Modelling of heat transfer in different materials in cooking vessels using COMSOL Multiphysics ®

Lew Zhiyi, Helen Trenner
Raffles Girls' School (Secondary), Singapore

Introduction: Heat transfer in kitchen appliances is investigated as kitchen appliances are used frequently. This project investigated the contribution of the material of a cooking pan to heat transfer efficiency of the pan, and hence determine the best material for a cooking pan. The materials investigated were Steel AISI 4340, Aluminium, Aluminium 6063-T83, Titanium beta-21S, Iron, Copper, Cast Iron and Structural Steel.

Figure 1. Structure of a Typical Cooking Pan

Computational Methods: We created a 3D geometry resembling the structure of a cooking pan. The geometry of an ellipsoid we started with was modified. Equations for heat flux were used as well.

$$\rho C_p \frac{\partial T}{\partial t} + \rho C_p \mathbf{u} \cdot \nabla T + \nabla \cdot \mathbf{q} = Q + Q_{ted}$$

$$\mathbf{q} = -k\nabla T$$

Figure 2. Equations used

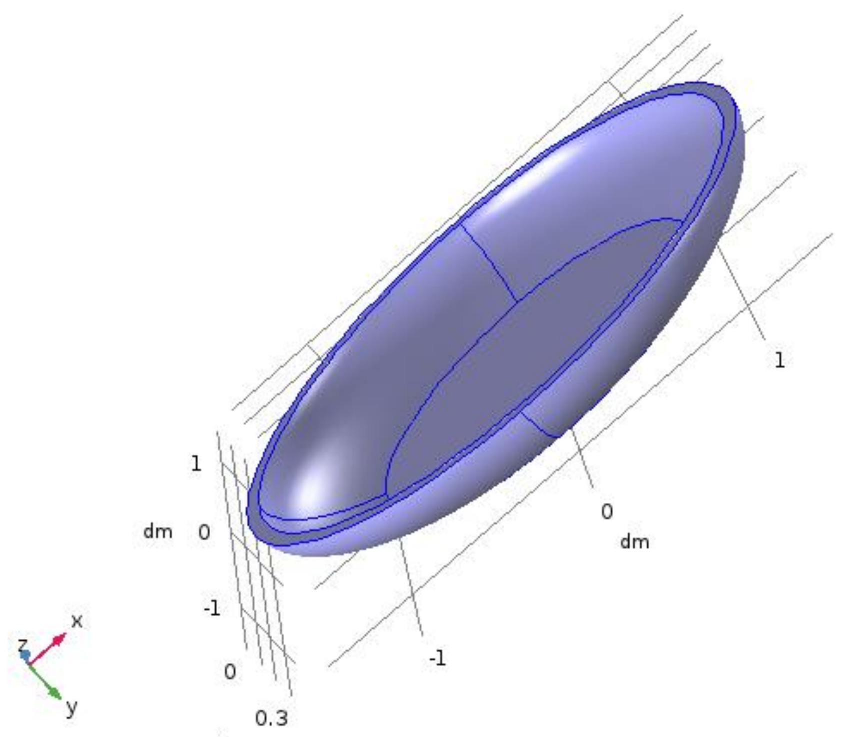

Figure 3. Geometry of Pan

Conclusions: Heat transfer efficiency is determined by the the heat dissipation in the bottom surface. For copper, the heat dissipation is more evenly spread out and therefore copper transfers heat the most efficiently. We hope this research will be applicable in in making decisions regarding the material in the designing and buying of cooking pans. Results may be corroborated with experimentation, which, although having greater limitations with regards to human error, may be able to, together with simulation results, yield a more comprehensive picture of the heat transfer process with different materials. Our research, in the future, may be extended to research of the cost-effectiveness of the various material through analysis heat-transfer efficiency results coupled with the costs of the various materials, allowing for better judgement in the selection of cooking pan material.

