Report on Locomotive Building at St Annes RC Primary School, Ormskirk

16, 19 June 2014

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Introduction

The Locomotive Builder embedded within the software suite comprising *ThingBuilder* and *ScenarioBuilder* was trialled with Year 6 at St Annes Primary School Ormskirk on 16 and 19 June 2014. Locomotive building is an extension of the capabilities of the software the children had met six months earlier when they successfully built and sailed paddle steamers through Liverpool Docks. This was a repeat of a session held for the previous Year 6 in June 2013[i].

The children learned the principles of steam locomotion and the vocabulary of steam locomotive structure e.g. firebox, boiler, cylinders, pistons etc. and used *ThingBuilder* to build a steam locomotive to a given design (Figure 1). The children then added the locomotive to a *ScenarioBuilder* scenario under narrative control (Figure 2). The session on 16 June lasted from 9:30 am to 2:15 pm with a half hour break for play time in the morning, and a one hour break for lunch. The 19 June session lasted from 9:30 am to 3:15 pm with an additional half hour break for play time in the afternoon.

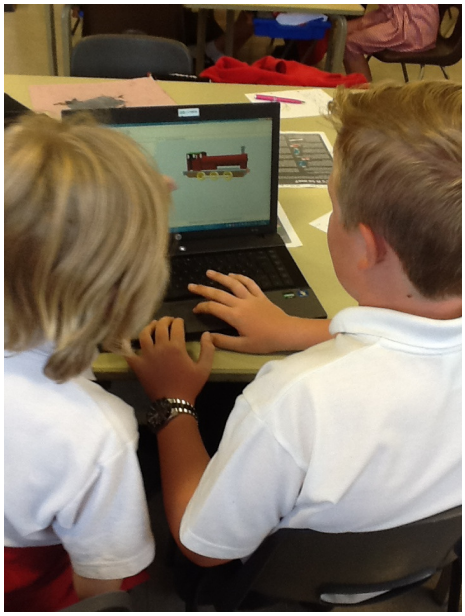

Figure 1: Building the locomotive

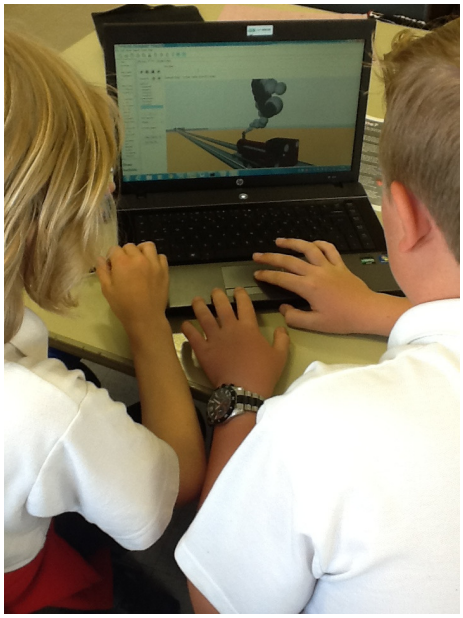

Figure 2: Running the train

Aims

The aims of the session were:

- to explore the proposition that appropriately designed 3D modelling tools can provide an engaging environment in which Year 6 children can successfully exercise and reinforce their understanding of mathematical concepts and skills.
- to explore the proposition that Year 6 children can build accurate 3D models from engineering drawings

Objectives

The objectives of the session were:

- to introduce the children to the principles and vocabulary of steam locomotives and their use on the railways around Ormskirk with special reference to the Lancashire & Yorkshire Railway that developed those railways
- to introduce the children to the use of engineering drawings to extract measurements for creating 3D models. Knowledge of symmetry and properties of circles to be exercised.
- to enable the children to build 3D models of historic steam locomotives by interpreting and manipulating tables of locomotive component attributes.
- to enable the children to place and run their models in a given visualisation within *ScenarioBuilder*

The session

The session consisted of 9 stages:

1. Real steam locomotives
    - video clips of locomotives in action
    - animation of how steam locomotion works
2. Demonstration of locomotives in *ThingBuilder* and *ScenarioBuilder*
3. Railways and locomotives in and around Ormskirk
    - Lancashire and Yorkshire Railway
4. The vocabulary of steam locomotives
5. Annotation of a drawing of a steam locomotive

Play time

6. Children making measurements from engineering drawings of a locomotive
7. Children using ThingBuilder to build the locomotive (continued after lunch)

Lunch time

8. Children adding their locomotives to a scenario
9. Tender engines and inside cylinders
    - video clips of tender engines
    - pictures of locomotives with no visible cylinders
    - demonstration using the Builder tools of building and running tender engines and adding inside cylinders to locomotives

A PowerPoint presentation (*Locomotive Builder Introductory slide show June 2014.ppt*) was used on the Smart board to structure and illustrate the session.

1. Real steam locomotives

Most of the children had seen a steam locomotive before. They had been to a visit at the National Railway Museum in York the year before. The children were shown video clips of steam locomotives in action in order to remind them what these things could do. The children saw passenger locomotives (Figure 3) and shunting engines in Southampton docks (Figure 3).

Figure 3: Express passenger locomotive

Figure 4: Southampton docks

The next step was to get across the principle of how steam locomotion works using an animation (Figure 5). This was run several times and discussed in order that the children had a good grasp of how it worked.

