Stirling Engine with cans… Interesting to teach thermodynamic !

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- **Introduction**

This workshop presents two parts. The first one is a multimedia presentation of a teaching activity we are carrying out with our first-year students of higher technical education. The second part of the workshop is more practical. It intends to give to the teachers the opportunity to build their own didactical material.

- **The teaching activity**

We are teaching in the technical Department of a College in Belgium. The activity suggested to the students gives itself several objectives; teaching, technical and human. For the teaching objective: the students think that the theory courses such as mechanics, thermodynamics, etc are not very useful. It is a question of showing them that it is possible to use the courses for better understanding a machine than they do not know well. It is, for many of them, the first time they will work on an engine with their hands. For the technical objective; the students have much difficulty to argue their answers with figures. To learn how to make measurements enables them to better explain how the things function. Among these measurements: measurements of pressure, couple, power, etc. It is also important that the students realize that if the manufactured engine is not looked after, this one will not function. And for the human objective; the construction of the engine is a team work! What is not as easy as they could believed… The students must learn how to work together, to respect the calendar, to carry out a file, to present their realization orally.

The first-year students also present quite specific misconceptions, and the most important are "The theory has no real use… Action first!, Valorisation of the method "test-error" on the reflection!, Nothing is used to reflect before making but it will always be time to modify the things afterwards! The time of reflection is seen like wasted time… If anything is not done (that to think), one cannot then solve a problem!". All these misconceptions on the training convinced us to put an alternative pedagogy; a Project Bases Learning (PBL).

The project consists in making the students work by groups of four or five for one 14- week-period. The majority of the students have never worked together and it is also necessary to teach them certain rules. The students receive all the instructions in a file: what is required, handover dates of the engine,… as in the professional life!

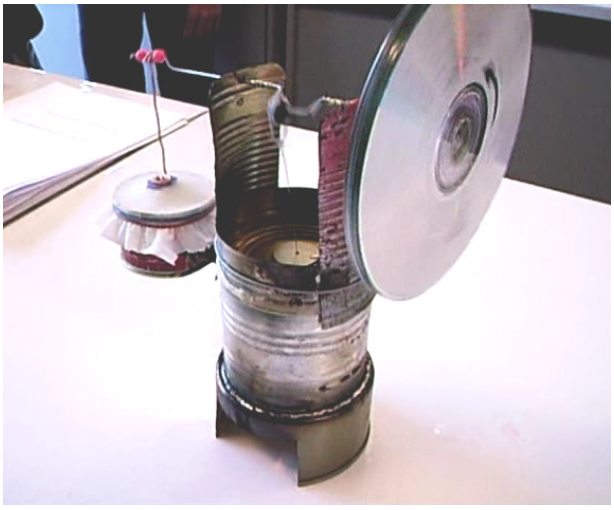
They are asked to build a small-scale model of a thermal engine which would be able to make a water pump function in a developing country. We state specifically that it concerns a country having few resources so that the engine uses recovery elements compatible with the local environment. The students are very surprised by the activity: few time constraints… Work is important goal length-term. Drank in 14 weeks year engine must function. Work is year activity off group where everyone will cuts to assumes responsibilities and share off work.

- **The Stirling engine**

We chose a Stirling engine for several reasons; first of all it is little known but its principle of operation is comprehensible in spite of knowledge… Moreover, it can be built with few average techniques (cans, etc.). The Stirling engine is a closed cycle heat engine driven by an external difference of temperatures applied on separate parts of the engine. It was invented

and developed by Reverend Dr Robert Stirling and his brother James, an engineer, over several years starting in 1816.

Stirling engines are external combustion engines, which means no combustion takes place inside the engine and there's no need for intake or exhaust valves. As a result, Stirling engines are smooth-running and exceptionally quiet. Because the Stirling cycle uses an external heat source, it can be run on whatever is available that makes heat — anything from hydrogen to solar energy to gasoline. Our Stirling engine is characterised by the fact that the combustion is external and that the gas, which transports thermal energy, is here of the air: wherefrom comes the name often given to the Stirling engine: driving engine "with hot air".



A Stirling engine gamma type is easy to build with cans.

The engine that the students (and you!) made build has two pistons and two different cylinders; it is a standard engine gamma type. It is easier to build than others versions of the engine where the two pistons are in the same cylinder. The standard Stirling engine gamma presents two cylinders: a cylinder displacer (on the right) and a drive roll (on the left). The cylinder displacer contains the piston displacer, which, by its movement, will put the air in contact with the heat source (here at the bottom) or the heat sink (here at the top). The drive roll is connected to the cylinder displacer by a pipe making it possible to transmit the variations of pressure.

- **The practical realisation**

This Stirling Engine is built from common materials (cans, CD, latex glove, etc.) which should cost no more than a few Euros. The most expensive item is the high temperature epoxy glue. Most of the items are free (i.e. aluminium drink cans and old CD ROM). No particular skill is needed to build this engine but, you must count two or three hours for an engine.

Parts lists

- Four tin cans (e.g. One tomato soup for the displacer cylinder, two little sausage for the top and the bottom of the displacer cylinder and one tomato concentrate for the drive roll),
- Two soft drink aluminium cans (for the displacer),
- A later glove for the power piston,
- Small copper pipe (for connecting cylinders : e.g. 10 mm diameter)
- Wire for the crankshaft (e.g. 1mm diameter),

- Wood pearl, rubber band, old CD, metallic washers,
- Nylon wire for the displacer rod, little candle,
- Quick epoxy glue, silicon glue, soft soldering, soldering iron,
- Tin snips or stainless steel scissors, cutters, pliers, hammer, drill, hand drill.
