

VIRTUAL WELDING SIMULATOR

PRACTICE

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graph TD; A[PRACTICE] --> B[IMPROVED DEXTERITY]; B --> C[BETTER WELD QUALITY];
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IMPROVED DEXTERITY

BETTER WELD QUALITY

VIRTUALLOGIC
SYSTEMS

Virtual Welding Simulator

PATENT PENDING
Application No. 1020/CHE/2013

AT FIRST GLANCE

The Virtual Welding Simulator is an advanced technology based training and performance evaluation simulator. It simulates welding equipment, tools and scenarios in a virtual reality based environment. **The simulator should be utilized to impart basic welding skills to novices and to qualify and improve the welding skills of experienced welders.** And thereby **IMPROVE THE QUALITY OF WELDING.**

Cutting edge technology

ACCOUNTABLE RESULTS

The simulator hosts a robust library of pre-determined exercises for any GMAW equipment system or sub-system.

The simulator follows a task based approach to train users to ensure effective training. And it includes robust analysis and evaluation tools to track the performance of the trainee and to archive their performance results.

A user / trainee performs welding by using the simulator hardware consisting of an actual welding torch, audio-visual unit and position tracking unit, incorporated with sensors and electronics which emulate the physical set-up of the welding operation.

Purpose

- To provide a **safe and risk free environment** to perform welding operations
- Help a **novice user/trainee** to **understand basic principles** of welding
- Teach **correct method** of performing welding and provide unlimited **practice to master welding techniques**, including
 - Torch position and angles
 - Tip to work distance
 - Travel speed, etc.
- Evaluate and quantify hands-on skill proficiency of **experienced welders on actual on-the-job tasks**

UTILIZE

HOW TO EFFECTIVELY DEPLOY THE SIMULATOR

1. Assign simulator administrators / instructors, who will be fully trained on all aspects of using the simulator for training, evaluation and qualification purposes
2. The administrator / instructor creates training batches and assigns training exercises or performance evaluation tasks to each batch
3. The users and trainees perform welding operations on the simulator as per the exercises and tasks assigned to them by the administrator / instructor
4. Provide easy access of simulator to users and trainees, even without presence of administrator / instructor

SKILL BUILDING

HOW DOES TRAINEE DEVELOP WELDING SKILL SET

PRACTICE, PRACTICE and MORE PRACTICE

1. The trainee starts with an induction course (explanation of welding and basic skills), moves to practice sessions and performing exercises at basic level, and then progresses to perform welding in different positions
2. At each stage of training and in practice sessions, the simulator provides feedback and tips on how to improve welding skills (the trainee cannot proceed to the next set of exercises without mastering the skills required at current stage)
3. Trainee gains dexterity via repeated practice and masters welding techniques by learning from the simulator's feedback mechanism

QUALITY CONTROL


DEPLOYING QUALIFIED & CERTIFIED WELDERS

ANALYSE & EVALUATE > PRE-QUALIFY > DEPLOY

1. Actual work pieces (real world job tasks) are recreated in the Virtual Welding Simulator
2. Existing / experienced welders perform welding on the recreated virtual welding work piece, and their performance is analysed and evaluated to check weld quality
3. Thereby the welder is pre-qualified to work on the specific job task

GAIN BY USING THE VIRTUAL WELDING SIMULATOR

SAFETY & ECOLOGICAL BENEFITS

- Personal injury while learning / training is avoided
- Trainee does not experience fatigue and effects of fumes, which are strong deterrents to learning
- Experience all actual job-tasks in a safe environment
- No emission of harmful gasses and reduced carbon foot print 

COST SAVINGS & MEASURABLE VALUE

- Training cost using Virtual Welding Simulator is 1/10th the cost of using actual welding equipment
- No cost on account of welding consumables
- No welding booth and welding machine maintenance costs
- No machine-use hours; actual welding machine is left open for billable work
- Train anytime, day or night, even without instructor being present: larger training throughput

ADVANTAGES FOR MANPOWER DEPLOYMENT & HRD

- Screen and test welders before hiring
- Training made independent of trainer's capability and attitudes
- Detailed, accurate, standardized and unbiased performance evaluation of user's welding skills
- Traceability – easy to track the performance of each welder and generate system compliance document for OSHA / ISO / TS / etc.
- Deploy simulator qualified / certified welders on CTQ (critical to quality) real-world / actual job works

UNLIMITED REPLAY & REDO the simulator never gets tired

TRAINING BENEFITS

- Practice repeatedly until perfection of skill
- 30% more efficient than learning on an actual machine, as more formative situations are experienced on the simulator
- Uniformity of trained output and standardization of training through technology based skill development and certification

SPEC

WELDING FEATURES

The Virtual Welding Simulator leverages the inherent power of Virtual Reality and real-time simulation technologies to deliver a life-like and realistic experience for training, practice, skill analysis and skill level evaluation.