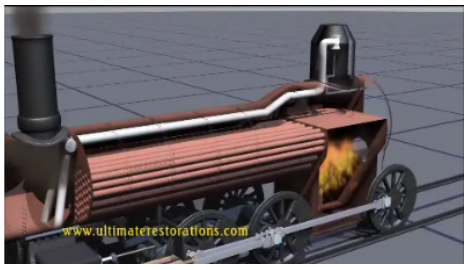

Figure 5: Steam locomotion animation

2. Demonstration of locomotives in ThingBuilder and ScenarioBuilder

The children were shown a 3D model of a locomotive named *demo1* already built in *ThingBuilder* (Figure 6). The model can be edited by changing the model tree and attributes in the left side panels. The dynamic version of the model was then built and exported to *ScenarioBuilder*. In *ScenarioBuilder* a scenario narrative is loaded in which demo1 is seen to be attached to a train. The children were familiar with the concept of scenario narratives from the ship building sessions in December 2013. Building the narrative resulted in the visualisation of the locomotive pulling the train.

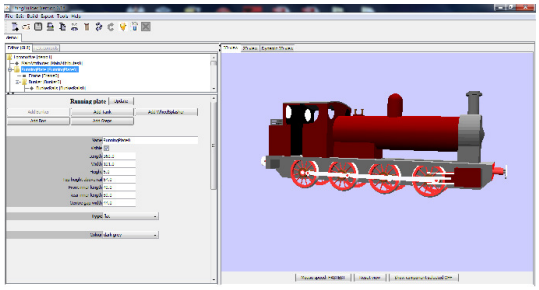

Figure 6: Locomotive demo1 in ThingBuilder

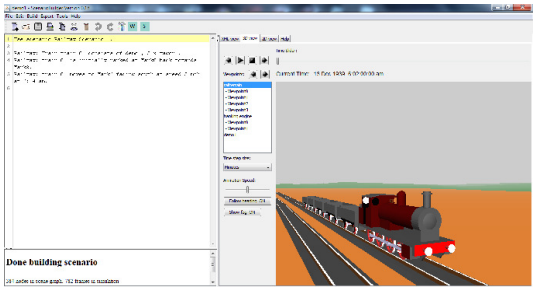

Figure 7: Locomotive demo1 in ScenarioBuilder

The scenario was run and its connection with the real locomotives pointed out. To emphasise the motion of the pistons, the various rods and the wheels, *demo1* was rebuilt with the upper body work hidden and then re-exported to *ScenarioBuilder* (Figure 8) and run again.

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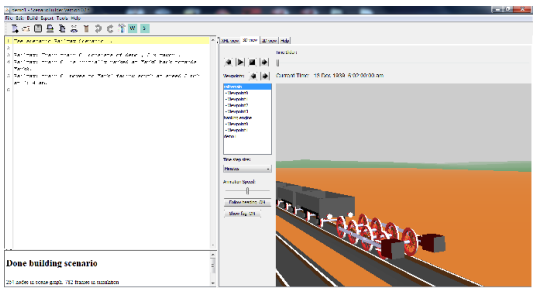


Figure 8: Locomotive demo1 with upper body work hidden

3. Railways and the locomotives in and around Ormskirk

In order to provide local historical context for the models being built, the children were shown maps of the railway company that built the railways around Ormskirk - the Lancashire and Yorkshire Railway (LYR). The children were able to pick out Ireland, Lancashire, Yorkshire and the continent.

Figure 9: The extent of the Lancashire and Yorkshire Railway

They were then shown pictures of Ormskirk station now (Figure 10) and 100 years ago (Figure 11). A discussion took place on the differences.

Figure 10: Ormskirk station now

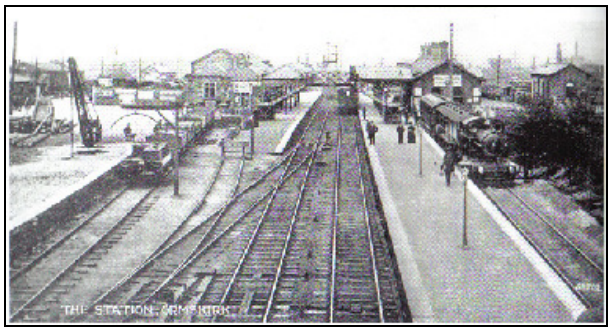


Figure 11: Ormskirk station 100 years ago

Pictures of different classes of Lancashire and Yorkshire Railways locomotives were then shown.

4. The vocabulary of locomotives

The children were then given a short session on the vocabulary of locomotives using Powerpoint presentation slides. Figure 12 shows a typical slide. Terms were repeated across the slides to reinforce the learning. This approach followed that successfully applied in *ChurchBuilder* and *ShipBuilder* sessions. The children were able to chant out the names by the end.

