SensorSim: The Exposure and Sensor Simulator for HAZMAT Field Exercises

Complete your field training exercises with handheld chemical and radiological exposure sensors that interact realistically with mock hazards:

- Learners perfect their hazard detection and classification skills.
- Exposure readings on the handheld sensor update in real-time as learner moves among mock hazards.
- Easy to add to your existing indoor and outdoor exercises.
- Any cell phone or tablet can serve as a handheld sensor, including learner and instructor personal mobile devices (BYOD).
- Easily configurable sensors and hazards, including leaks, spills, downwind plumes, and contaminated bodies of water.
- No limit on the number of trainees, hazards or handheld sensors in a training exercise.
- Instructors can focus on assessment (not dictating exposure levels from the sidelines).
- Instructors see on their mobile device what the learners see on their sensors, and receive post-exercise training reports.
- Developed with the Rutgers Center for Public Health Workforce Development, the Environmental Management Institute at Ivy Tech, the National Institute of Environmental Health Sciences, and the National Institute for Occupational Safety and Health

SensorSim consists of a handheld sensor simulator that displays exposure values on a mobile phone, and a hazard simulator that represents a chemical or radiological leak. Cell Podium offers two types of hazard simulators: a Bluetooth beacon placed at the source of the simulated leak, and a virtual hazard positioned in Google Maps. The sensor and hazard are pre-configured by Cell Podium to instructor specifications, and are easily reconfigurable by the instructor to accommodate new field exercises.

SensorSim with Android sensor simulator and two Bluetooth beacon hazard simulators

SensorSim with I-Phone sensor simulator and GPS-based hazard simulator

The SensorSim Learner Experience

SensorSim is designed to let HAZMAT field exercises begin quickly.

Prior to the exercise, the instructor gives the learners a scenario code that defines the hazards in the exercise and the type of sensor that will be displayed to the learner. The instructor can give the code in the form of an ID number, a URL, or a quick response (QR) code (left image below) – whatever is more convenient for the instructor and learners.

To begin the exercise, the learner simply opens the SensorSim app (free in the Google App Store) and enters the scenario number (center image below), or scans the QR code with a cell phone or directs its browser to the URL. Any of these approaches will immediately make the cell phone behave like a handheld sensor (right image below). This process takes only a few seconds, is anonymous (no identifying information is recorded such as name, phone number, MAC or IP address), and no username or password is required (a login button is only for debug and admin functionality). If the learner enters optional team name, SensorSim will generate a report for the instructor labelled with this name.

From this moment forward, the sensor simulator displays exposure readings as if the mock hazards are real, accounting for learner's distance to each hazard, and the nature of each hazard as specified in the scenario by the instructor. The simulator is now an indispensable part of interactive exercises including:

- Detection and classification of chemical and radiological hazards.
- Communications between entry team and site supervisor.
- Delineation of exclusion and safety zones.

To end the simulation, the learner simply closes the web browser or the app.

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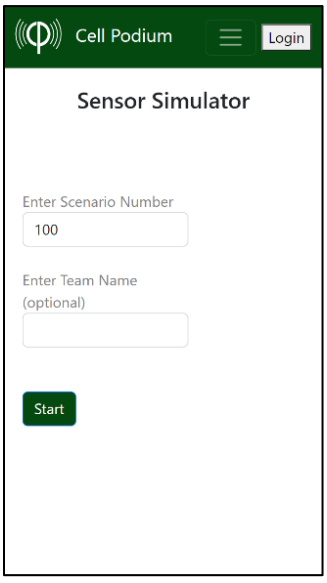
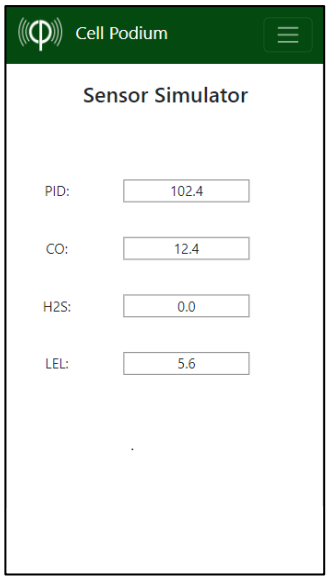
https://cellpodium.com/#/simulation?id=34

