, Water Temperature, Oil Temperature, and Battery Charge. With the exception of RPM, which is updated in real-time, the gauges will not move in normal operation. They will respond to injected faults if included.

Engine Start/Stop – Start and Stop functionality of the crane.

Throttle – Manual control of the baseline throttle position.

Crane Function – Turns crane functionality on.

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Boom Tip Camera – Turns on and off the boom tip camera as well providing zoom control of the image.

Boom Extension – Deploy the jib boom extension (at 0 degrees) during runtime operation. To deploy the jib the operator will need to follow on-screen instructions to ensure proper safety procedures are followed.

Outrigger pads – Manually place outrigger pads directly under the outriggers. Note that in order to be deployed the outriggers cannot be touching the ground.

Reeving – Deploy multiple reeving during runtime operations. Choose from two to seven parts of line. The operator will need to follow on-screen instructions to ensure proper safety procedures are followed.

Auto-Deploy – Once operators understand how to set up the crane they can use the auto-deploy function to automatically set the crane on the outriggers and deploy the boom and hook. Note that the crane function will need to be ON and operator will still need to program the LMI.

Attach Chains – Attach chains on either the main hook or auxiliary line during runtime operations. The operator will need to follow on-screen instructions to ensure proper safety procedures are followed.

Point of View – Change the operator point of view during runtime operations.

LMI – Set up the crane's selected load chart by properly configuring the LMI. If the crane configuration is changed during operation the LMI will need to be reprogrammed. There is a button on the LMI to change the working units. The LMI also shows warning lights when the crane enters into a fault condition. At runtime the LMI will display some information on the crane's current condition including boom length, boom angle, working radius, weight on hook, maximum allowable weight given configuration, and parts of line.

The design of the LMI is based on existing LMIs that will feel familiar to experienced operators.

1.3 Sounds

The following sounds are simulated to immerse the operator in the training environment:

- Hoisting winch
- Engine RPM
- Hydraulic valves and cylinders
- Safety alarms
- Horn
- Trolley winch
- Wind
- Rain

Ambient construction site sounds

1.4 Heads Up Display (HUD)

Vortex training modules include an integrated HUD to guide the operators through the training exercises.

The display includes work sequence information for the operator, messages and a list of metrics updated continuously.

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For the Rough Terrain Crane the HUD is broken into 3 sections:

- Message notifications (top)
- 360 degree goal compass (middle)
- Progress status (bottom)

The message notifications could include one or all of the following information at any given time:

- Instructional message (green)
- Collisions (yellow or red depending on severity)
- Metrics (grey)
- Information (white)

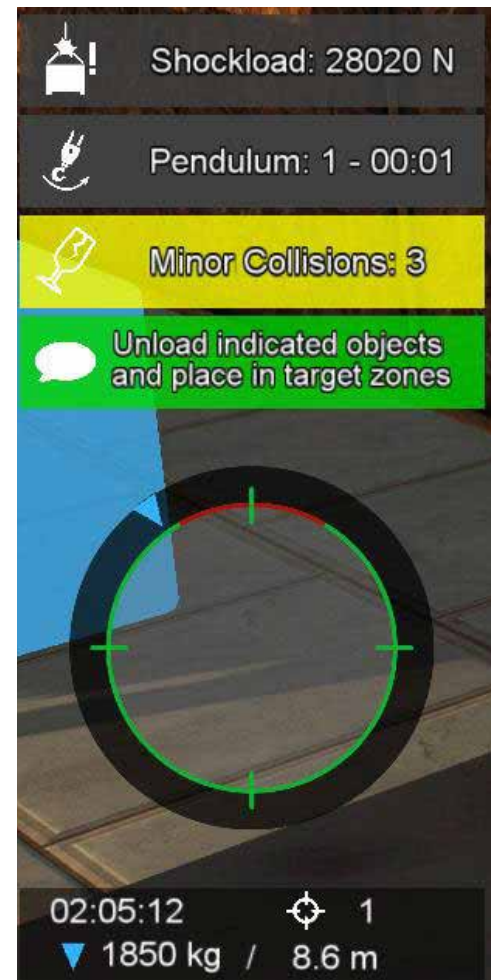
The 360 goal compass shows the operator where the next objective relative to current orientation.

The progress status section continuously displays information regarding the running exercise.

In the example shown the following information is displayed:

- Running time
- Current goal count
- Weight of next lift object
- Boom distance of next goal

The information displayed in this section could change depending on the objective of the exercise.



1.5 Simulation Capabilities

The Vortex RT Crane Training Module is powered by Vortex – the industry’s leading dynamics simulation engine. It provides the highest fidelity simulation of lifting and earthworks construction equipment.

1.5.1 Cable and Sling simulation

Slings and cables are modeled with accurate engineering properties, including stiffness and proper dimensions. All components of the rigging are individually modeled and transition from slack to under tension when loaded.

Cables and slings bend and pendulum just as they do in the real world.

1.5.2 Collision with objects

The equipment and slings will all collide with all objects within the environment.