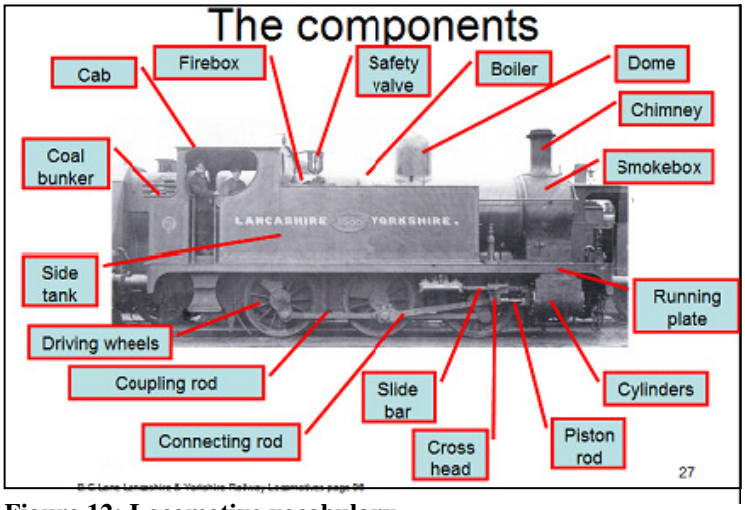


Figure 12: Locomotive vocabulary

5. Annotation of a drawing of a steam locomotive

In order to further reinforce the learning of the vocabulary, and to give the children a written record of the vocabulary the children completed the picture shown in Figure 13.

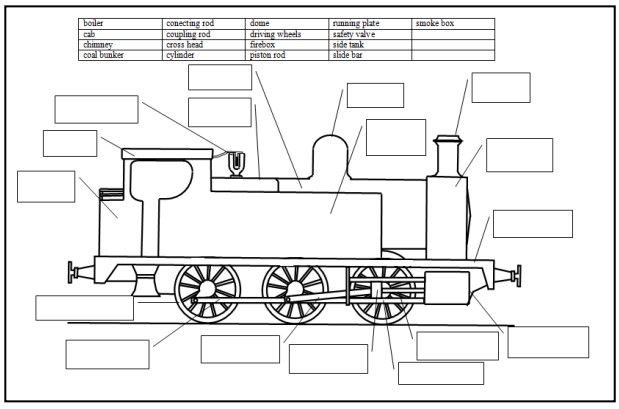


Figure 13: Naming the parts

The children generally completed these successfully in a few minutes. They were happy to tick them off in the table above the drawing as they worked through them. The components concerned with the cylinder caused the most problems (piston rod

and cross head). Misspellings were corrected and names completed with the help of staff.

Morning play time break

6. Children making measurements from engineering drawings of a locomotive

The children were now guided through making measurements on engineering drawings of the model to be built. The drawings are shown in Figure 14.

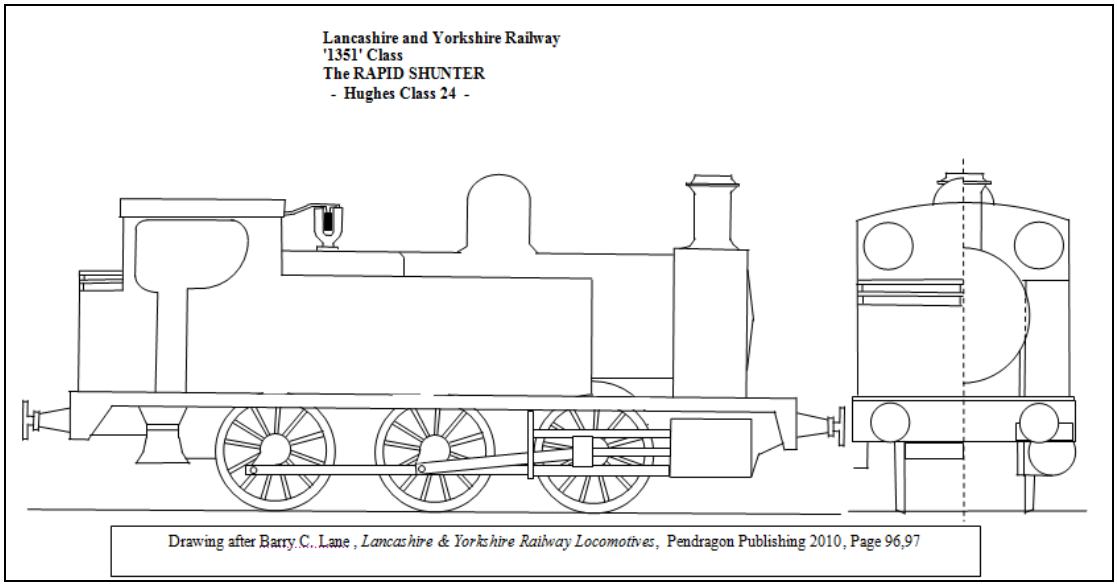


Figure 14: Engineering drawings of Lancashire & Yorkshire Railway Rapid Shunter

The Lancashire & Yorkshire Railway rapid shunter was chosen as the first model because it has visible external cylinders and motion, does not have leading or trailing wheels and does not have a tender. Thus the children are seeing the means by which the locomotive moves but are not distracted by wheels of different sizes and behaviours and the tender. Inside cylinders and tenders were introduced in the afternoon session.

The children quickly appreciated the right hand drawing which shows on the left the rear of the locomotive and on the right the front of the locomotive. They were familiar with the concept of symmetry and were able to apply it successfully when measuring.

The drawing is made to an arbitrary scale and so the children are provided with a paper "ruler" indicating scale lengths in inches as shown in Figure 15.

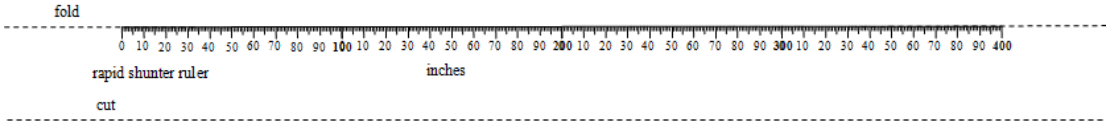


Figure 15: The measuring ruler

It was pointed out to the children that the original steam locomotives were built using feet and inches. The class teachers confirmed that learning about old units of measure was part of the curriculum.

