# Project Brief

ML Predictive Modeling & Multi-Objective Optimization of 2.5D Lidless glass/silicon interposer Flipchip Packages

In this project you will build machine-learning (ML) regression models—Random Forest (RF) and XGBoost—to predict four key reliability/thermal metrics, and then use Bayesian Optimization (BO) to explore trade-offs among them.

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| Objective | Metric symbol | Scenario |
| Junction-to-ambient thermal resistance | Θ\_JA | Steady-state heat flow |
| Accumulated strain-energy density, corner µ-bump | ΔW\_bump | Thermal cycling |
| Accumulated strain-energy density, outer C4 | ΔW\_C4 | Thermal cycling |
| Accumulated strain-energy density, outer BGA | ΔW\_BGA | Thermal cycling |

I’ll walk through the physics behind each objective during the next few lectures, but you do not need deep domain knowledge to start Deliverable #1.

## Resources Provided

* Input data - Three Excel workbooks containing simulation data for training and testing your models. Keep every workbook in the same folder as your Python script.
* Starter Python script - Verified to run end-to-end on a clean install of Python 3.10. Generates baseline predictions, BO runs, and saves plots to the working directory.
* Reference material (background reading & examples) - Sample student report on predictive modeling. Torres-Surillo et al., “Bayesian Optimization of Large Glass Package Architecture …,” ECTC 2024. H. M. Torun, PhD Dissertation, Georgia Tech, 2020 — see pp. 156-164.

## Getting Started — Step-by-Step

1. Set up the environment - Install Python, PyCharm, and create a fresh virtual environment (see Week 03 instructions). On first run, pip-install missing libraries as prompted in the PyCharm console.
2. Run the starter script unmodified - Confirm it reads the Excel files and writes: Learning-curve / parity plots for RF & XGBoost, Rad-Viz plot of the 5-D Pareto front, 2-D pairwise Pareto plots. If errors appear, use Gen-AI tools (ChatGPT, Gemini, Copilot, …) to troubleshoot, when no solution found, you can contact your corrector Farough
3. Interpret the output - Examine each figure; write down questions or insights. Use Gen-AI if you need quick explanations of unfamiliar metrics or plot styles.
4. Refine & extend - Cosmetic fixes (adjust label positions, font sizes, or line styles) and analytical additions (feature importance plots, confidence intervals, hyper-volume indicator).

## Deliverable #1 — What to Submit

* Enhanced plots - Cleaned-up versions of all baseline figures plus any new visualizations you created.
* Updated script - that reproduces your results when placed in the same directory as the Excel data.

## Important Housekeeping

* Data revisions. I may release updated Excel files; simply overwrite the old ones and re-run your script.
* Selective plotting. Not every figure you generate must appear in the final report—use them to deepen understanding first.
* Validate results. Always sanity-check Gen-AI suggestions and your own plots; if something looks wrong, it probably is.
* Version control. Keep an internal backup (Git or zip) so you can roll back if needed.

Questions? Bring them to the class, or reach out by email to me or your corrector. Good luck, and have fun exploring the design space!  
  
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