ID number (green), QR Code, and URL (yellow) identifying the same HAZMAT Field Exercise



Launch Screen



Sensor Simulator with Exercise-Specific Configuration

The SensorSim Instructor Experience

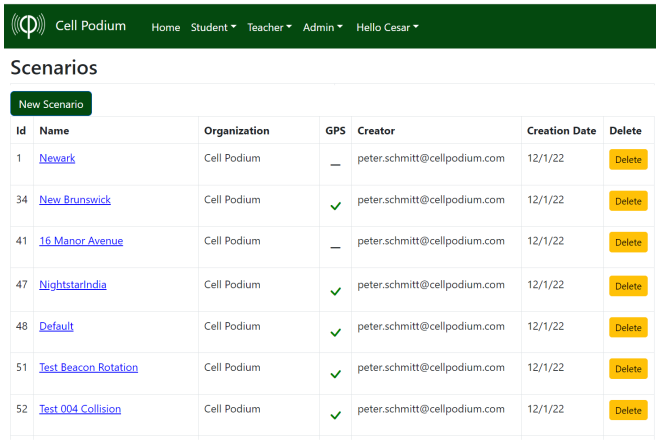
SensorSim integrates seamlessly with the lesson plan of the HAZMAT instructor.

As with any teaching tool, the main role of the instructor is to set up the exercise and evaluate leaner performance. With SensorSim, instructors can choose two different ways to set up a mock hazard: placing a Bluetooth beacon at the source of the hazard, and geotagging a virtual hazard positioned in Google Maps. The table below illustrates the differences in these two SensorSim technologies.

Differences and Similarities Between the Two Types of the SensorSim HAZARD Sensor Simulator

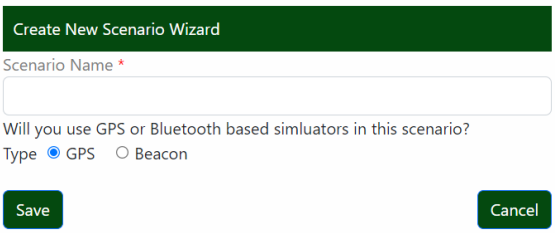
	SensorSim - Bluetooth	SensorSim - GPS
Types of hazard simulated	Any chemical or radiological leak.	Any chemical or radiological leak or wide-area contamination.
How to position a mock hazard in SensorSim	Place one Bluetooth beacon on the mock hazard.	Using any web browser and Google Maps, click on the desired location of the leak, or outline the contaminated area.
Special Hardware and Software Required	Free SensorSim app. One miniature Bluetooth beacon per hazard (low cost, waterproof, 5-year battery life).	None (any cell phone browser)
How to change the layout of hazards in an exercise	Move the Bluetooth beacons to the new desired locations of hazards.	Change the coordinates of the hazards on Google Maps.
Configurable hazard chemistry and radiation	Yes (also easily reconfigurable)	
Configurable handheld sensor display and alarm	Yes (also easily reconfigurable)	
Assessment data collected for the instructor	Exposure readings, distance from hazards	Exposure readings, distance from hazards, birds-eye view replay of exercise on map
Repeating an exercise	Confirm each mock hazard has a Bluetooth beacon; reuse the SensorSim scenario ID.	Reuse the SensorSim scenario ID.

At the heart of SensorSim is the *scenario*: a description of hazards and sensors in an exercise. An instructor with an existing exercise plan need only record the same hazards in the SensorSim scenario. The instructor creates this scenario in the SensorSim Instructor web site in which s/he has a private account (see screen shots below). The web site guides the instructor through this process, which can take place any time before the exercise. The instructor can also create, copy, edit, and store multiple scenarios for different types of exercises. SensorSim assigns each exercise a unique scenario code, which is all learners need to launch the exercise.



