

Teacher Guide 3

This set of guides has been prepared for steeluniversity.org 'ambassadors' and approved teachers and trainers to help in using the website resources in a range of teaching and learning scenarios.

They are not intended for general release to the public and on no account should electronic versions be posted on publicly-accessible websites or file servers.



1. Basic Solutions for All Four Grades in EAF and Secondary Steelmaking Simulations

These are suggested production routes that Teachers/Demonstrators can use. They should lead to a successful result (at University Student level), although this will not be the best (least cost) solution.

2. Production Solutions for the Linepipe Steel Grade in BOF, EAF, Secondary Steelmaking and Continuous Casting Simulations

These are suggested production routes for a single grade through several different steelmaking simulations which are, or will soon be, linked. Note: Suggested additions for secondary steelmaking will need to be re-calculated if the simulations are linked (using a saved cast from EAF/BOF) rather than run as 'standalone'.

3. Suggestions for Using Steelmaking Simulations with Adults and Children

Case studies and materials (recipes, equipment requirements, certificates etc.) for running simulations and/or steelmaking challenges with different age groups.

If you have any feedback regarding this guide, please get in touch via the [contact page](#) at www.steeluniversity.org.

Suggestions for Using Steelmaking Simulations with Adults and Children



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1 Purpose of this Guide

This guide is designed to provide demonstrators with ideas and materials to help them use steeluniversity simulations with (a) adults and (b) children. These methods have been used successfully by the steeluniversity project team, but demonstrators should not be limited to these scenarios and should remember that they are free to use the resources in the manner most appropriate for their organization or audience group.

2 Using steeluniversity with Adults

Each year, steeluniversity runs an Annual Challenge, where competitors are given 24h to make a specified steel grade at the lowest possible cost. This scenario can be duplicated on a smaller scale to run a Challenge between groups or individuals in a limited time frame, e.g. 1-3 hours, over lunch, during an afternoon etc.

Any of the steelmaking simulations can be used in a competition format. Please note: Users must be registered and logged on to the website to enable the simulations to be linked. Alternatively, simulations can be run as ‘standalone’ and the final cost/tonne compared to determine a winner. If participants are from a non-technical background or are unfamiliar with steelmaking, the basic solutions given in Teacher Guides 1 and 2 may be used to give them guidance on the steps and additions required to complete the designated simulation. This information could be presented, for example, in the form of a recipe with ‘ingredients’ and ‘cooking’ instructions to indicate the raw materials/additions and processing steps required. In this case it might be more appropriate to name the

winner as the first person/team to produce a correct solution, although the cost/tonne could still be used.

If internet access is not available, it is possible to run the simulations offline on a laptop computer as 'standalone' exercises. Instructions for using the simulations offline are included in this guide.

Prizes or certificates may be awarded to winners, or all participants, where appropriate.

Helpful hints:

- If learners are not familiar with steeluniversity.org or its simulations, it may be worth spending 15-30 minutes before the Challenge for them to become familiar with the basic operation of the furnace, cranes etc.
- Depending on the technical experience of the learners, the amount of detail given in the recipes can be changed to provide a challenge at an appropriate difficulty.
- Alternatively, teams can simply be challenged to complete any one of the simulations within a specified time limit. In this case, the steel grade to be made can be announced at the start of the challenge or 15-30 minutes before the start to allow teams to begin calculating additions or production routes.
- See the **Study and Work** section of steeluniversity.org for further case studies describing how the simulations and exercises have been used within companies and universities around the world.

2.1 Running Simulations Offline on Laptops/Notebooks

For occasions where no Internet access is available it is possible to run standalone simulations on portable computers using the standard browser caching facility.

- Prior to the demonstration, connect to the Internet and access all the pages that you require later.
- Make sure each page is fully loaded. In Internet Explorer, the page is saved in a folder called "Temporary Internet Files".
- After you have accessed all the necessary pages (including simulations) select File | Work Offline... on your browser menu and disconnect from the Internet.
- Check that you can still view the pages. It is easier if you open the "History" panel (Ctrl+H in Internet Explorer).

3 Using steeluniversity with Children

steeluniversity simulations can also be used effectively for activities involving children between 4-15 years old, e.g. interactive events at science museums.

These events can be a great way of raising the awareness and interest in the steel industry among young people, their parents and teachers. They can also introduce them to the concept of steel recycling. The events can easily be tailored to support different age groups, simply by adjusting the level of demonstrator input and the type of prop/supporting material used.