WELDING PROCESS

GMAW. Extensible to include SMAW and GTAW.

WORK PIECE AND FILLER MATERIAL

Mild Steel. Extensible to copper, aluminum and stainless steel. **Filler material is automatically chosen to suit the weld metal.**

SHIELDING GAS

CO₂.
Extensible to include Argon and Argon-CO₂ mix.

WELDING JOINTS

Butt and Fillet.

WELDING EFFECTS

Realistic simulation of:

- welding pieces
- weld puddle and weld bead
- spark, flame and fumes (visuals)
- welding sound/s

WELD PIECE

Standard training on weld piece of 50mm, 100mm and 150mm length. Extensible to include pipe or any other custom weld pieces, which will be recreated from 3D CAD models or from suitable references (photographs, dimensions and drawings) to suit customer preferences and priorities.

SPEC WELDING FEATURES

Continued.



MACHINE SETTINGS

- Current – 60 to 320 Amperes
- Voltage – 14 to 30 Volts
- Gas type and flow rate – 10 to 25 lt/hr.
- Base material and material thickness
- Type of filler material and gauge of filler material (feed rate is calculated automatically based on current and voltage settings).

SPEC

WELDING FEATURES

Continued.

WELDING POSITIONS

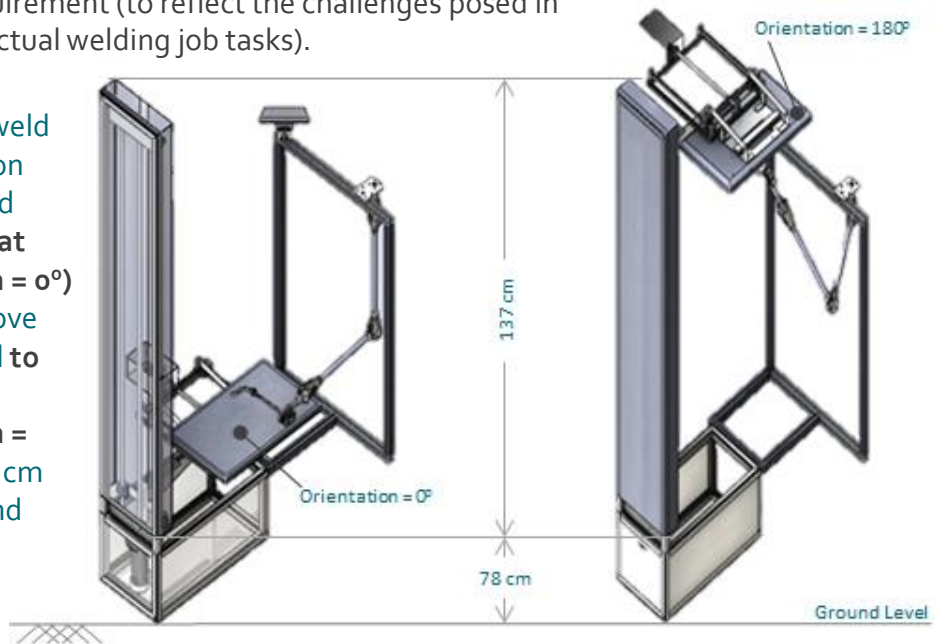
Standard positions include:

- Butt joint (1G, 2G, 3G and 4G)
- Fillet joint (1F, 2F, 3F and 4F)

Extensible to include 5 and 6 positions.

TRAIN IN ANY POSITION. The virtual welding pieces can be positioned to suit any specific requirement (to reflect the challenges posed in real-world actual welding job tasks).

The virtual weld piece position can be varied from fully flat (orientation = 0°) at 78 cm above ground level to overhead (orientation = 180°) at 215 cm above ground level.



TORCH CONTROL

Standard exercises for straight line and curved line. Extensible to include pipe and other custom shapes. And also for multi-pass welding.