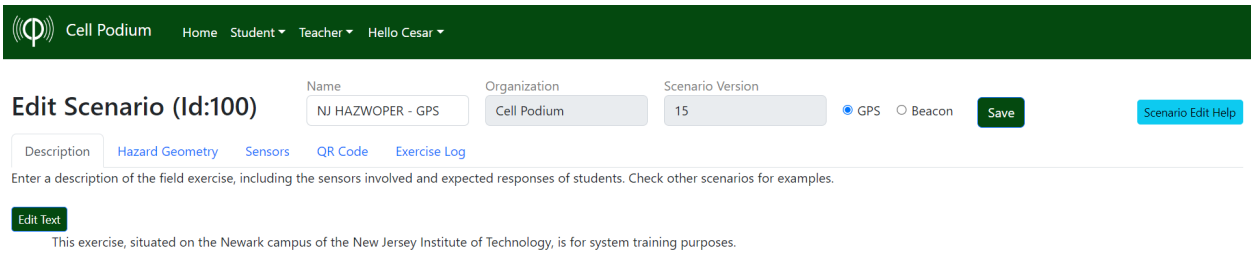
Example Scenario Page on the SensorSim Instructor Website

Creating and Conducting an Exercise with SensorSim - GPS

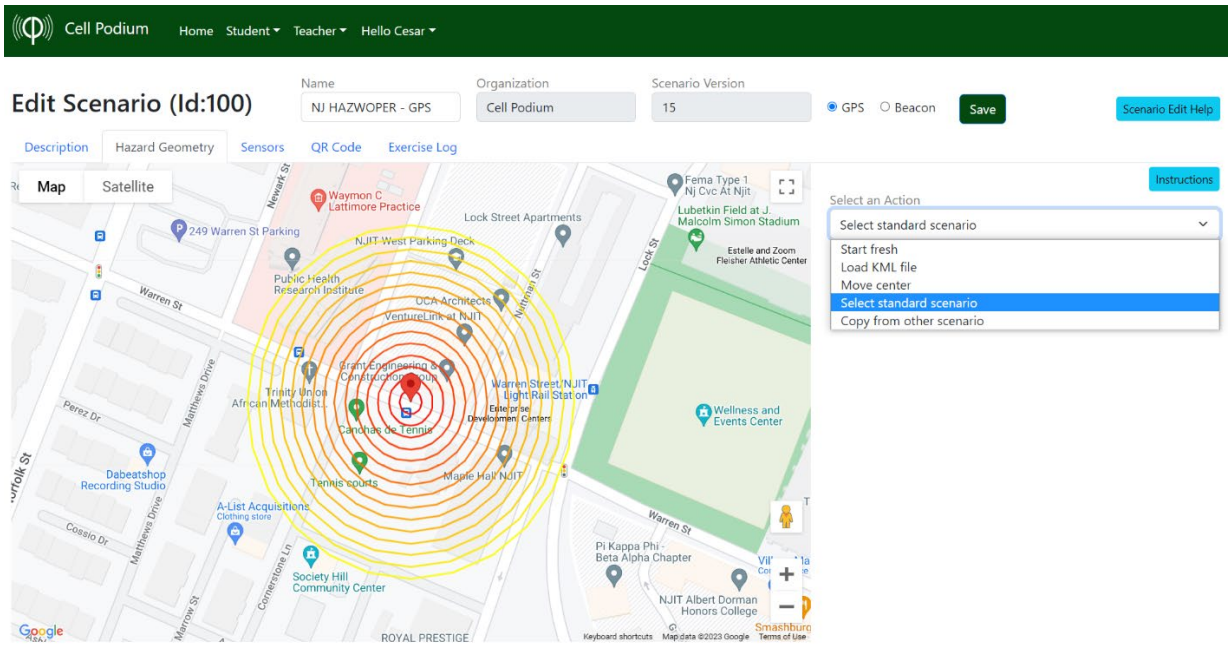


From the Scenario page of the SensorSim Instructor Website, the instructor starts the creation of a new scenario by clicking on the "New Scenario" button. This launches the Create New Scenario Wizard (right), which asks the instructor for a scenario name and the type of technology s/he will be using in the field exercise (GPS or Bluetooth beacon). The Wizard ensures that the scenario name is not already in use by that instructor.