This guide gives a basic outline of how the Electric Arc Furnace (EAF) simulation can be interactively demonstrated to children. The Study and Work section of

steeluniversity.org contains a number of case studies detailing successful events, including details of the room set-up and hardware requirements.

The EAF solutions included in the “Basic solutions” guide can be used by demonstrators for this activity. For older children it is possible to interactively demonstrate the Secondary Steelmaking Simulation (SSM), again using the suggested solutions in the “Basic solutions” guide.

3.1 Pre-Knowledge

The following pre-knowledge is preferable:

- Numbers up to 100, possibly into 1000s
- Metals
- Concept of recipes and ingredients

3.2 Suggested Format

In most cases it is useful to have a number of ‘hands-on’ props available for children and adults to investigate, ask questions about and generally start thinking about the wide range of steel applications, the different steel grades available and the raw materials/scrap used to make them. If possible, examples relevant to the four simulation grades should be obtained (construction, linepipe, engineering, automotive panel) so that the children can chose which product to make in the simulation.

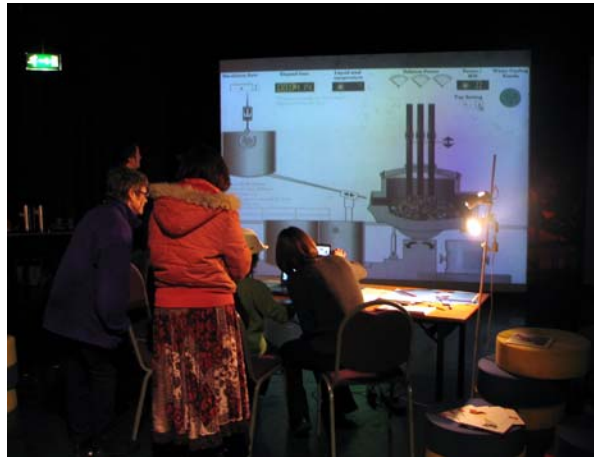


A table with examples of steel (and some non-ferrous) applications. Children can use a magnet to separate ferrous from non-ferrous objects, and then to wear a steeluniversity hard-hat when running the simulation.

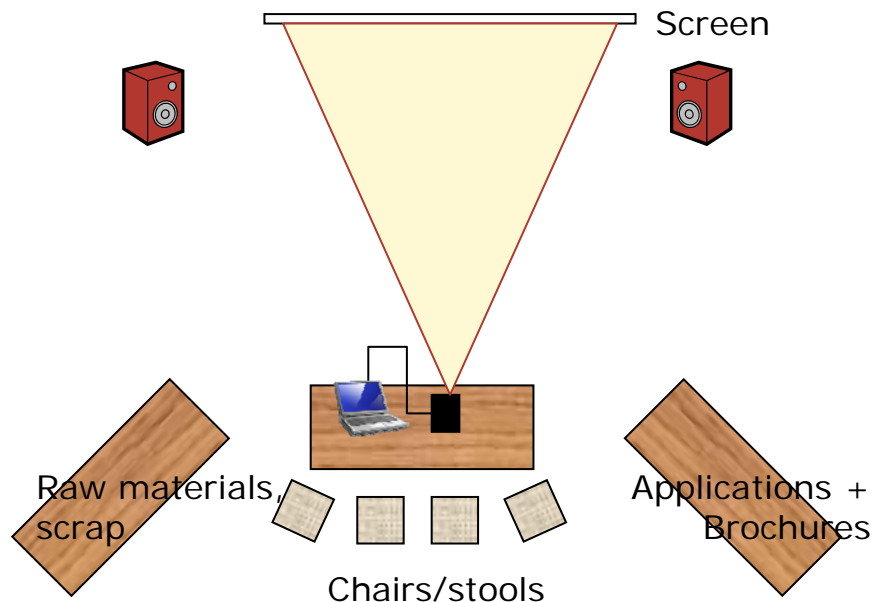
It is helpful to have an adult (teacher, parent, demonstrator) to talk the children through these props, explain the principles of different 'recipes' for different steel grades, recycling etc. and help select a grade for the simulation.

During the simulation, the demonstrator will guide the children through the suggested solution (e.g. which additions to make and when, when to turn the furnace power on etc.), while the children are in full control of the mouse and keyboard and follow verbal instructions from the helper.

At the end of the simulation, whether successful or not, each child will receive a certificate of their achievement, showing the steel grade they have produced.