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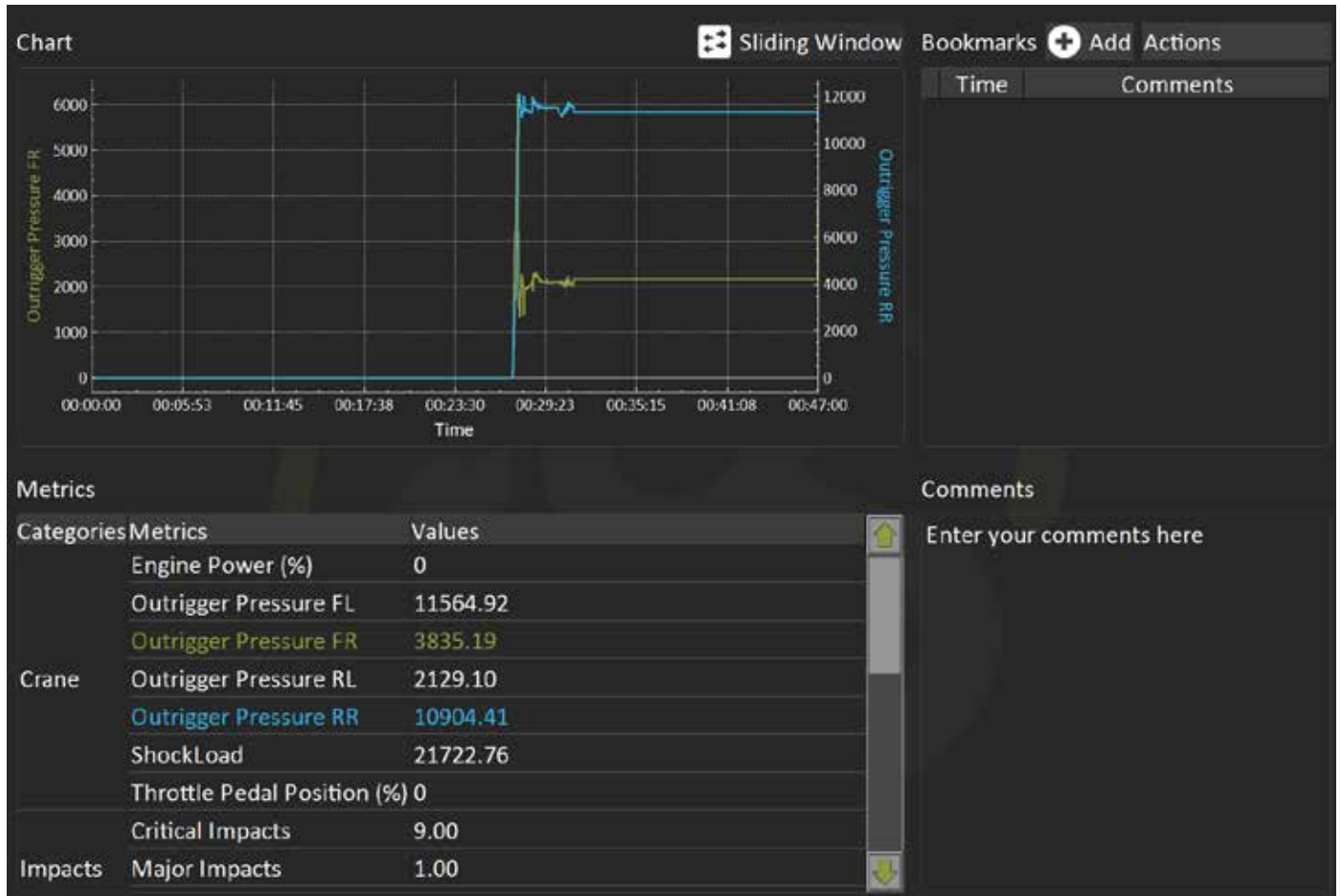
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1.5.3 Metrics

The exercises in the RT Crane Training Module will measure the following metrics. Some metrics may apply only to specific exercises.

Metric	Description	Units
Time	Time to complete course	Hr:Min:Sec
Engine Power	The amount of power used versus total available	%
Ground Reaction pressure	Pressure under each outrigger	MPa
Balls knocked over	Balls knocked of poles	Number of balls
Poles touched	Number of time a poles is touched by the load or a piece of equipment	Number of poles
Poles knocked over	Number of time a poles is knocked over by the load or a piece of equipment	Number of poles
Weight touching the ground	Number of time and the duration when the weight touched the ground	Number of time and duration (Min:Sec.mill)
Chain leaving the ground	Number of time and the duration when the chains leaving the ground	Number of time and duration (Min:Sec.mill)
Pendulum	Number of time and the duration passed in uncontrolled hook movement	Number of time and duration (Min:Sec)
Load Collision	Relative collision force of load impacts	Minor:Major:Critical
Goals	Number of task completed and the total of tasks of the exercise	Number / Total
Shock-load	Maximum load applied on the crane hook to experience as a result of rough handling	Force (lb or N)
Lift objects moved	Objects placed in their correct location	#

All metrics are displayed during runtime on the console dashboard:



1.5.4 Student Management and Reporting (optional)

The student management system allows instructors to add, group and archive students as the training program evolves. Students can access their records to review past performances and print out any report generated from an exercise session.