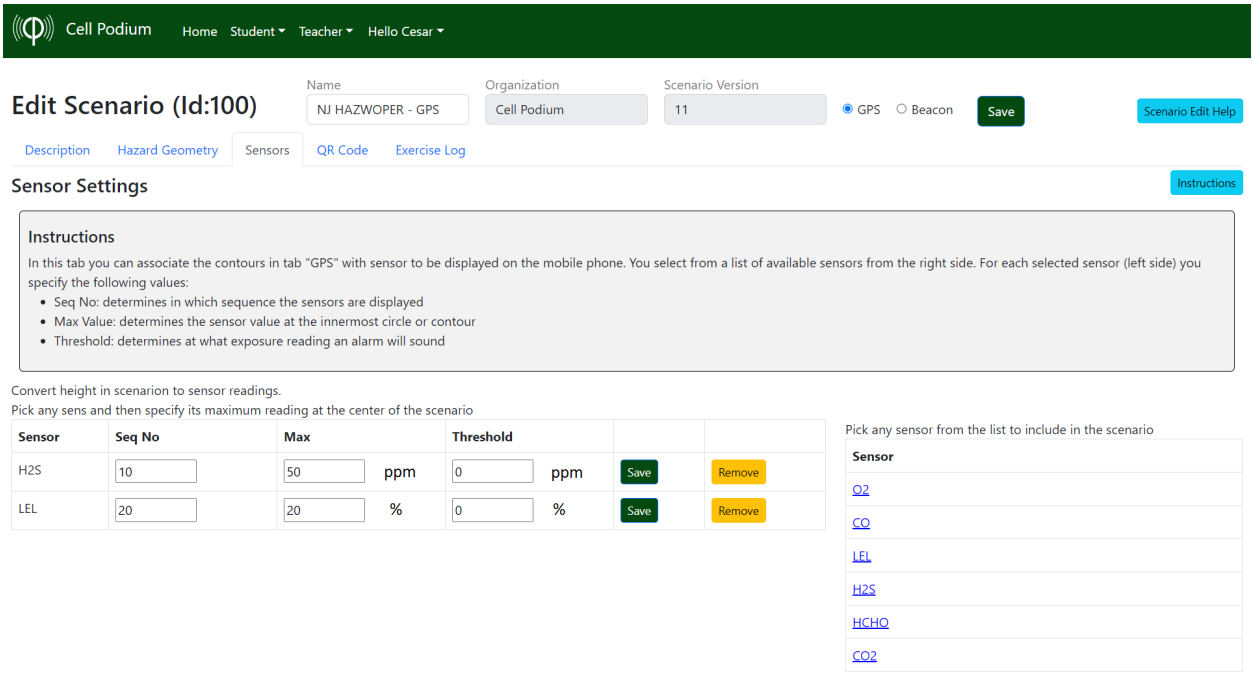
The Wizard then opens the Edit Scenario web page, where the instructor enters an optional description of the exercise, the location and shape of a hazard's exposure, and the configuration of sensors (below). The instructor can change any of these parameters at any time; SensorSim automatically updates the version of the scenario whenever a change is saved.



Optional Description of a SensorSim exercise

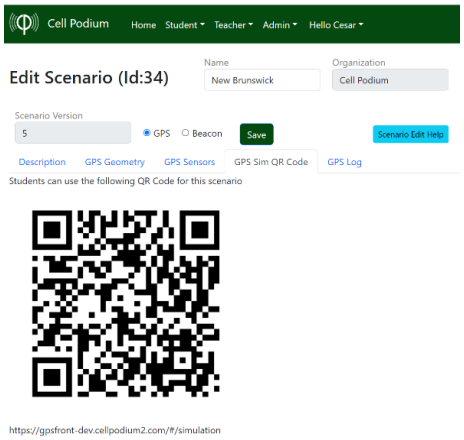


Entering the location and shape of a hazard's exposure. To save time, the instructor can copy an existing exposure shape and location, or import an existing KML file for the location and shape.



