12. **MatLab Challenge/Application to manufacturing/Case study/Casting mold design/Casting economics**:

Jigsaw activity. Your instructor will divide the class in groups (same as term project groups). Members of each group will be asked to attend discussion sessions to be conducted by the following expert groups:

1) Material properties.
2) Casting technology/economics.
3) Heat treatments/alternative block materials

During the first 30 minutes, the expert groups will be investigating the following:

1) **Material properties**: Define material parameters (properties) that are relevant to solve this case study. Search on the internet or elsewhere for the parameter (property) values to be used, and/or for ways to calculate it.
2) **Casting technology/economics**: Define advantages and disadvantages of sand and investment casting vs. permanent molds (refractory metals or carbon based) casting. Search the internet for pertinent information. Recommend mold type based on your findings.
3) **Heat treatments/alternative block materials**: As mentioned below, gray cast iron of 4wt% carbon has been chosen for the engine block. Investigate what heat treatments may make the block perform better. If you think it is appropriate, consider alternative engine block materials (e.g., aluminum alloy).

Come back to your group and share your findings (30 minutes). Prepare a ***poster*** to present your group's conclusions. Be ready to present your poster to the class during a 1-minute ***elevator pitch***.

Work individually outside class to formulate a solution to the case study and prepare MatLab code to calculate the mold filling time.

Deliverables (due a week after the jigsaw activity):

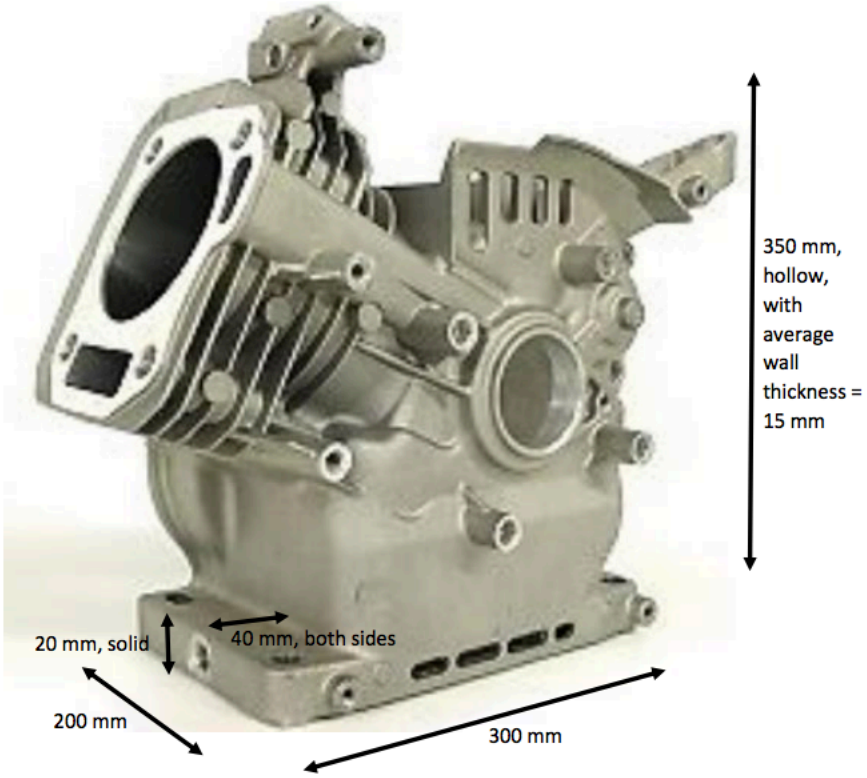
Submit a formal report, separate from your solutions for the other problems in this HW. **Include**:

1) Your MatLab code to compute mold filling time, based on parametric inputs (mold dimensions, material properties, etc.).
2) Your estimate of mold filling time using proper parameters. Show that your mold filling time will be less than the solidification time. Show that your sprue design will not lead to aspiration or turbulence.
3) **For 50 pts EC**: A brief (no more than 2 pages) section with your methods to estimate Chvorinov's constant (*C*), recommendation (with justification) for expendable or permanent mold casting, heat treatments for gray cast iron to make the block perform better, and consideration for alternative engine block material (e.g. aluminum alloy).
4) **Declare who worked with you, and what expert group was assigned to you. While you are responsible for your general report accuracy, however, your instructor will hold you especially accountable for the MatLab program, and for data from your expert group activity.**

The case study:

Formula 0.1 has asked uncle Nelson's consulting firm to recommend mold design to cast go-kart engine blocks. They expect demand of 1000 engines per year. The casting mold can be either expendable sand or ceramic, or permanent refractory metal or graphite, depending on what is more appropriate from cost and other considerations. They will make the engine block from gray cast iron (4 wt% carbon), but welcome suggestions for better materials. The block's basic geometry consists of one open cylinder, as per the illustration below.

i) Define mold and material parameters relevant to the case.
ii) Write MatLab code to calculate the mold filling time. Run your code with proper parameters to show that mold filling time will be less than the solidification time.
iii) Based on expected costs and finish/dimensional accuracy, make recommendations to decide between expendable or permanent mold casting.
iv) Note that Formula 0.1 is looking for valuable suggestions to make engine blocks efficiently.



Engine block basic geometry