During a training session the instructor can view student metrics either as values or plotted in real time on a graph. The instructor can also set flags with comments for use during the after-action playback review.

At the end of a training session the instructor can assign a pass/fail (or neither) grade and add final comments before generating a report.

For additional information regarding Vortex Simulation and the Vortex Console, please consult the **Vortex Simulation Platform Product Specification** document.

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2 ROUGH TERRAIN CRANE WORKSITE ENVIRONMENT

The environment simulated is an urban construction site based on a water-front condo development.



Workers and models are placed in such a way as to provide the need for situational awareness from the operator at all times. Workers are always present on the construction site, so are allowed to move within the construction environment.

At any point, the time of day or weather conditions of the environment can be changed from the console.

Clouds

Changes the amount of cloud cover from clear skies to completely overcast resulting in a change in the appearance of shadows.

Fog

Changes the amount of fog present in the environment and thus the resulting visibility.

Wind & Gusts

Controls the speed and direction of the wind within the environment during runtime.

Precipitation

Changes the type and intensity of the precipitation within the environment. Users can select rain or snow. The precipitation will be affected by any wind.

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Lighting

Allows changing of the time of day and month. This will change the sun's position and cast different shadows within the environment. Changes can be made during runtime operations.



Heads Up Display

The heads up display (HUD) is an on-screen aid located on the main display that provides critical information to the operator such as:

- location of next target
- weight of next load
- distance to the next load
- exercise progression
- metrics such as collisions, shock load and pendulum events
- directions on what is the current objective
- information relevant to the operator

The HUD is color coded and is designed to be unobtrusive.



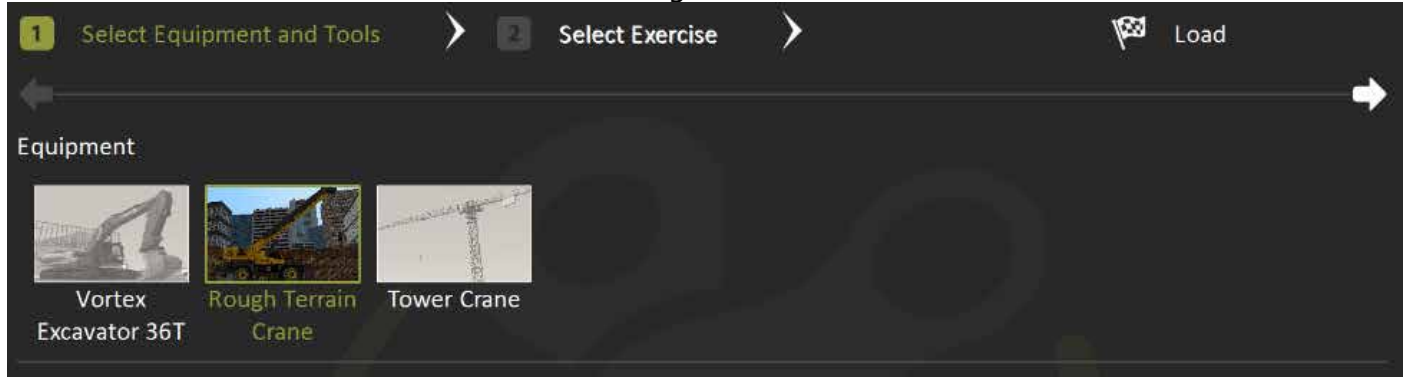
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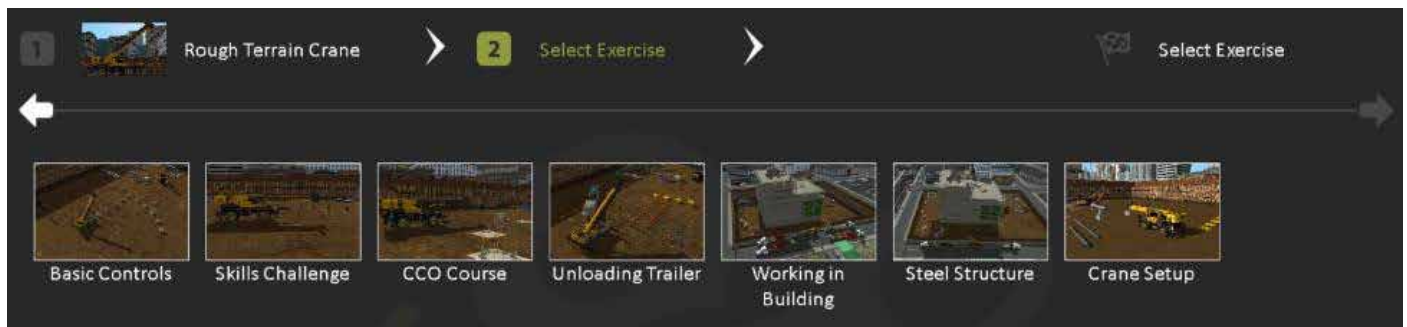
3 ROUGH TERRAIN CRANE TRAINING EXERCISES

The Vortex RT Crane exercises are designed to provide progressive learning and guide a novice operator into more complex operations.