Results:

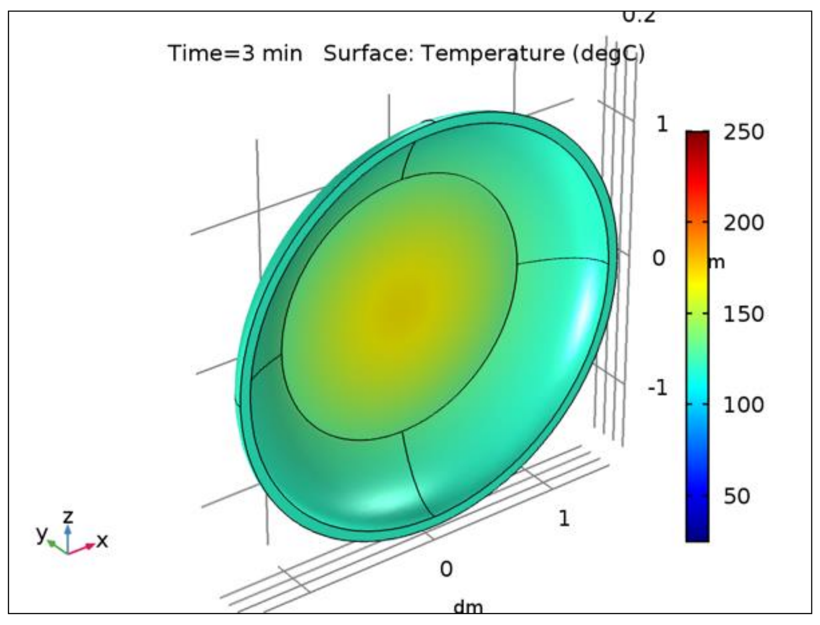

Figure 4. Aluminium 6063-T83

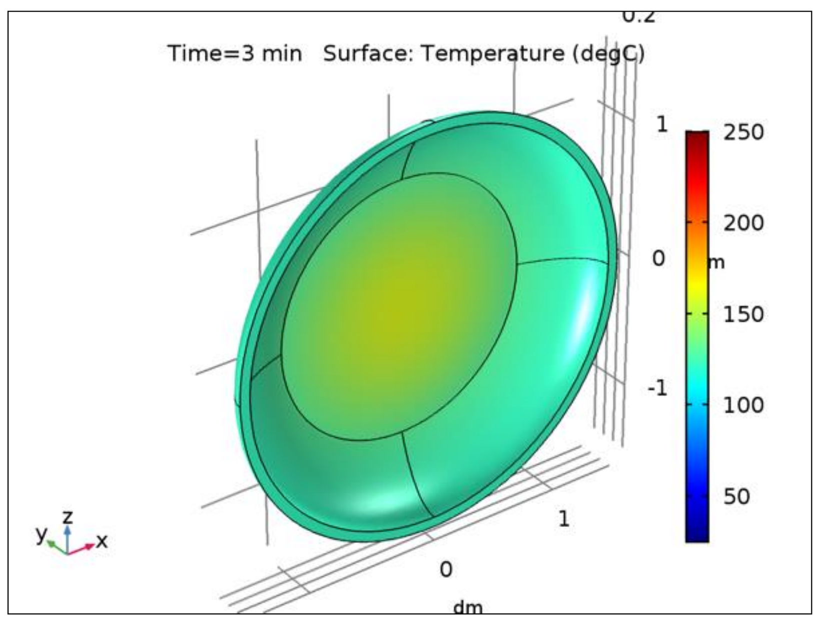

Figure 5. Aluminium

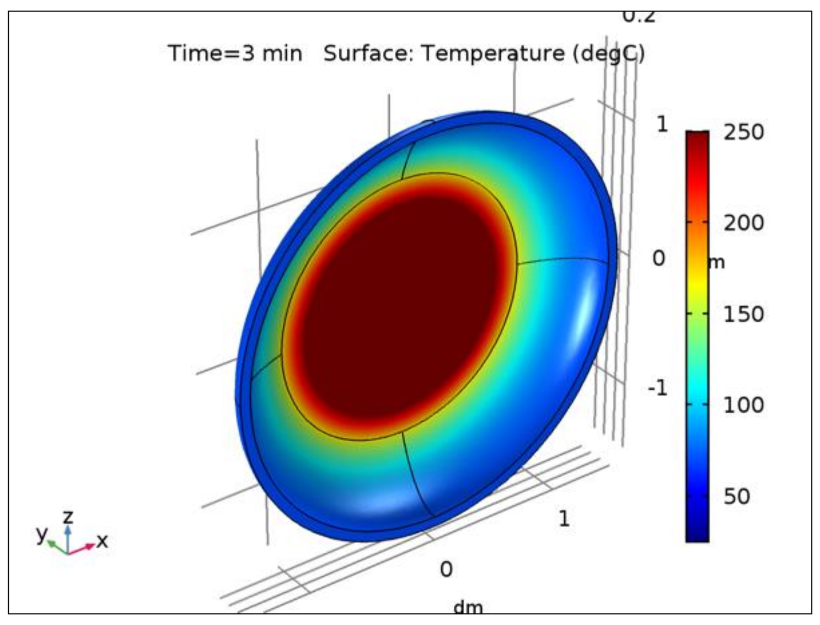

Figure 6. Cast Iron

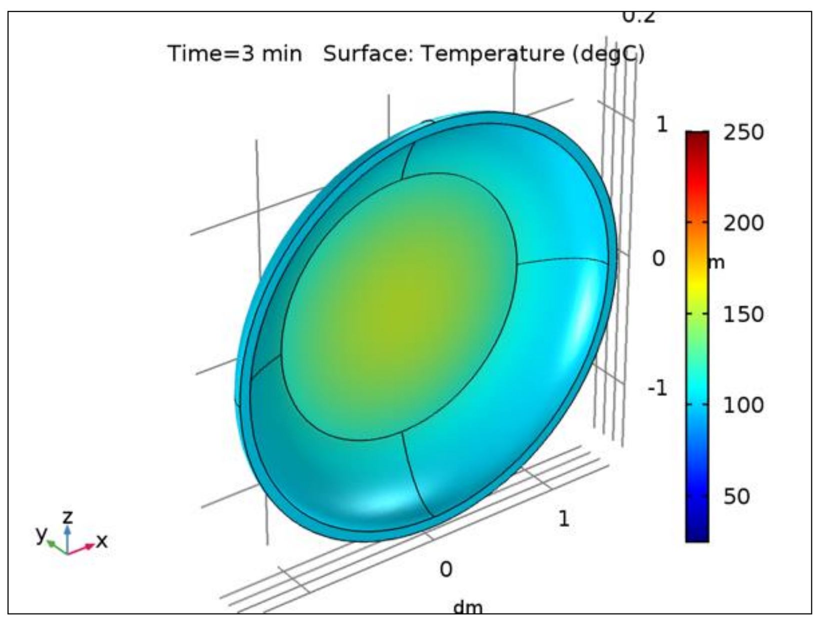

Figure 7. Copper

