Optimization of Fin Geometries with a Genetic Algorithm

Objectives

- Create a tool to automate the thermal analysis of arrays of straight fins.
- Provide the possibility to reach **optimal designs** subjected to **financial constraints** and **performance requirements.**

Methodology

- A genetic algorithm (GA) finds the best possible array of fins by maximizing the heat transfer rate, given a set of design constraints and goals.
- 6 variables involved: number of fins, material, fin profile, width, thickness, & length.

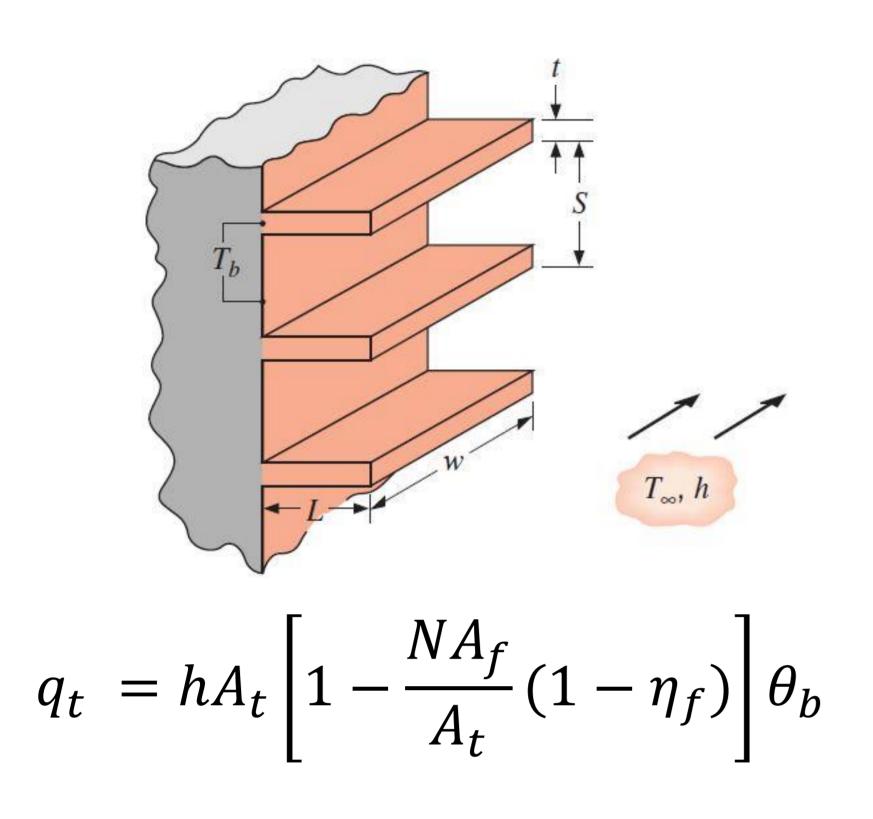


Figure 1. Heat transfer rate from an array of fins [2].