The console is used to load and unload the training module.



Following machine selection, the user selects the appropriate exercise.



Selecting an exercise will bring up a short description of the objectives. Loading the selection will launch the simulation with the selected exercise and crane configuration.

The eight exercises are grouped into three training segments: Control Familiarization, Control Refinement and Working Scenarios.

3.1 Training Segment 1 – Control Familiarization

This module focuses on providing the operator the exercises necessary to learn the basic controls of an RT crane.

Training Objectives

- Familiarization with the main crane controls
- Learning to control pendulum motion of the hook (no load)
- Learning to control pendulum with load
- Hand control coordinate to perform simple lifts and positioning the load

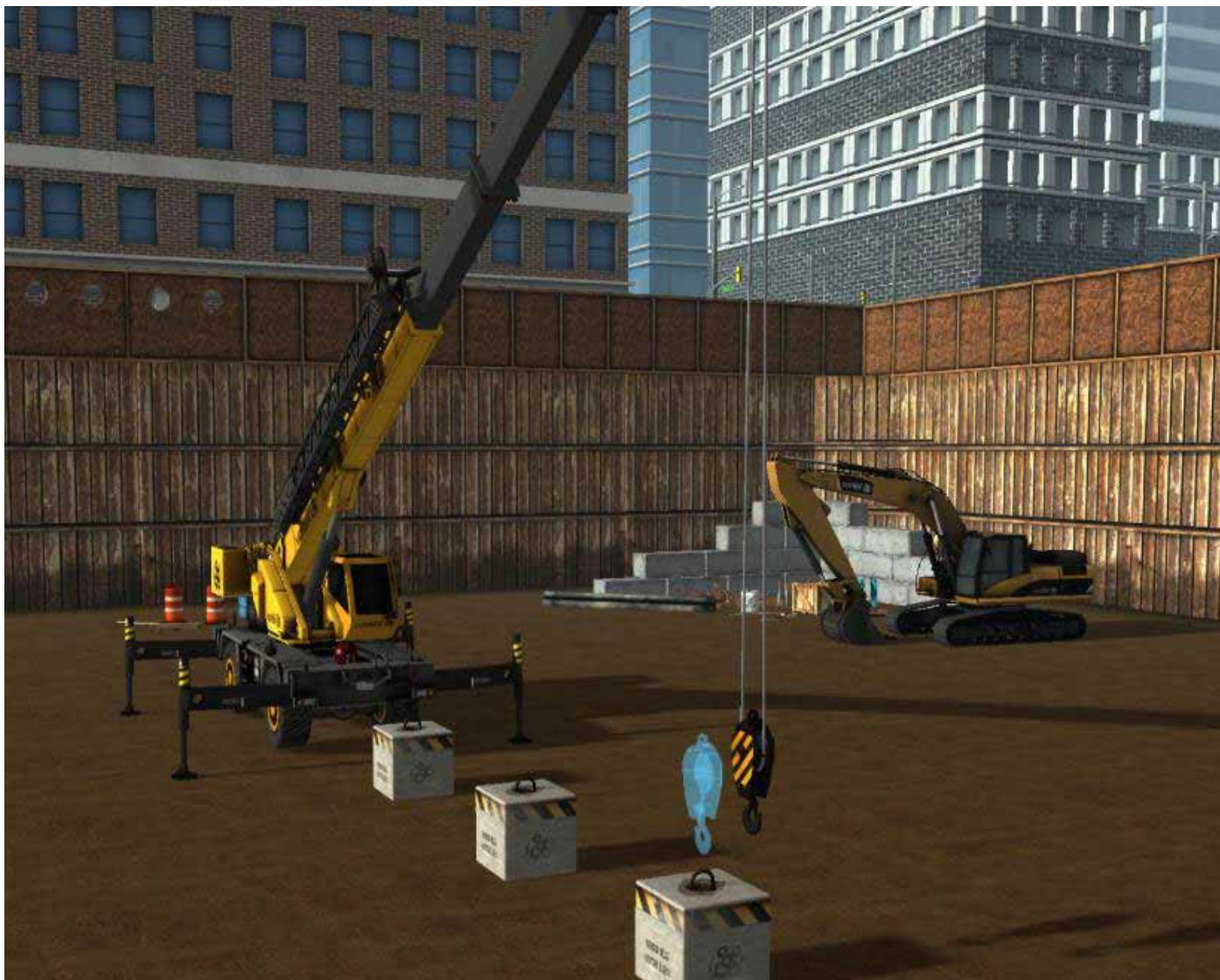
A description of the training exercises follows.

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3.1.1 Basic Controls

The operator will need to use the crane controls to position the hook block within 15 targets. Once matched, the target will move to a new position for the operator to follow. The targets reposition to progressively more complex positions.



The operator will be measured on time to complete goals, amount of pendulum and collisions.

3.1.2 Unloading a Trailer

The operator will pick up objects from a trailer and place them with precision around the worksite. Some barriers were placed to require the operator to control the load safely before landing it within the required tolerance.