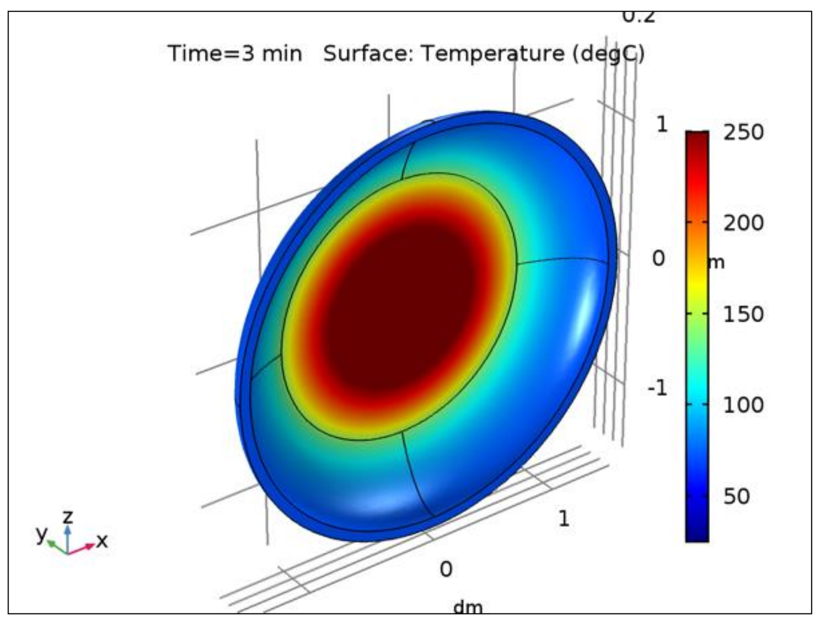

Figure 8. Iron

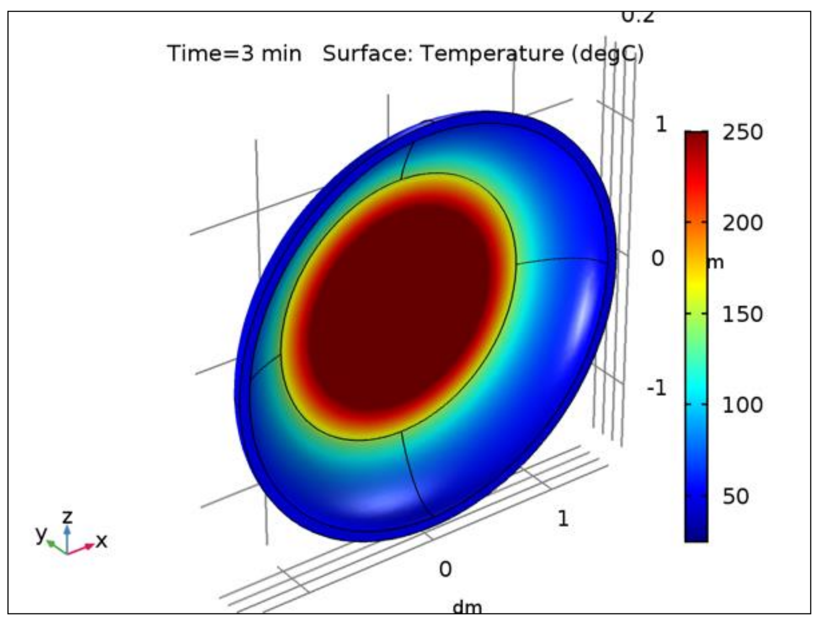

Figure 9. Steel AISI 4340

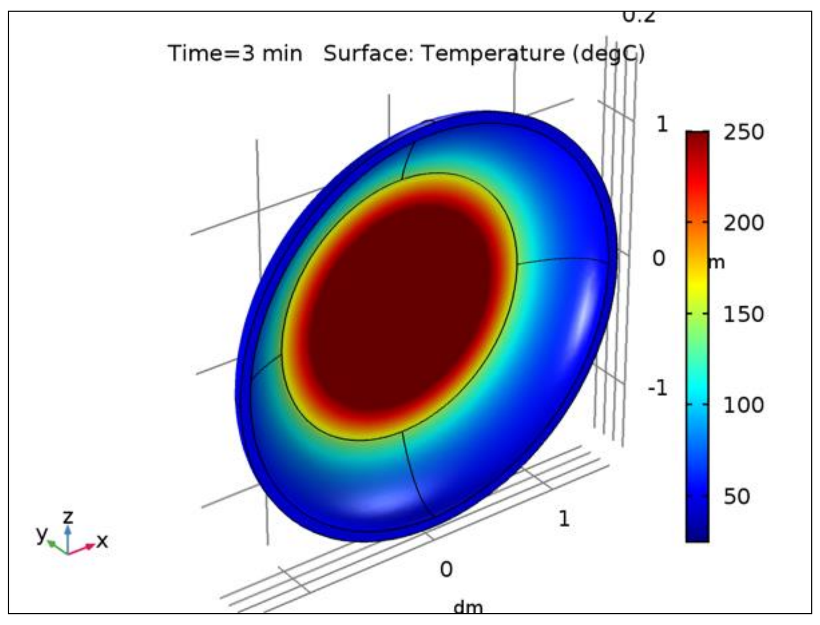

Figure 10. Structural Steel

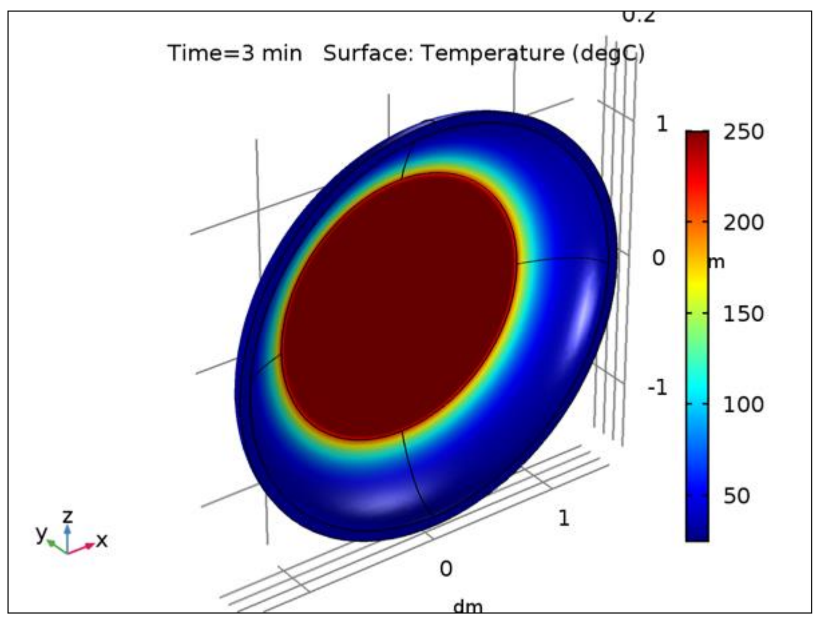

Figure 11. Titanium beta-21S