Entering the location and shape of a hazard's exposure

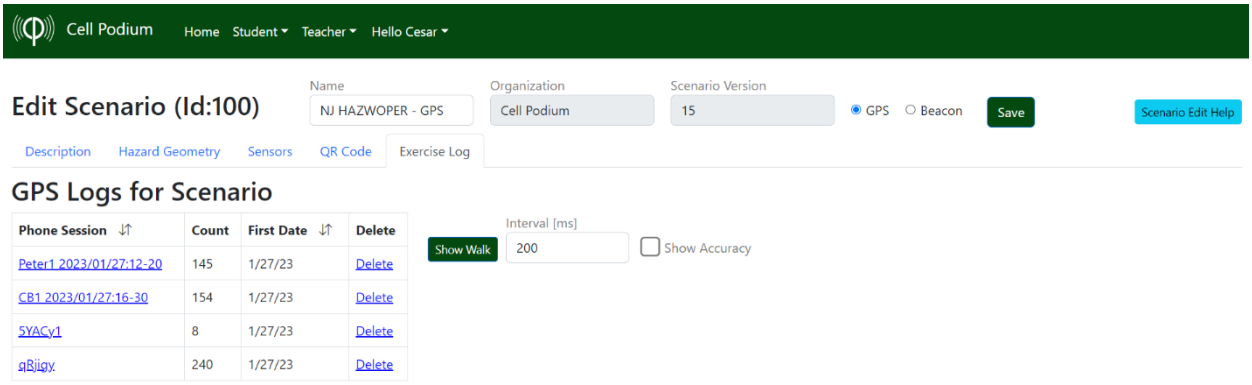
Once the instructor enters the above information into the Edit Scenario page, SensorSim is ready to simulate the exposure levels and handheld sensors of the exercise whenever a learner directs a cell phone to SensorSim. The instructor need only give the learner the QR code or the URL of the exercise, both which are provided by the same Edit Scenario page(right). When the learner directs her/his mobile device to the QR code or URL, the simulation begins as described in the Learner Experience section of this guide.



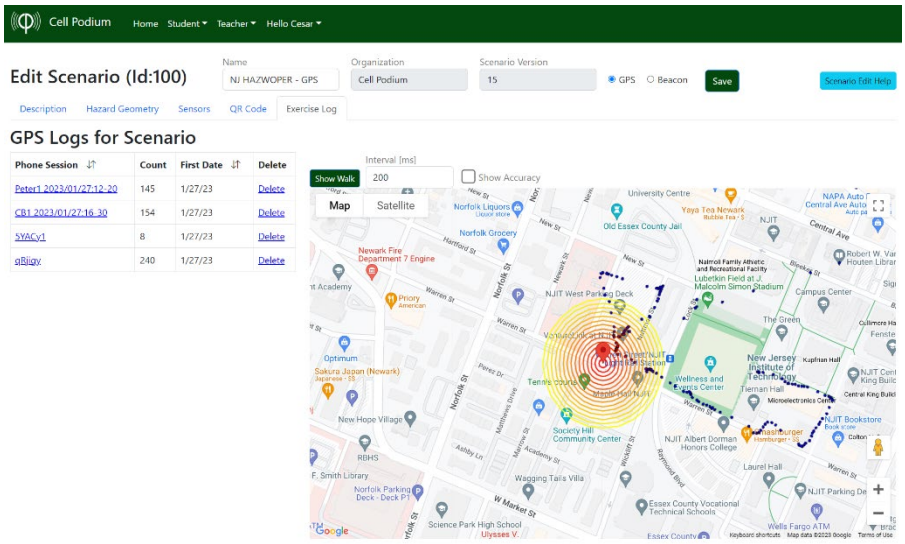
Edit Scenario Page showing scenario ID, URL, and QR code, any of which launch the sensor simulator on a mobile device.

As the learner moves within the exercise, SensorSim records the learner position and exposure levels in a log file that the instructor can access in the Exercise Log page (below). This page shows all the logs of all the learners using this particular SensorSim scenario. If the learner entered an optional team name at the start of the exercise, the log name consists of that team name, date and time; otherwise, SensorSim names the log name is a random alphanumeric string.