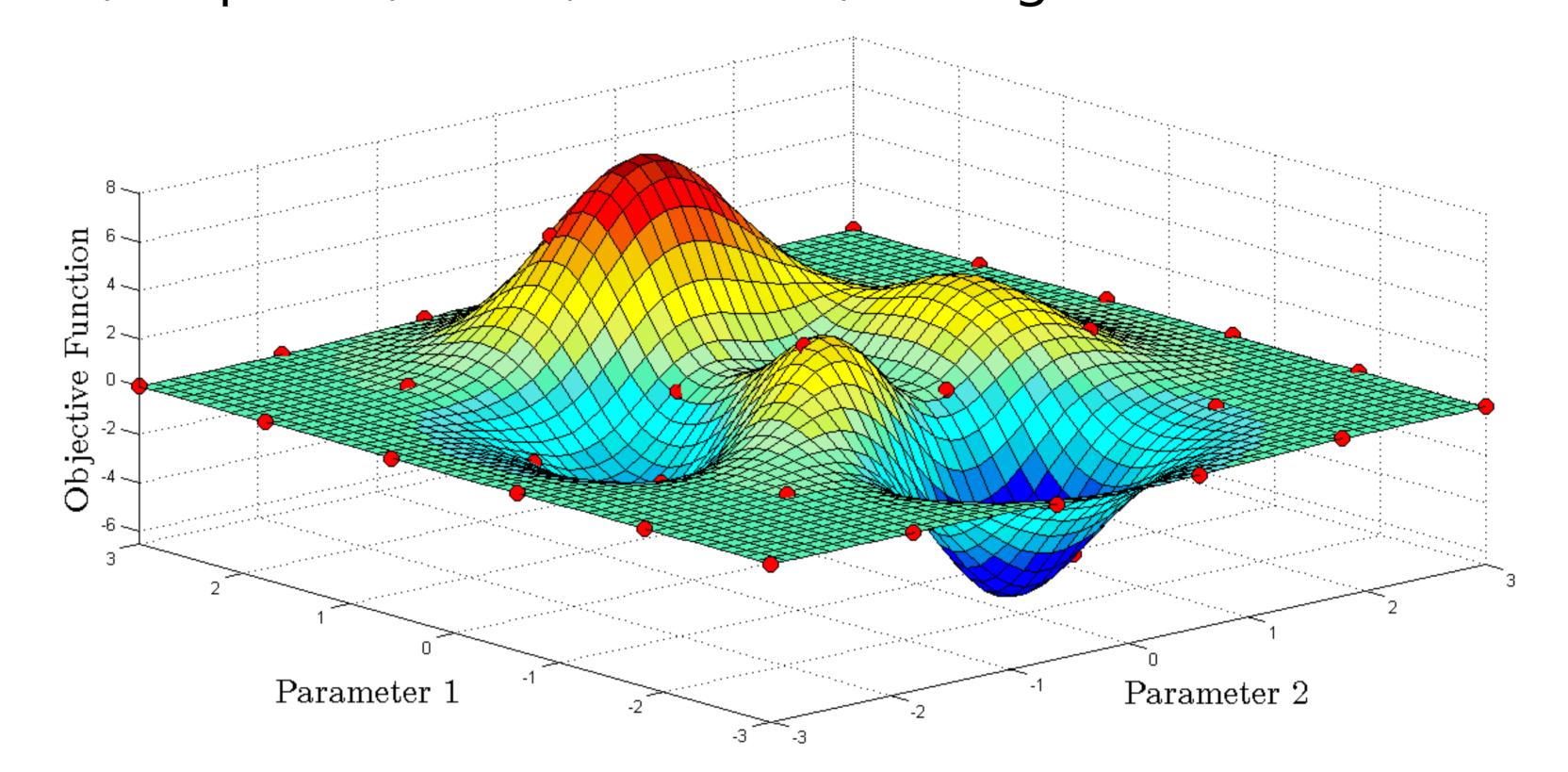


Figure 2. GA population exploring a surface with multiple local maxima [1].

Results FIN_DESIGN_GUI Heat Sink Optimization Boundary Conditions. — Design Goals. Temperature at base [K] 473 OPTIMAL FIN GEOMETRY File Name : Budget [USD] materials.csv Fluid Temperature [K] 298 Heat Transfer 150 Rate [W] Load 50 Coefficient [W/mK] Design Constrains Base Height [m] Min. fin pitch [m] CHECK **BEST PARAMETERS:** No. of fins: 5 4e-3 w = 47.415246 [mm]t = 5.000000 [mm]1 = 30.420461 [mm]Max Fin type: Triangular profile Material: Al-2024-T6 Number of Fins Qt: 153.822612 [W] V: 1.802992e-05 [m^3] Cost: 9.988576e-01 Fin Length [m] 1e-3 0.1Number of fins: Fin Thickness [m] 0.05 5e-3 Maximum distance 6.25 between fins [mm] Fin Width [m] 0.05 Heat Sink Optimization Software v.1.0 // Authors: Lino Mediavilla & Javier Miranda // Contact: lino.mediavilla@estud.usfq.edu.ec ; javier.miranda@estud.usfq.edu.ec // All Rights Reserved (c) 2017

Figure 3. Fin design GUI implemented in Matlab.

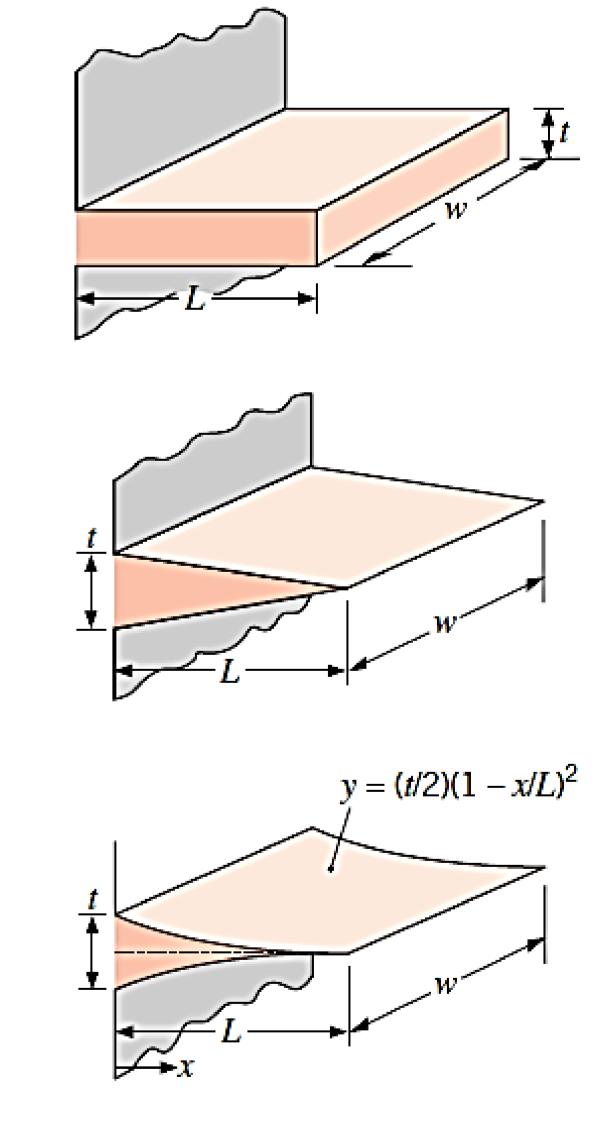


Figure 4. Fin profiles considered.

Conclusions & Remarks

- The software implemented allows to find the best possible fin array under arbitrary design constraints.
- Although the results from the thermal analysis may be encouraging, mechanical properties should also be
 assessed to ensure that the potential designs are safe.

[1] Haupt, R. L., & Haupt, S. E. (2004). Practical genetic algorithms. Hoboken, NJ: Wiley-Interscience.
 [2] Bergman, T., Dewit, D., Lavine, A. and Incropera, F. (2011). Fundamentals of heat and mass transfer.
 New Jersey: John Wiley & Sons.