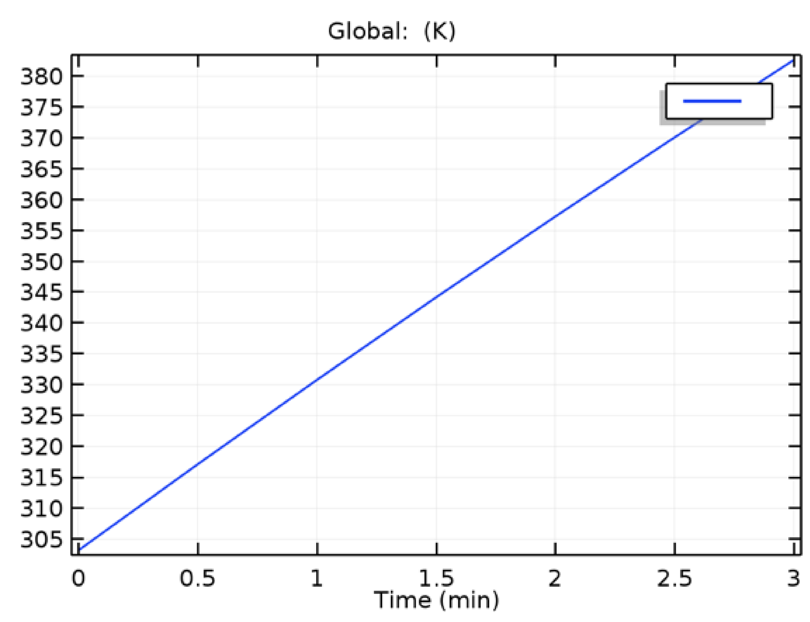

Figure 12. Graph of Temperature of Copper against Time/min

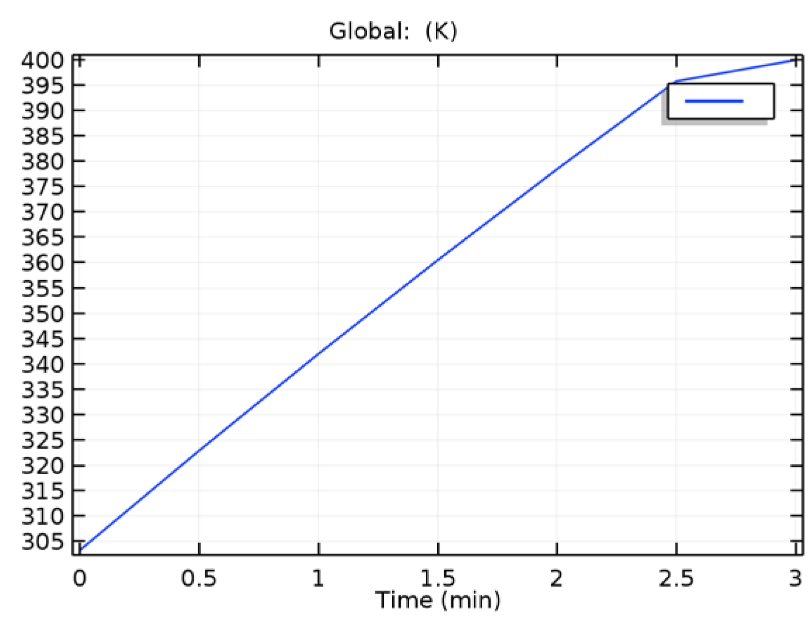

Figure 12. Graph of Temperature of Aluminium against Time/min

References:

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2. Barakat, M. A. and R. Kumar. CHAPTER 10 Modified and New Adsorbents for Removal of Heavy Metals from Wastewater. Heavy Metals In Water: Presence, Removal and Safety, *The Royal Society of Chemistry* **2015:** 193-212.
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