WELD DEFECTS

- Spatter
- Pin hole
- Under cut and weld cut
- Burn through
- Weld bead pattern (wide bead / narrow bead)

Apart from standard defects, the simulator is extensible to include custom requirements, if any.

SPEC

TRAINING FEATURES

- Module 1: Induction (with simple exercise)
- Module 2: Straight and curved line practice with increasing level of difficulty
- Module 3: Welding in Flat, Vertical and Overhead positions
- Module 4: Advanced welding, various positions and multi-pass welding

- Visual cues for work angle and for lead angle
 - Visual cue for tip to work distance
 - Visual cue for welding position
 - Alerts for work piece touch
 - Brightly lit welding environment
- All cues are provided in the form of a HUD (heads up display) such that it does not interfere with the actual weld pool.
The training cues are extensible to include sound alerts.

- Configurable lead angle tolerance range: '+20 to -20 degrees'
- Configurable work angle tolerance range: '+20 to -20' degrees
- Configurable value for tip to Work distance
- Configurable weld bead position / leg length tolerance range: '0.5 to 6' mm

Practice Mode: use of training cues, unlimited attempts and performance report is only displayed.

Test Mode: Limited no. of attempts, dimly lit welding environment mode.

EXERCISE TYPES

TRAINING CUES

EXERCISE DIFFICULTY SETTINGS

MODES

[A USER PERFORMING A TRAINING EXERCISE]



Usage

The Virtual Welding Simulator can be used for 3 purposes.

1. NOVICE TRAINING – provide a safe and risk free environment to train freshers on gaining basic welding skills
2. REFRESHER TRAINING – provide periodic training to experienced welders to identify and specifically train on problem areas
3. QUALIFICATION & CERTIFICATION – assess the performance of a welder on a task specific virtual weld piece. Thereby certifying the welder as qualified to perform welding on the specific joint in real-world (actual job task)

The Virtual Welding Simulator can be effectively employed as a tool for both 'training' as well as 'quality control, compliance and audit'.

PERFORMANCE EVALUATION

Performance evaluation helps the trainer evaluate a trainee's performance on the simulator based on various metrics. The result, a **quantified** and **objective evaluation** of the trainee's virtual welding performance along with feedback on how to improve his / her skill.

The Virtual Welding Simulator has a precise and robust 'rule based' evaluation engine, which works both in the practice and test modes.

Parameters or metrics considered for performance evaluation:

- Torch angles (work angle and lead angle)
- Distance of torch from work piece (Tip to work distance)
- Travel speed
- Weld pattern
- Penetration depth
- Machine settings (voltage, current and gas flow rate)

WELDING DEFECTS and **THEIR CAUSES** are presented to the trainee and trainer both. Few examples:

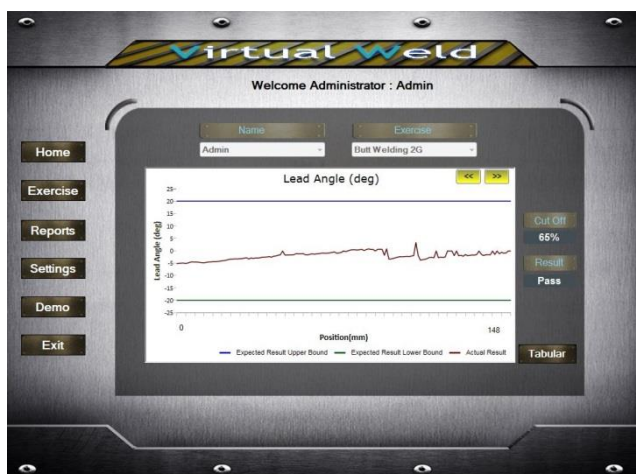
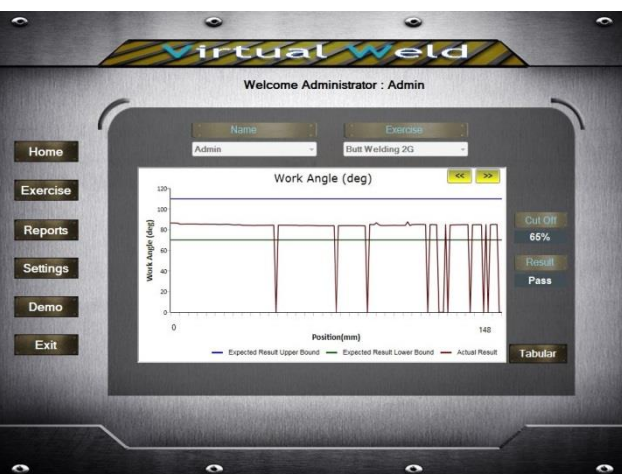
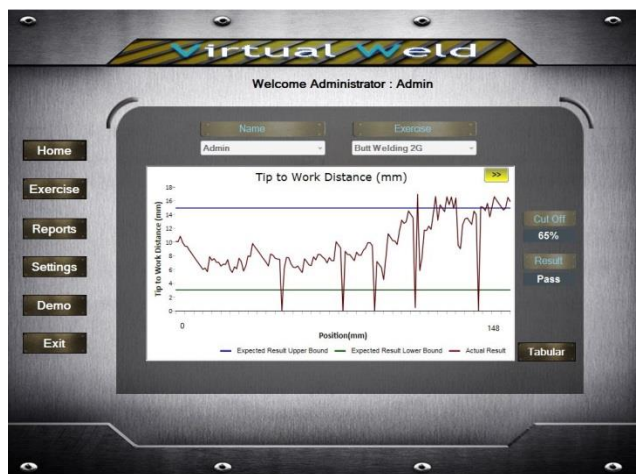
- 'Spatter' – due to improper distance between work piece and electrode, improper torch angles and insufficient gas flow
- 'Bead variations' – wide bead due to slow rate of traverse and narrow bead due to fast rate of traverse
- 'Burn through' – very slow rate of traverse leading to excessive penetration and also resulting in burn through