Note that the engineering drawings were created in Microsoft Word using images scanned from Barry Lane's book on Lancashire & Yorkshire Railway Locomotives[ii]. The ruler was drawn and scaled on the same page using the longest dimension (length of running plate). The page is reproduced in Appendix 1. A copy was produced for each child, the ruler cut off and then folded to place the marks along the edge. The children had no problems making accurate measurements with this ruler.

In discussions with the teachers beforehand it was decided to prepare a record sheet for the key measurements. The sheet would be single sided, the components to be measured would be identified and the attributes to be measured would be indicated. The sheet is shown in Appendix 2.

Some of the more tricky to measure attributes were filled in already e.g. distance between driving wheel centres because the front centre was hidden behind the piston rod and cross head. *ThingBuilder* was set up so that the other component attribute values of the rapid shunter were the default values.

In class, the children would be taken step by step through the record sheet making the measurements themselves and confirming with the presenter, the teacher and the teaching assistant and other helpers that they had got it right. In this way confidence was built up as the children recorded their answers on the sheet.

We found that rather than go through all the measurements in one go as we did in the first session, it was better to measure a few then show on the Smartboard the values being entered into *ThingBuilder* for a new locomotive and do this repeatedly. In this way the children were able to see more immediately how the measurements developed into an accurate model.

Once the measurements were complete, the children started their lap tops (one between two) and prepared to build their models.

We found that the easiest way to help those children who were struggling to identify what to measure was to have the drawing displayed in Microsoft Word on the Smartboard and have thick red lines drawn on top to show what was to be measured at that point. This made it very clear to puzzled children.

7. Children using ThingBuilder to build the locomotive

The children had met ThingBuilder six months before and used it to build paddle steamers. The first ThingBuilder trials had confirmed that the children are comfortable with manipulating the component tree employed by ThingBuilder. The tree's structure is similar to the folder/directory structure used by **File Open/Save** dialogs and the *Windows Explorer* view of the files on a disc. Thus they were happy with finding the various components in the component tree and using the measurements as attribute values in the component forms.

Some had difficulty working out where to go to add particular components. Dialogues between helpers and children took place along the following lines:

Pupil: "How do I add the safety valve?"

Teacher: "What is it attached to?"

Pupil: "The boiler"

Teacher: "Well there you go then!"

Pupil: "Oh yes"

Pupil clicks on the boiler in the component tree and the "add safety valve" button is revealed.

It was found that the extra time dedicated to demonstrating adding the measurements in *ThingBuilder* in the second session was rewarded by the children needing less help when building their models. This particularly applied to the mechanism for adding and positioning wheel sets.

8. Children adding their locomotives to a scenario

The children found little difficulty in adding their models to the scenario. A few had forgotten that they needed to build the dynamic model and export it but were soon reminded. They found editing the narrative to use their own model straightforward. The editing required them to replace AAA in the sentence:

Railway: Train train101 consists of rapid shunter, 15 x wagon1.

with the name of their own locomotive.

9. Tender engines and inside cylinders

Drawings and measurement sheets have been prepared for Aspinall's class 'A' 0-6-0 tender engine (see Appendix 3). This is available for use if the teachers wish to extend the work themselves in the future.

Besides having a tender, this locomotive has inside cylinders. We completed the day by showing the children these two features.

Tender

The children were shown a video of the preserved Aspinall class 'A' in action on the East Lancashire Railway. They were shown photographs and diagrams of other tender engines including the National Railway Museum's cut away tender (Figure 16).

Figure 16: Merchant Navy Class Locomotive at the National Railway Museum

The water scoop was explained and video shown of locomotives using water troughs.

The children were shown how tenders are added in *ThingBuilder*. One or two had already discovered this while building the rapid shunter!

Inside cylinders

The children were shown photographs of locomotives with no visible cylinders. They were asked where they might be. The answer was not obvious to them and they were a little baffled. Locomotive *demo1* was loaded in *ThingBuilder*, its outside cylinders removed and inside cylinders added and all was revealed. The children particularly enjoyed watching the inside cylinders in operation with the superstructure hidden (Figure 17).

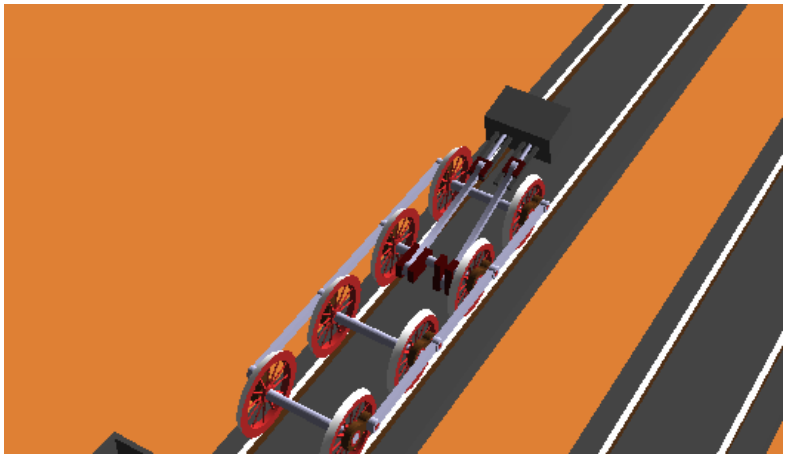


Figure 17: Inside cylinders revealed

demo1 was then converted into a four cylinder engine and shown in action (Figure 18).