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The operator will move a total of 14 objects including concrete blocks, barrel pallets and a generator.



The operator will be measured on time to complete goals, amount of pendulum, shock load and number of collisions. Wind speed, ground pressure under outriggers and throttle position will also be recorded during the exercise.

3.2 Training Segment 2 – Control Refinement

This module builds on the previous exercises and challenges the operator to more complex tasks.

Training Objectives

- Hand-eye control of the crane and load in 3-dimensional space
- Improving precision in pendulum control
- Learning load-moment indicator set-up and crane configuration
- Controlling pipe load while standing on end

A description of the training exercises follows.

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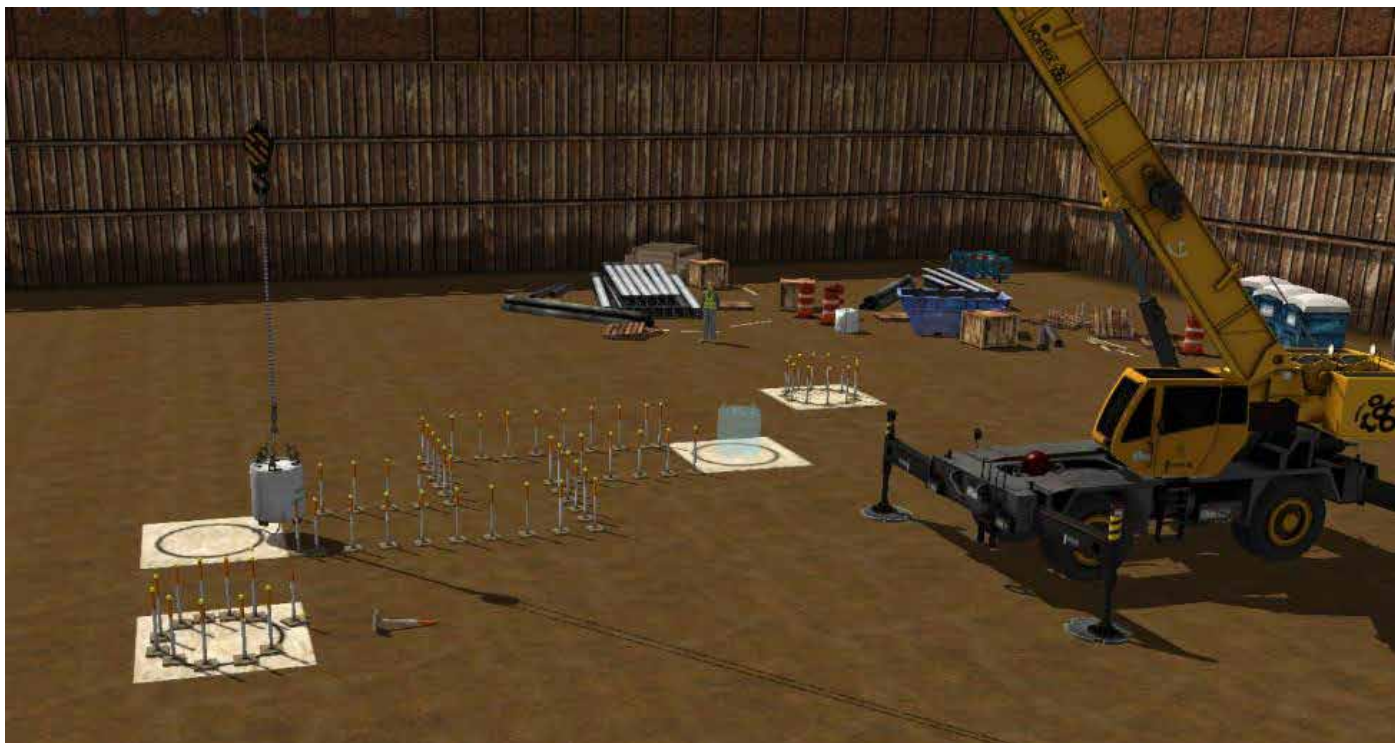
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3.2.1 CCO Course

The operator will first need to pick up a test weight and maneuver it through a zigzag course lined with poles topped by tennis balls.

Following completion the operator will need to place the test weight on two targets to demonstrate control of the load.



The operator will be measured on time to complete goals, amount of pendulum, number of poles touched or knocked over, number of tennis balls knocked off of the poles, amount of time the barrel was too high or low, and maximum shock load.

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3.2.2 Skills Challenge

The operator will need to use the RT crane to control loads through three challenges: Hook in Barrel, Slalom, and Pipe Stand-Up.

To successfully complete the Hook in Barrel challenge, the operator will need to place the crane's hook inside two barrels and return it to the home position. Next the operator will maneuver a test barrel through a slalom course to complete the Slalom challenge. Finally, for the Pipe Stand-Up challenge, the operator will be required to hook and stand up a pipe, place it inside a barrel, and return it to the starting position.



The operator will be measured on time to complete each of the challenges, amount of pendulum number of cones touched, amount of time the barrel was too high or low, and maximum shock load.