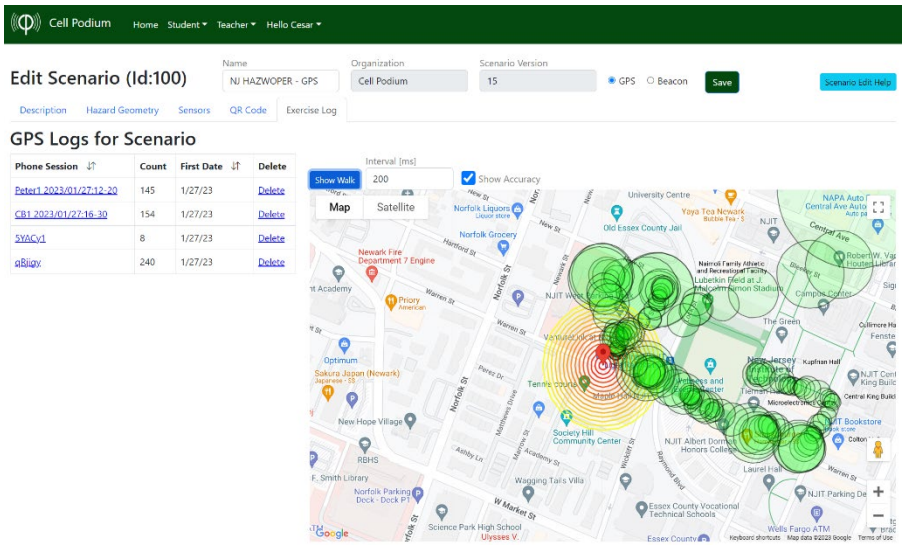
To view the activity recorded from a specific exercise, the instructor simply clicks on the corresponding log file in the Exercise Log page. SensorSim then displays a map of the exercise and the path that the learner walked during the exercise. The instructor can view an animated rendition of the learner's path, whereby the "breadcrumbs" appear in the order the learner walked. Optionally, SensorSim will draw a circle around the learner, indicating the estimated GPS accuracy of the learner's mobile device.



List of activity logs of learners who participated in exercises using the selected SensorSim scenario.



Activity of learner "Peter1" (above) and GPS accuracy (below)