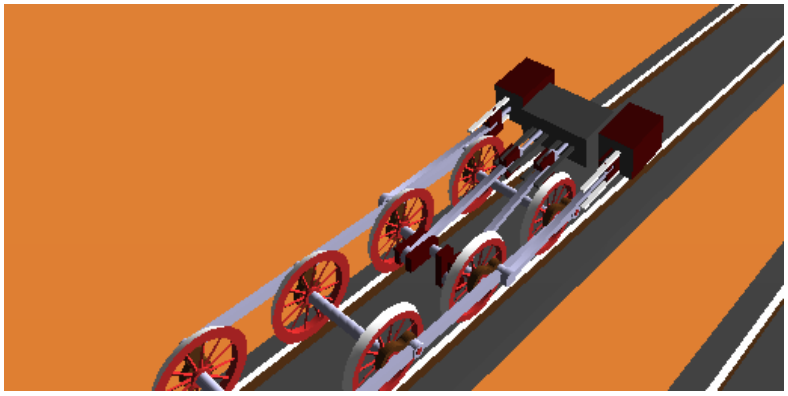


Figure 18: 4 cylinder engine revealed

At the end of the first session a boy asked if it would be possible to build a 5 cylinder engine. He was asked if there would be enough room to squeeze in the extra cylinder next to the two inside cylinders. He said there would be if you had the fifth cylinder pointing the other way!

Outcomes

By the end of the day the children had

- completed the labelling of the locomotive drawing
- completed the measurements from the engineering drawings
- worked on building the model from the drawings
- run their models in a scenario

All the children were able to make some sort of locomotive and run it in the Scenario. A few children in the first session and more in the second session were able to complete accurate, models. The colours they used were ... original. Figure 19 shows what the children started with when they selected menu option **File | New** in *ThingBuilder* and selected the type *locomotive*:

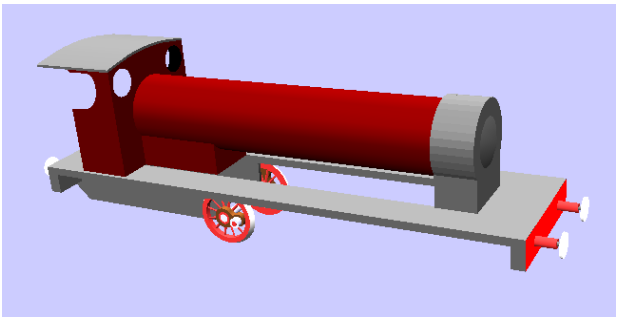


Figure 19: Starting point for locomotive building

Figure 20 shows a model that a pair of children completed. The colour they chose was black but this has been changed to dark red by us to show the detail more clearly in this document.

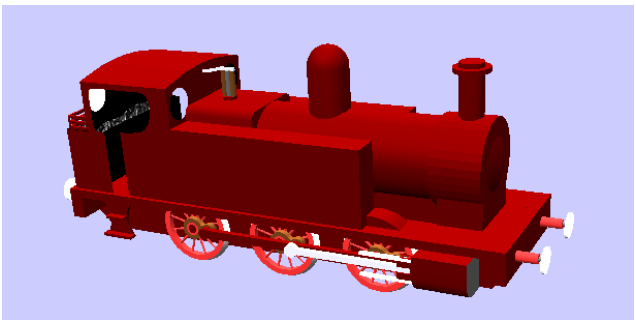


Figure 20: Model of rapid shunter completed by two Year 6 children

Figure 21 shows an attempt that was not completed (no side tanks or cylinders).

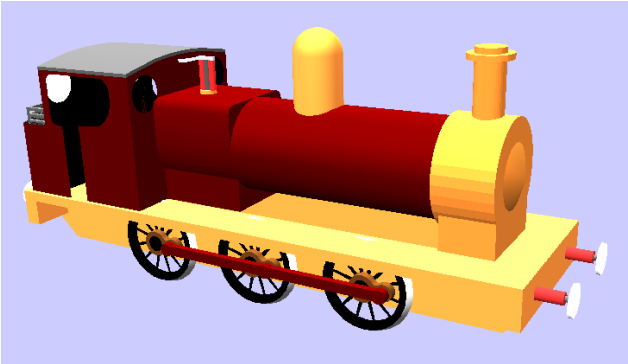


Figure 21: Partially completed model

Comments and conclusions

This trial was a considerable step up from the previous, ship building trial. It required the children to learn many new, technical words, make careful measurements and make models using those measurements.

Vocabulary

In the ship building trial the children met some new words e.g. hull, superstructure but not half as many as they met this time. We were uncertain how they would cope with all these words but the way they were able after 15 minutes to chant the names of components as they were pointed to in photographs was very encouraging.

Making Measurements

In the previous trial the children were free to build their ships by using approximate numbers. In this new trial they were expected to make accurate measurements in order to create accurate models. This was quite challenging but we found that with careful guidance the children were able to pick up confidence. The quickest children found little to trouble them and they raced away. Other children needed more help. It was interesting that there was a bit of variation in the measurements e.g. 330 was measured as 331 or 329. This was put down to the rulers not being folded accurately. Future sessions may use prepared laminated rulers.