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3.3 Training Segment 3 – Working Scenarios

These modules place the operator in real-work scenarios where tasks will need to be performed in a safe and effective manner.

- Training Objectives
- Learn worksite awareness in real-world situations on a busy construction site
- Maintaining safe, precise and efficient work practice through repetitive tasks
- Moving loads to different working heights
- Working with the boom jib extension
- Learning to safely stand long loads on end (steel structure)
- Crane and LMI set-up with different lifting and load conditions
- Optional: Working in various weather conditions
-

A description of the training exercises follows.

3.3.1 Working in a Building

In this exercise the operator will need to move various objects around the work site. The exercise can be up to three hours in length and will require objects to be lifted with the main hook or using the jib.

All objects will need to be placed within a certain degree of precision before the load will be considered completed.



The operator will be measured on the number of objects moved, the amount of pendulum, and number and severity of collisions. Wind speed, ground pressure under outriggers, and throttle position will also be recorded during the exercise.

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3.3.2 Steel Structure

The operator will need to pick 27 steel structures and place them with a high level of precision to construct a steel structure next to the building.

The steel structures will be on a flatbed truck located on a side street. The operator will need to hook and lift the structures, and place them in the required positions indicated by a target ghost.



The operator will be measured on the time to completion, the amount of pendulum, max shock load, and number and severity of collisions. Wind speed, ground pressure under outriggers, and throttle position will also be recorded during the exercise.

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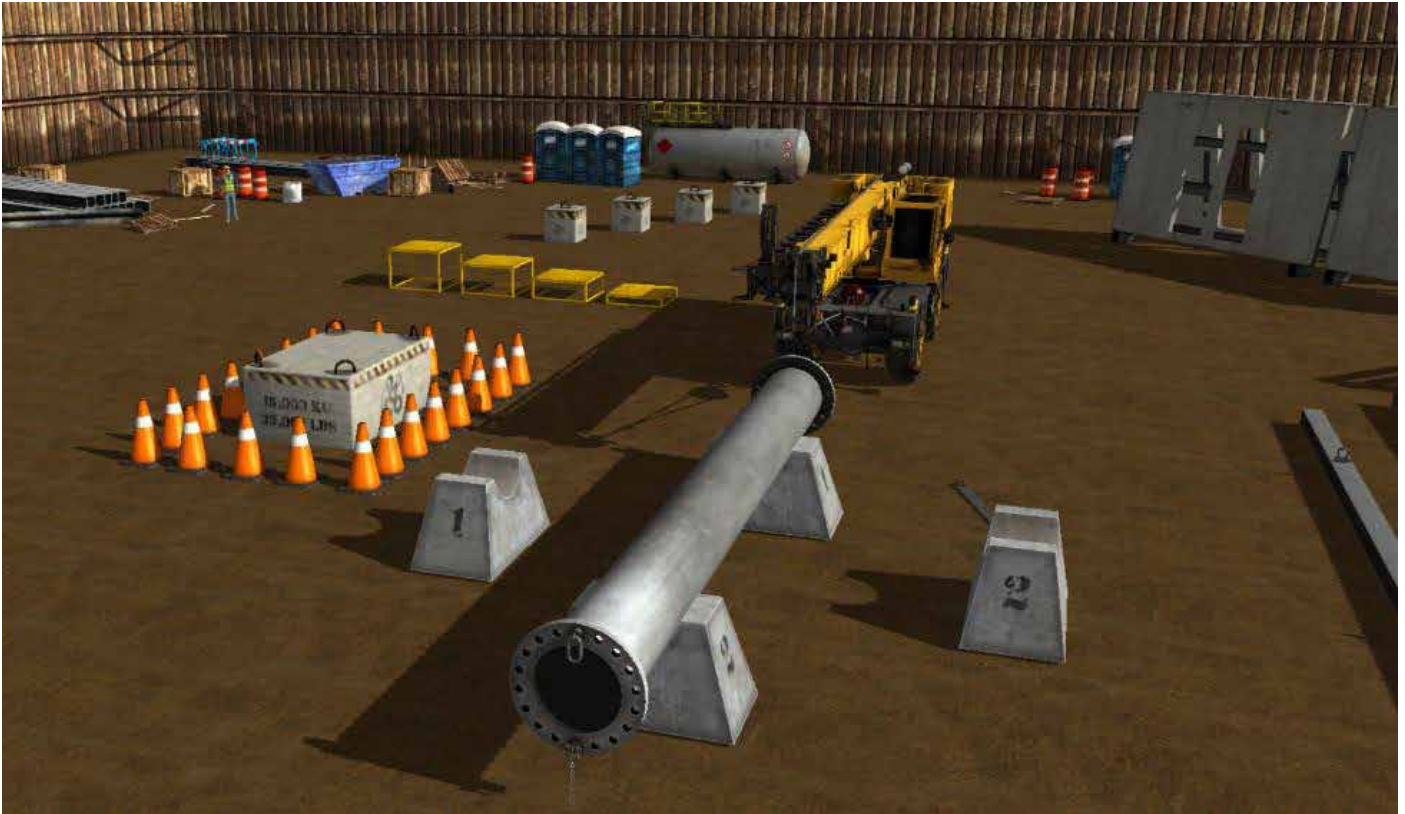
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3.3.3 Crane Setup Exercise

The crane setup exercise is free-form training where the operator can choose to pick up different shaped and weighted objects at different distances and place them in designated areas. The purpose of the exercise is to practice lift planning and to set up the crane with the correct configuration before performing a lift.