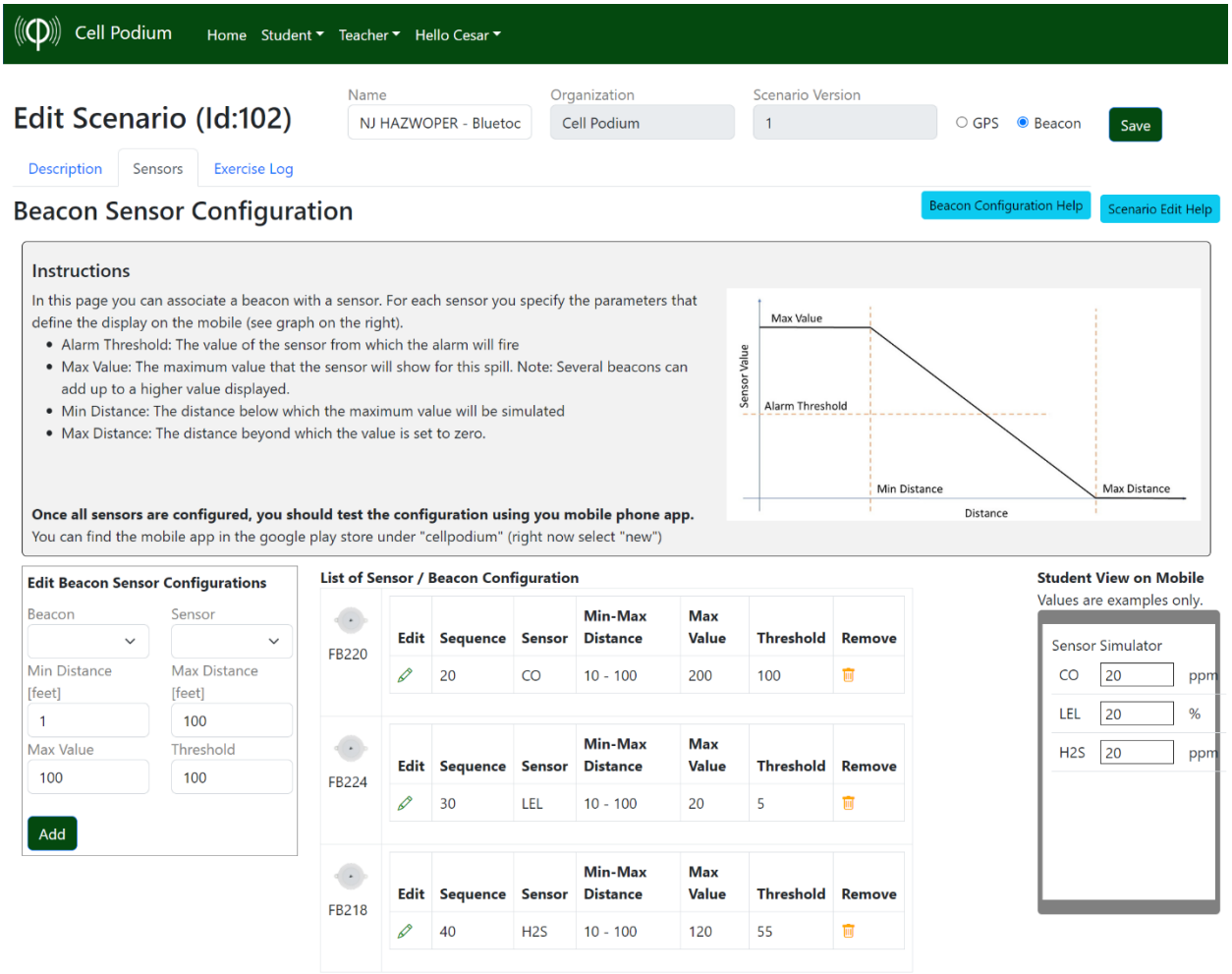


Creating and Conducting an Exercise with SensorSim - Bluetooth

Whereas creating a SensorSim GPS exercise involves associating a hazard to a virtual point on a map, creating a SensorSim GPS exercise involves associating a hazard to a physical Bluetooth beacon that the instructor places at the desired location of the (mock) hazard.

> *Technical Summary*: A Bluetooth beacon is small battery-powered device that broadcasts a radio signal with a unique ID several times per second. The SensorSim app listens for these signals, identifies the ID of each beacon within range (up to 100 meters), estimates the distance from the mobile device to each beacon, looks up the hazard configuration set by the instructor for that beacon, and then calculates exposure levels at the mobile device as a function of the distance of the device to each beacon and the type of hazard each beacon represents.

The instructor creates a new scenario by first clicking on the “New Scenario” button in the Scenario page of the SensorSim Instructor Website, and selecting “Beacon” as the scenario type. This invokes an Edit Scenario page (below) that looks different from the Edit Scenario page for a GPS-based exercise.



Beacon-Sensor Configuration Page within the Edit Scenario Page

The “Edit Beacon Sensor Configurations” pane list all the beacons available to the instructor. To add a beacon to an exercise, the instructor simply selects one from the Beacon drop-down list, and associates with it a hazard profile consisting of the sensor affected by the beacon (CO, CO2, O2, H2S, LEL, or CHCO), the maximum reading of the sensor when located at an instructor-defined distance close to the beacon (in meters), and the distance from the beacon at which the reading is zero.

All the beacons configured for a scenario are listed on the right of the pane under “List of Sensor / Beacon Configurations.” The sequence number dictates the order in which the chemical and radiological sensors are displayed on the SensorSim app display (sensors with lower sequence number appear closer to the top of the screen). This way, the instructor configures the simulated handheld sensor display.

The instructor can create many different scenarios, each one configuring the same beacons differently. When the instructor conducts an exercise, s/he gives the learners the ID of the scenario. The learners launch the SensorSim app and enter the scenario ID, upon which the app automatically downloads from

the SensorSim server the beacon configuration specified by the instructor for that scenario, and begins displaying exposure readings. The app is available for free at https://play.google.com/store/apps/details?id=com.sensorsimulator.sensorsimulator .

After an exercise, the instructor can look at the learner activity logs that SensorSim stored under the Exercise Log tab in the corresponding Scenario web page. The log includes a plot of distance between the learner and the hazard as a function of time (below)