One girl asked if they had to use the measurements. When told that they did have to - as happened in the real world - but that she could use any colours she liked she was quite happy.

Applying the measurements in ThingBuilder

In the first session the children went through all the measurements before being shown how the first few were applied in *ThingBuilder*. We found that this was all that was needed for a few children but most of the children needed more guidance.

Consequently, in the second session we went through the measurements a few at a time and showed them being applied in *ThingBuilder*. The children were generally much happier with this approach which helped the children gain confidence and expertise in building the models accurately with *ThingBuilder*.

Mathematical skills

The children were able to demonstrate their ability to measure accurately. They were also able to show their familiarity with symmetry when using the front and back drawings and the properties of circles. Transference of 2D measurements into 3D was successfully achieved.

Overall the teachers and teaching assistants agreed that the sessions had been a great success, fully engaging and challenging the children. All the children were able to make some sort of locomotive and run it in the Scenario. Some children were able to complete accurate models. They all felt they had got something valuable out of the day.

Next time

It is intended to repeat the builder sessions with next year's Year 6 classes. Ship building would take place in the first term and locomotive building at some point after that. Further development of the Builder tools may offer appropriate follow-up sessions on particular topics e.g. programming shunting operations for locomotives in the Ormskirk goods yard of 1914, determining the effect of driving wheel diameter on the performance of locomotives pulling heaving trains up hills.

Regarding the measurements and model building, further reflection will take place regarding the best way to show the children how to measure the drawings and create the models.

Appendix 1 - Rapid Shunter drawings

fold

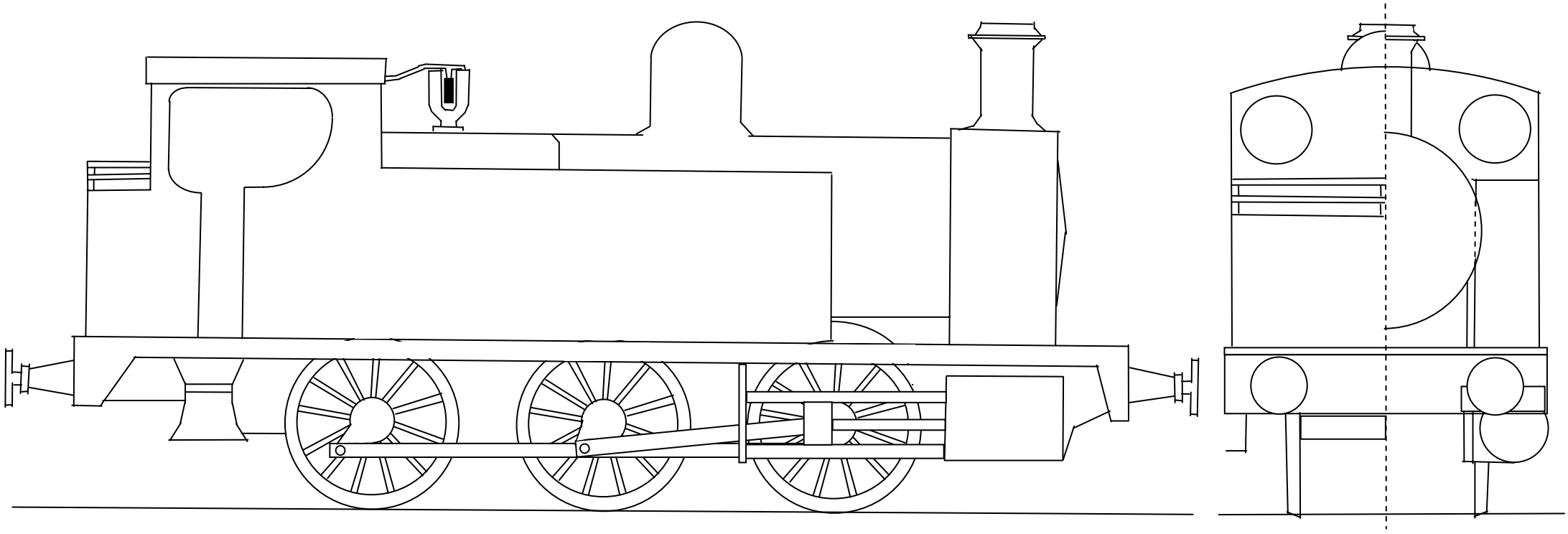
rapid shunter ruler inches

cut

Lancashire and Yorkshire Railway

'1351' Class

The RAPID SHUNTER



Drawing after Barry C. Lane , *Lancashire & Yorkshire Railway Locomotives*, Pendragon Publishing 2010, Page 96,97

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Appendix 2 Rapid shunter measurements

Units = inches

Running plate	length =	**Boiler**	length =
	width =		
	height =	**Smoke box**	diameter =
	top height above rail =		length =
			saddle centre height =
Frame	length =		saddle width =
Driving wheels	offset from running plate back =	**Chimney**	offset from back of smokebox =
	distance between axles (from rear) = 72, 72		
	wheel outer diameter = 55	**Dome**	offset from back of boiler =
			diameter =
Cab	offset of cab front from back of running plate =		straight height =
Cab side wall	type = front and back	**Side tank**	offset from back of running plate =
			height =
Cab rear wall	Add this.		length =
			width =
Bunker	offset from back of running plate = 5		
	height =	**Engine**	Driving wheel number 2
	length =		
		Outside cylinders	Add this
Bunker Coal	Add this. Change height.		case type = half round bottom
			offset to driving wheel centre = 105
Bunker Rails	Add this. num of rear vertical posts =		height above driving wheel centre = 0
Safety valve	offset of base from back of boiler =	**Steps**	back offset =
	base type = round		type = LYR type 1
	valve type = Ramsbottom		
		Wheel splashers	axle number from back = 3
Firebox	length =		number of axles = 1
	type = Belpaire (square)		