REPORTS

The Virtual Welding Simulator's evaluation engine analyses and displays the trainee's performance in the form of reports (in both TABULAR and GRAPHICAL formats). These reports are stored in the form of training records in the database section of the trainee management system.

Performance reports

- Display of weld defects and corresponding reasons
- Overall result – pass / fail
- Cut-off scores
- Tabular & graphical format reports of all performance parameters
- Printing of reports
- Individual and batch-wise performance reports can be selected, displayed and printed by the instructor / administrator



TRAINEE MANAGEMENT FEATURES

1. Login with password
2. Modes of login
 - **ADMINISTRATOR LOGIN** with complete access, including trouble shooting, maintenance, etc.
 - **INSTRUCTOR LOGIN** which includes trainee management, batch management, training exercises and view reports (both individual and batch reports)
 - **TRAINEE LOGIN** which includes exercises, help and performance reports
3. Trainee profile management for instructor
4. Batch management for instructor with
 - Batch creation and deletion
 - Assignment of exercises to each batch
 - Assignment of trainees to a batch
 - Batch start and end date settings
5. Exercise settings for each batch with
 - Set cut-off percentage for performance evaluation
 - Set difficulty level for individual exercises
 - Set limit for number of attempts to pass a particular test
6. Record and replay of all the tests including playback with Ghost (Real & Ideal positions)



SPEC

SIMULATOR COMPONENTS, SERVICES & CUSTOMER END INFRASTRUCTURE REQUIREMENTS

VIRTUAL WELDING SIMULATOR HARDWARE	
Welding terminal with, - 6 DOF articulated arm connected to a welding torch - Welding work piece adjustment system with height and tilt adjustment mechanism	1 no.
User's perspective correction system (tracking system)	1 no.
3D stereoscopic display device	1 no.
3D stereoscopic glasses	2 nos.
PC workstation with requisite GPU	1 no.
VIRTUAL WELDING SIMULATOR SOFTWARE	
Node locked virtual welding simulator software license package comprising of training curriculum and exercises, simulation engine, rendering engine, performance evaluation engine and trainee management system (pre-installed on the PC workstation)	1 no.
Software installer CD	1 no.
MANUALS & USER GUIDES	
Operating instructions manual	1 no.
Maintenance and troubleshooting manual	1 no.
Manufacturer's recommended spares' manual	1 no.
Routine maintenance plan	1 no.
SERVICES	
Deployment services (packaging, delivery, installation and commissioning)	-
Onsite training services and training at OEM's site	-
Warranty	1 year
RIMS (remote infrastructure maintenance system) based services, and phone, fax and email support services	1 year
Onsite preventive maintenance and AMC (annual maintenance contract) services	Annual basis
Customer and user specific customization services	-
CUSTOMER END INFRASTRUCTURE REQUIREMENTS	
6 ft x 6 ft clear floor space	-
5A, 220 V power sockets	2 nos.
Back up power supply (1 kVA online UPS)	1 no.



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