# Phase 1 Mechanical Carousel 3- Manufacture & Assembly

## Aim

At the end of the carousel (11 days total) you will have produced a working model of a Rotary Beam Engine and gained theoretical knowledge of the Engineering processes involved.

## Objectives

Manufacture piece parts to specification – 2 piece parts per day "Minimum"

- Manufacture all piece parts to specification
- Functionally test and evaluate results / modify
- Complete end test

# Background Theory

### *'Steam' Engine*

The steam engine can easily be considered the single most important invention of the entire industrial revolution. There is not one part of industry present in today's society that can be examined without coming across some type of reference or dependence upon the steam engine. But, who deserves the credit for this great invention? Some give the credit to James Watt, while others claim that Thomas Newcomen was the original inventor. However, the idea of the using the power of steam to the advantage of human beings has been around practically since the beginning of time. But, no practical uses for steam emerged until the 17th century.

The majority of people will tell you that the steam engine was invented by James Watt. But, this is far from the truth. Like all other great inventions and great discoveries, the steam engine came about after centuries of work by numerous scientists, engineers and even writers. It came from a compilation of work and theories that took centuries to complete. If James Watt was not the first to create the steam engine, who was? How did James Watt end up with all of the credit for the invention? Was he just the one that was there at the right time and in the right place? Is it true that James Watt discovered the steam engine when he observed the lid of a kettle lifting as water boiled within?

"...inventions only become successful when they are not only needed, but when mankind is so far advanced in intelligence as to appreciate and to express the necessity for them, and to at once make use of them"~**Robert H. Thurston**.

## Beam Engine

A beam engine is a type of steam engine where a pivoted overhead beam is used to apply the force from a vertical piston to a vertical connecting rod. This configuration, with the engine directly driving a pump, was first used by Thomas Newcomen around 1705 to remove water from mines in Cornwall. The efficiency of the engines was improved by engineers including James Watt who added a condenser, Jonathan Hornblower and Arthur Woolf who compounded the cylinders, and William McNaught (Glasgow) who devised a method of compounding an existing engine. Beam engines were first used to pump water out of mines or into canals, but could be used to pump water to supplement the flow for a waterwheel powering a mill.

The rotative beam engine is a later design of beam engine where the connecting rod drives a flywheel, by means of a crank (or, historically, by means of a sun and planet gear). These beam engines could be used to directly power the line-shafting in a mill. They also could be used to power steam ships.

Picture for demonstration only - The design is subject to continual change

**Q, How can I achieve a positive outcome to this carousel ?**

**A,**

- **Study & Read all given documentations**
- **Be able to interpret measurement units – "Fractions to decimals & Metric Conversion"**
- **Be able to interpret and understand Engineering Drawings**
- **Be able to read Imperial and Metric Micrometers**
- **Have a basic understanding of Engineering Materials**
- **Ask Questions**
- **Study at home**

**Q, How can I ensure my engine works ?**

**A, There are 3 important steps to guarantee functionality;**

1. **The crank shaft is to specification – The flats are in the correct position with the groove in position and accurately formed.**
2. **The crank case is to specification and the crank shaft is a <u>Transitional Fit</u> in the crank case *(turns easily whilst creating a seal)*. The air inlet aligns perfectly with the groove on the crank shaft.**
3. **The piston is a <u>Transitional Fit</u> in the cylinder *(moves easily whilst creating a seal)***

**Q, How can I ensure that I meet the required target of 2 piece parts per day?**

**A, There are simple measures you can take to meet targets;**

- **Plan you task – regularly consult with the Training officer**
- **Support each other through collaboration – discuss potential problems and bottle-necks.**
- **Work efficiently as a team – for example parts can be batch produced on one machine therefore no need for each trainee to set-up a machine – one machine can be set to do a certain task as each trainee can take a turn to produce their part.**
- **Return all tools and equipment after use regardless if somebody else needs to use it later – this is a vital tip as most lost time is due to trainees looking for tools which have not been returned!**