Appendix 3 Aspinall 0-6-0 drawings

fold

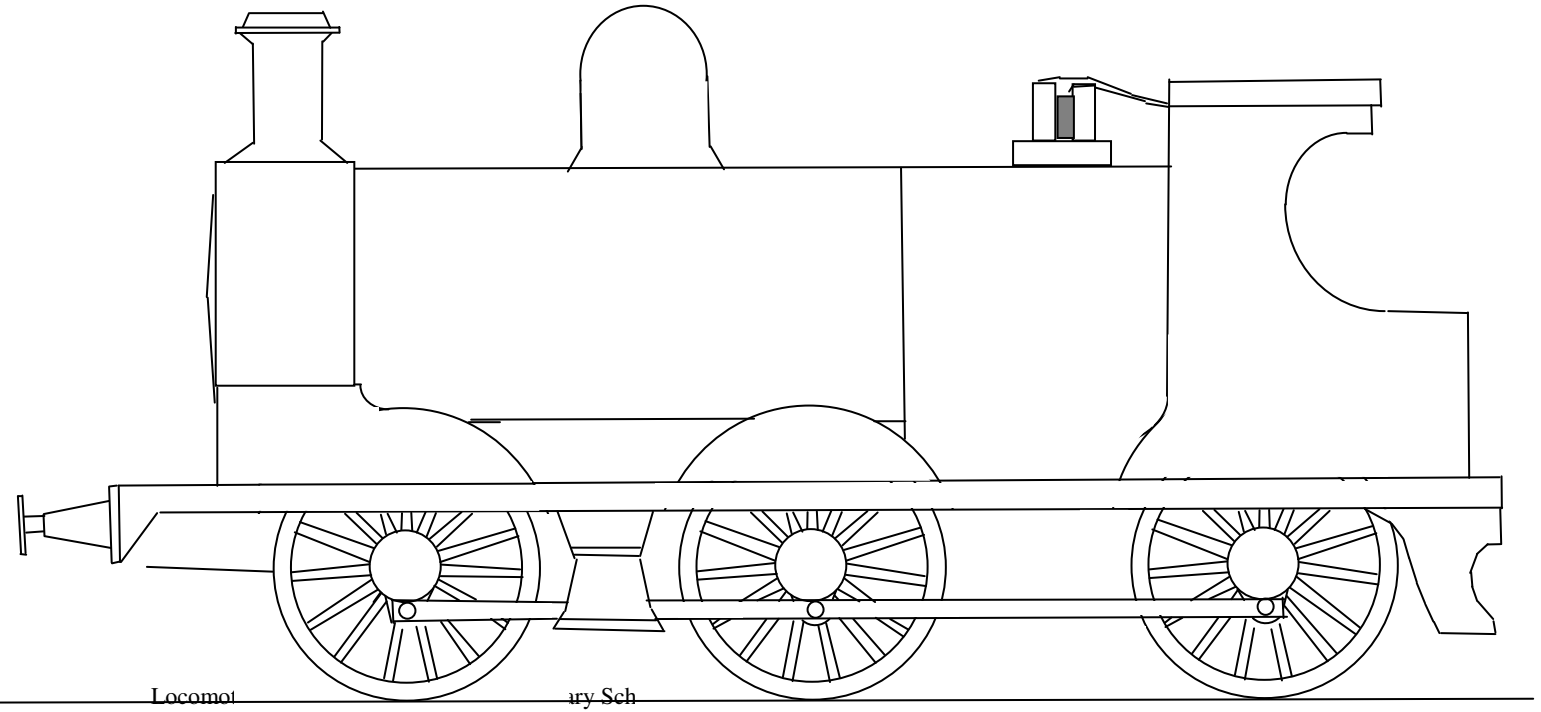
Aspinall 0-6-0 ruler

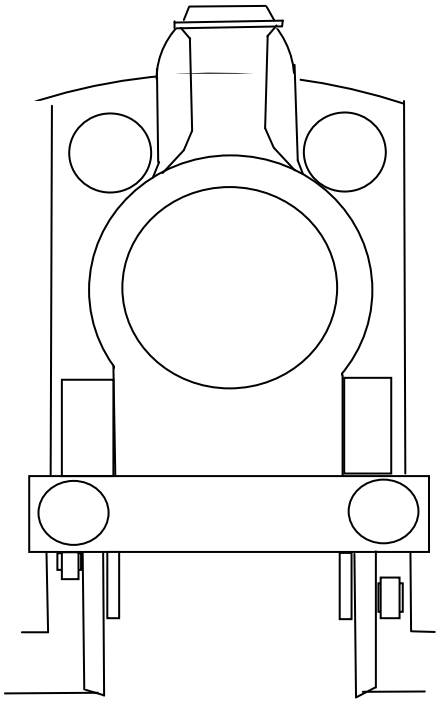
cut

Lancashire and Yorkshire Railway

'11' Class

Aspinall 0-6-0 (LYR Class A)