The operator will need to determine distances of the source and target destination and configure the LMI and crane (out riggers and parts of line) before performing the lift. Should the operator not set up the crane properly, poor crane performance will result.



The operator will be measured on the time to completion, the amount of pendulum, cones touched, max shock load, and number and severity of collisions. Wind speed, ground pressure under outriggers, and throttle position will also be recorded during the exercise.

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4 ROUGH TERRAIN CRANE INSTRUCTOR OPERATOR CONTROLS

The Vortex Rough Terrain Crane Training Module comes with the optional Instructor Console (see Console Product specification for more details). From here the Instructor will be able to monitor the status of the controls based on the inputs from the operator.

From the console the Instructor has visibility of the following controls:

HMI

Full view of the HMI (Human Machine Interface, also known as LMI)

Controls

Full view of the following controls:

- Main hook hoist/lower
- Auxiliary hook hoist/lower
- Boom up/down
- Swing left/right
- Boom tip camera zoom
- General stop (Emergency power off)
- Engine start/stop
- Hoisting Gear slow/fast
- Horn
- Hook button
- Swing brake pedal
- Telescopic Boom in/out
- Throttle

5 HARDWARE CONFIGURATIONS

The Vortex Training Simulation product can be deployed in different configurations, including hardware, to increase the training value of the simulation. The following configurations are available:

- **Vortex Software** for affordable training using generic USB game-style controls and a single 3d display
- **Vortex Master**, full seat and controls training solution with optional motion base and from 1 to 5 3d displays

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5.1 Vortex USB Joystick Controls

This is a simple-to-deploy solution designed to run from a workstation computer. Controlling the crane is performed using standard USB gaming joysticks.



One of the displays is configured for the Vortex Console user interface with the crane (HMI), and the second renders the virtual environment from the operator's point of view. It is recommended that the HMI be a minimum of 17 inches and the virtual environment be displayed on a minimum of a 42-inch 1080p resolution monitor.

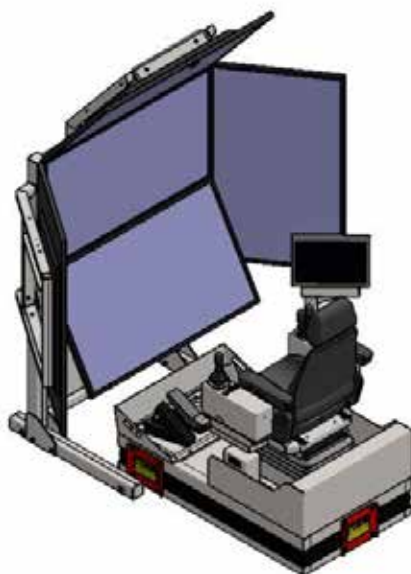
5.2 Vortex Trainer

The Vortex Trainer includes the RT Crane Training Module with a simple-to-install table-mounted industrial-grade device that includes generic multi-equipment OEM replica controls and a 17-inch touch-screen monitor for the Vortex Console.

5.3 Vortex Master

The Vortex Master simulator is a one-, three-, or five-screen visual system with generic multi-equipment OEM replica controls. Optionally, a motion system can be added to further enhance the training.

The hardware controls are swappable so that the same base can be used for multiple crane/vehicle types, including those which require a steering wheel.