**Q, How can I avoid breaking small drills & Taps ?**

**A, During the manufacture of the Beam Engine you will be required to drill and tap various piece parts most of which are in different materials. It is therefore necessary to learn as much as you can about the materials being used and their characteristics – for example Aluminium is 33% lighter than steel, it is ductile, corrosive resistant and easily machined. But if overheating occurs during machining operation, the characteristics change drastically; the material can plasticise and adhere to the cutting tool causing irreversible damage i.e. like breaking drills/taps or cutting tools. Even if the tool does not break, the damage to the machined surface can still be catastrophic, so it is essential you follow some simple tips for machining.**

- **Peck drill holes – regularly back off drill to clear swarf**
- **Small drill = fast RPM**
- **Use cutting fluid e.g. WD40 when drilling /tapping /reaming use coolant for turning and milling.**
- **When tapping thread one turn in then one turn out to break the swarf**
- **CONCENTRATE**

**Q, How can I ensure quality reamed holes?**

**A, Reamers are precision cutting tools designed specifically to produce accurate holes to a high tolerance diametrically and geometrically (ROUND) Reamers come in two formats:**
**1, Machine Reamers which usually have a Morse taper – although smaller diameter machine reamers can also have a straight shank - but no square end. Machine reamers are completely parallel and have no lead in.**
**2, Hand Reamers have parallel shank with a square end which is held in a tap wrench and rotated by hand to produce the reamed hole, they are <u>not</u> completely parallel the first third of the cutting edges have a lead-in taper so correct alignment can be achieved.**

**To ensure reamers achieve an accurate hole certain measures must be taken to ensure this occurs**

- **The correct reamer must be used – do not use a hand reamer on a machine and visa versa**
- **Reamers require a pilot hole to be 0.2mm – 0.5mm below the nominal diameter anything outside this the reamer will not be effective.**
- **Machine reamers require a <u>SLOW</u> RPM to perform**
- **Depending on the material cutting fluid is recommended**
- **Never ream from both sides – the hole will not be concentric**

**Q, What measures can I take to use efficiently use the lathe to manufacture the turned parts?**

**A, There are many ways to produce turned parts and by following some simple steps you ensure a successful outcome;**

- **Plan your turning operations – e.g. safety shoulder, rough turn, finish turn, centre drill, drill, ream, chamfer, part-off, face to length & chamfer.**
- **Check the tools are on centre height and have a good cutting edge**
- **Securely grip the workpiece ensuring minimum overhang**
- **Ensure there is sufficient overrun when turning diameter lengths close to the chuck – TIP if you are turning close to the chuck allow at least 0.1" 2.5mm extra for overrun**
- **Use the correct speeds & feeds**
- **Use the DRO (Digital read out) Always calibrate the DRO to the tool before starting**
- **Take even cuts – e.g. 20mm to remove – 3 x 6mm cuts 1 x 1mm cut – Measure then 1 to 2 finish cuts.**
- **Avoid damage and distortion from the chuck jaws by – using shim, supporting the bore with a fitted rod, do not over tighten**

**Q, How can I ensure a good quality surface finish on the Lathe?**

- **Leave between 0.5 -1mm for a finish cut**
- **Use a good quality turning tool with a tip radius of between 0.2 - 0.8mm**
- **Select the correct speed & feed for the material and size - e.g. 50mm diameter BMS 800-1000 rpm @ 0.1mm feed**
- **Use the required coolant depending on the material being cut**
- **Ensure the work-piece is gripped firmly with the minimum overhang**

# Safety first

- ✓ **Plan your tasks**
- ✓ **Complete risk assessments**
- ✓ **Request toolbox talks**
- ✓ **Listen to Instruction**
- ✓ **Wear and use the correct PPE at all times**
- ✓ **Follow safe systems of work at all times**
- ✓ **Check the condition of tools & machinery before use**
- ✓ **Do not operate any machinery unless instruction has been given on it's safe use**
- ✓ **Check guards are in good condition and interlocks are operational**
- ✓ **When using the drilling machine – ensure that vices and work-pieces are clamped and secured**
- ✓ **Always remove cutting tools /centres etc before cleaning machines**
- ✓ **Never remove swarf with your hands – stop the machine and use a rake**
- ✓ **Report any damage or unsafe conditions**
- ✓ **Follow good housekeeping – return all tools and equipment and re-instate the work area**
- ✓ **If in any doubt – STOP & ASK**