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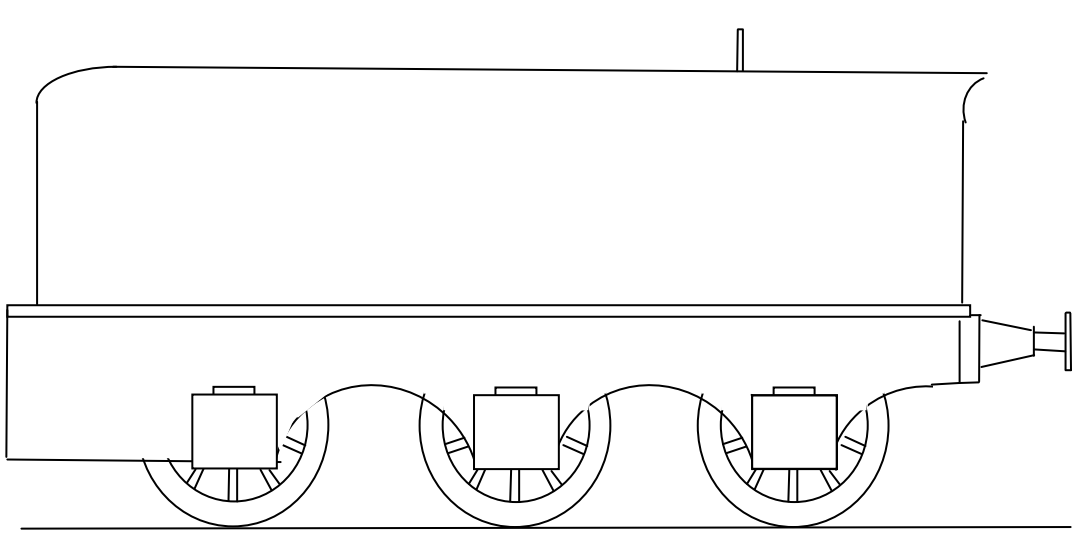
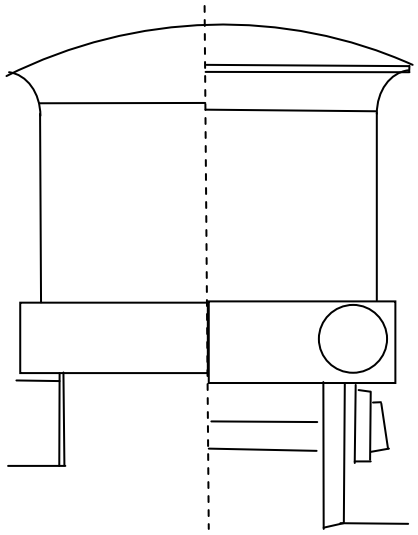
Lancashire and Yorkshire Railway

'11' Class

Aspinall 0-6-0 (LYR Class A)

- Hughes Class 27 -





Appendix 4 Aspinall 0-6-0 measurements

Units = inches

Running plate	length =	**Boiler**	length =
	width =		smoke box indent =
	height =		type = parallel
	top height above rail =		
		Smoke box	diameter =
Frame	length = 313		length =
			saddle centre height =
			saddle width =
Driving wheels	offset from running plate back =		
	distance between axles (from rear) =	**Chimney**	offset from back of smokebox =
	wheel outer diameter =		
		Dome	offset from back of boiler =
Cab	offset of cab front from back of running plate =		diameter =
	centre height above firebox =		straight height =
	side height drop from centre =		
	running plate indent =	**Safety valve**	offset of base from back of boiler =
	roof length =		base height =
			base type = round
Cab side wall	top length = 45		base diameter =
	centre length = 26		valve type =
	bottom length = 67		valve spacing = 3
	top height = 6		valve height =
	upper curve width = 14	**Wheel splashers**	axle number from back = 1
	upper curve height = 15		number of axles =
	opening height = 40		indent from running plate side =
	lower curve width = 22		base length =
	lower curve height = 25		width =
	type = front		
Firebox	length =		
	type = round		

Steps (front)	back offset =	**Tender**	
	type = LYR type 1	**Tender chassis**	base width =
	top length = 20		base length =
	middle length = 15		solebar height above rail =
	bottom length = 24		
	full height = 26	**Tender suspension**	length top = 63
	middle height = 17		width = 10
Steps (back)	back offset = 0		axle box width = 19
	type = LYR type 3		axle box height = 17
Box	type = Jbox (looks like letter J)	**Tender wheels**	offset from base plate back =
	length =		distance between axles (from rear) =
	back offset =		wheel outer diameter =
	top height =		
	bottom height =	**Tender body**	straight height = 42
	width =		front offset =
	sideoffset =		side offset =
			back offset =
			top type = flared
Engine	Driving wheel number = 2		
		Tender water tank	offset from top = 12
Cylinders	type = inside cylinders		offset from tender front = 0
	offset to driving wheel centre = 105		length of central gap = 104
	height above driving wheel centre = 11		width of central gap = 36
		Coal	Add this

References

[i] Farrimond B., Anderson M., *Report on Builder Session at St Annes RC Primary School, Ormskirk 5 June 2013*

(http://www.edgehill.ac.uk/computing/files/2013/06/Report-on-Builder-Session-at-St-Annes-RC-Primary-School.pdf)

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