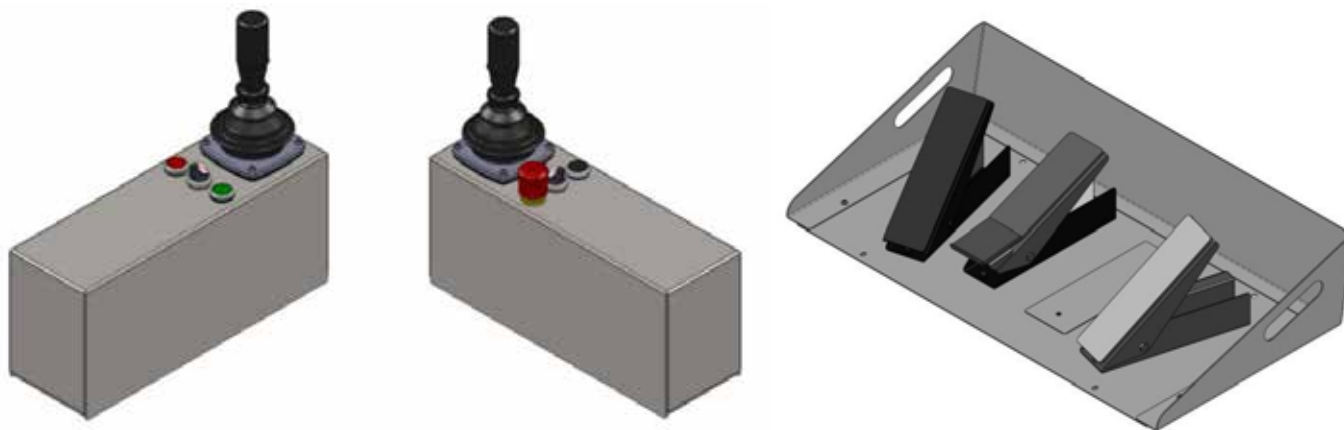
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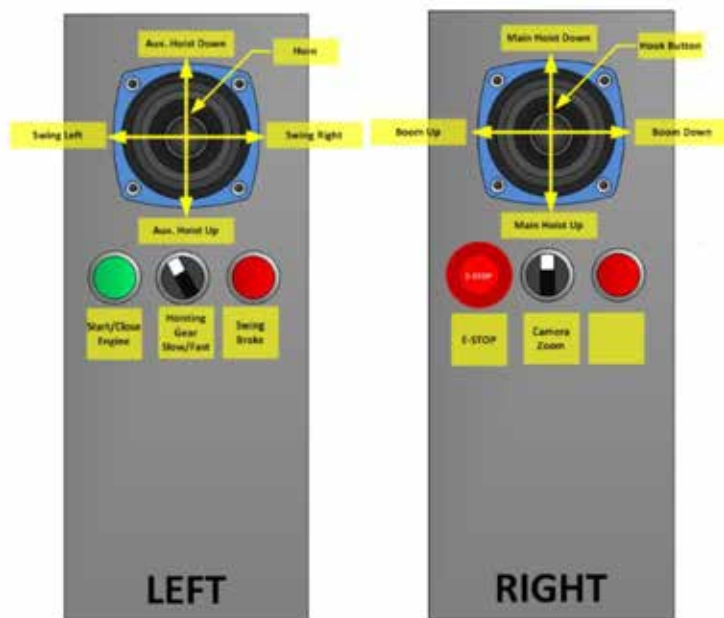
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5.4 Rough Terrain Crane Controls

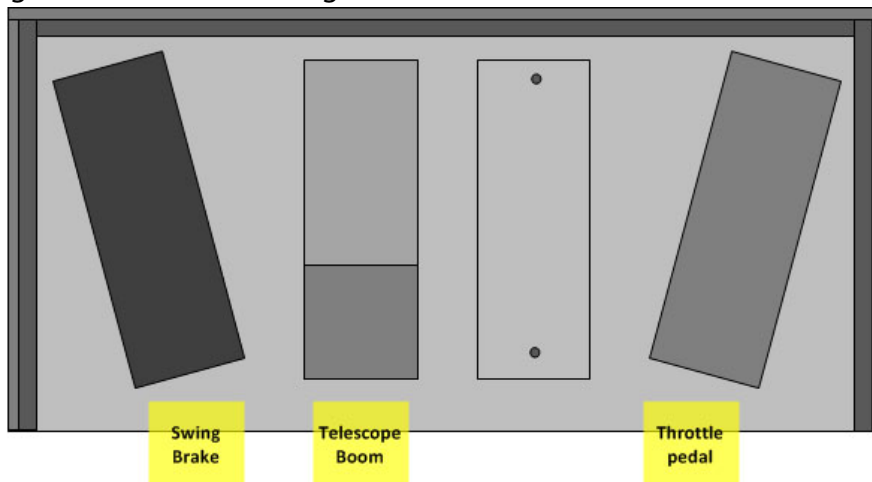
The simulators come with OEM grade controls. The controls are the same controls used in industry, and can be swapped out easily to accommodate multiple training modules.



The joystick controls are configured with the following functions:



The pedals are configured with the following functions:



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6 RESOURCES

6.1 Technical Support

MIMBUS and LVE provide dedicated full time support for products that have a valid maintenance and support (M&S) contract agreement. Maintaining support provides software updates and online license management as well as access to our product experts for any questions or problems that arise. Access to support is provided by e-mail and telephone.

6.2 Product Training

Whether you're new to Vortex or a long-time customer, we have the right training program for you. We can provide our standard training for individuals or entire departments – at your site, our offices, or another location. We can develop custom training modules for any aspect of Vortex such as vehicles, hydraulics, and human-in-the-loop testing, as well as simulation integration strategies to help accelerate your projects.

6.3 Consulting Services

In addition to our training simulators, MIMBUS and LVE provides a full range of expert services designed to ensure that you meet your project delivery requirements quickly and successfully.

Our services team will provide you with complete knowledge transfer sessions and training, as well as maintenance services, for full protection of your investment.

With an iterative approach to project management, our services team can also provide service bundles tailored to your needs.

Quick Start package

Combine our services for end-to-end acceleration of your simulation project.

Application management services

Improve the performance and accuracy of an existing simulator with Vortex software: We supply you with the application management services required to overhaul and future-proof your system.

Custom turnkey simulators

If you're looking for a turnkey simulator, we can provide a full-service package to create and customize it to your requirements.

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