3.3 Suggested Room Layout for Interactive Demonstration



3.4 Running the EAF Simulation with Children

- **Start by showing pictures, videos, etc. of an electric arc furnace.**
Explain that the furnace is used to melt and recycle the metal we throw away. If necessary, explain that a furnace is like a very, very hot oven.

- **Open the simulation and proceed through initial screens to the third screen “select a target steel grade”.** Ask the child/ren to choose what type of thing they want to make (I-beam, car body, pipeline or “engineering steel”). **Then go to the scrap selection screen.**
- Explain with the use of pictures, that scrap metal is sorted into different shapes, sizes and “types” (e.g. composition) and depending on what we want to make with the recycled metal, we can use different mixtures of scrap. **Select the scrap mix according to the Demonstrators’ Guide.** Explain that the composition bar chart is to help grown-ups decide if we’ve chosen the right materials. **Proceed to next screen.**
- Explain that the scrap has to be loaded into baskets and then dropped into the furnace. **Use the “transfer mass” selector to move scrap from the bins into the loading baskets. If you have any coarse scrap, always try to distribute it evenly between two or three baskets.** For older children, you may highlight the total cost of the scrap contained in the baskets. **When loading is complete, proceed to the next screen.**
- This is the main part of the simulation in which the scrap is charged into the furnace and melted. Before starting, just highlight the different parts of the screen:
 - **Point to the furnace and to the electrodes.** Explain that these are where the electricity comes from. Explain that the roof of the furnace opens and closes
 - **Point to the loading baskets.** This is where the scrap they have so far selected is currently located.
 - **Point to the crane** and explain this is how the scrap baskets are lifted.
 - **Point to the ladle on its transfer car (lower right).** Explain that when the melting is finished, the liquid metal will be poured into here.
 - **Point to the simulation rate control.** Explain that this allows us to speed things up and slow things down.
- To run the simulation, **first set the simulation rate to between $\times 10$ and $\times 15$.**
- **Click on the down arrow above the crane hook to pick up the first basket.**
- **Click on the crane right arrow to move it towards the furnace.**
- **Click on the right arrow on the furnace roof to open it.**
- **Click on the crane right arrow again to position the basket above the furnace. The “sliding door” icon appears on the basket. Click on this to empty the basket into the furnace.**
- **Click on the crane left arrow to move the basket away.**
- **Click on the crane down arrow to lower and drop the first basket.**
- **Use the crane controls to pick up and transport the second basket.** Explain that this is so that it is ready for later.
- **Click on the left arrow on the furnace roof to close it.**
- **Click and hold the down button next to the electrodes to lower them until they reach the scrap. Then make about 10 separate single clicks to bore the electrodes a little way into the scrap. Don’t bore down too far or too quickly, especially if you have coarse scrap, as the electrodes are fragile and are easily broken.**

- **Turn the tap setting (electrical power) to 3 to start off with.** After a little while you will start to see the molten metal collect at the bottom of the furnace (the yellow layer is molten steel, the red layer that floats above it is slag).
- Explain that as the scrap is melted, it progressively sinks down into the furnace. **Therefore keep gradually lowering the electrodes.** If a gap appears between the electrodes and the top of the scrap, the power goes down and eventually ceases. Point this out to the child/ren.
- **Increase the tap setting to 4 after a couple of minutes.**
- **Keep lowering the electrodes to keep pace with the scrap, until the electrodes reach the top of the molten steel.**
- **CRITICAL POINT:** although the (solid) scrap eventually disappears from view below the surface of the molten steel, there is still solid present for a little while afterwards. Eventually this will also melt. Keep an eye trained on the "Liquid steel temperature" gauge at the top. As soon as melting is complete, the electrical energy heats up the molten steel, and the temperature can rise rapidly. **Stop the electricity (tap setting to zero) before the temperature goes too much above 1600 °C.**
- **Fully raise the electrodes.**
- **Open the furnace roof, transfer and drop the contents of the second basket into the furnace.** Explain that as the furnace now contains molten steel, the second (and third) baskets have to be smaller than the first.
- **Close the furnace roof.**
- **Repeat procedures as before, including the third basket if required.**
- **After the final basket is fully melted, reduce power to tap setting 1 and wait until the temperature is within the required window (written below the elapsed time counter at the top of the screen).** Explain that although melting is complete, it is necessary to heat the molten steel to an even higher temperature before tapping.
- **Fully raise the electrodes, but do not remove the roof.**
- **Click on the "tilt" arrow beneath the furnace to tap the molten steel from the furnace into the ladle.**
- **The simulation is over and the final results displayed once tapping is complete.**

