SENIOR DESIGN
FOUR PHASES

Dr. Kamal Sarkar
University of Texas – Rio Grande Valley

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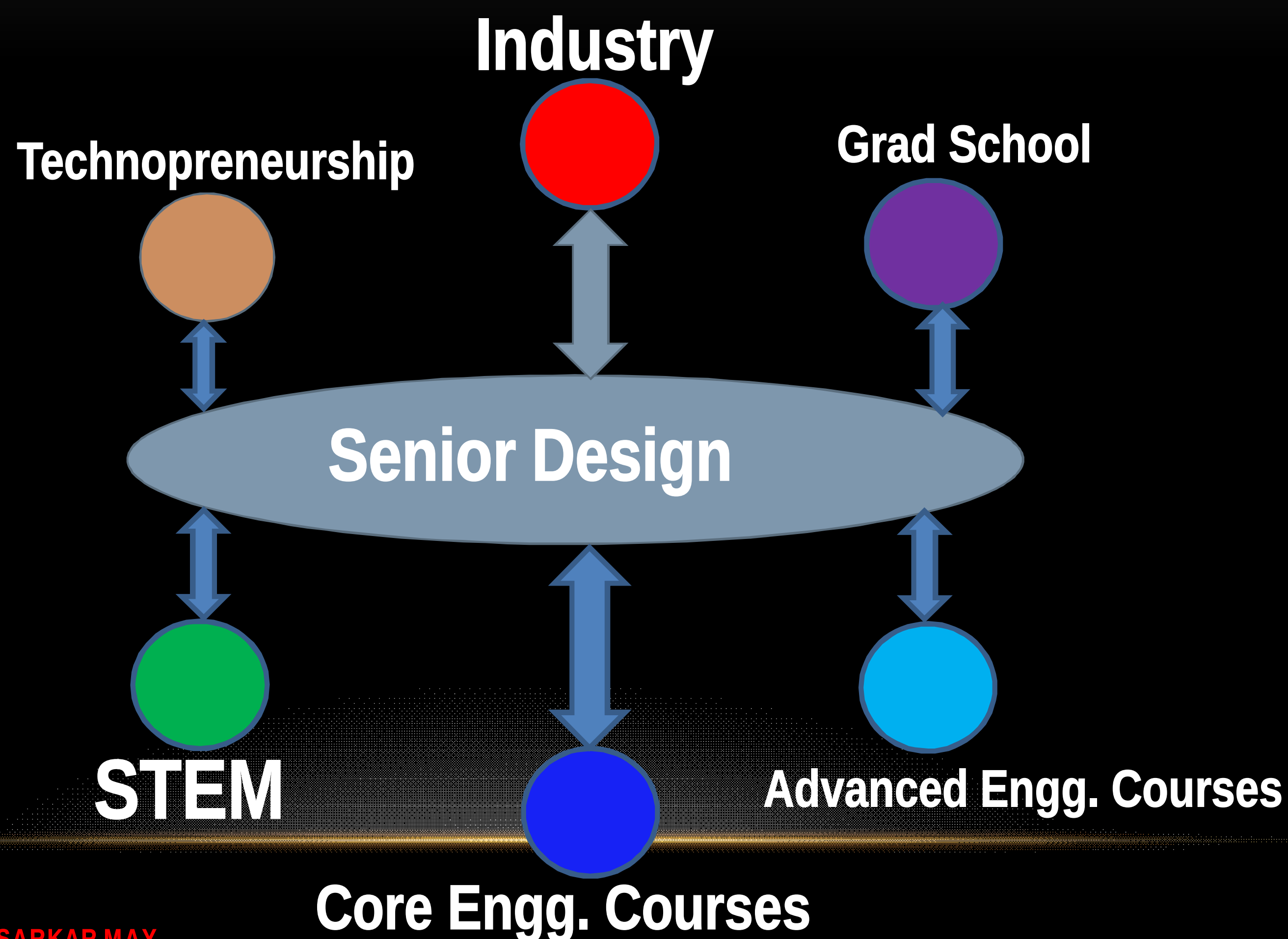
SENIOR DESIGN: THE BRIDGE
BETWEEN THE PROFESSION & EDUCATORS



FOUR PHASES OF DESIGN

- Problem Formulation
- Concept Development
- Design Embodiment
- Design Validation

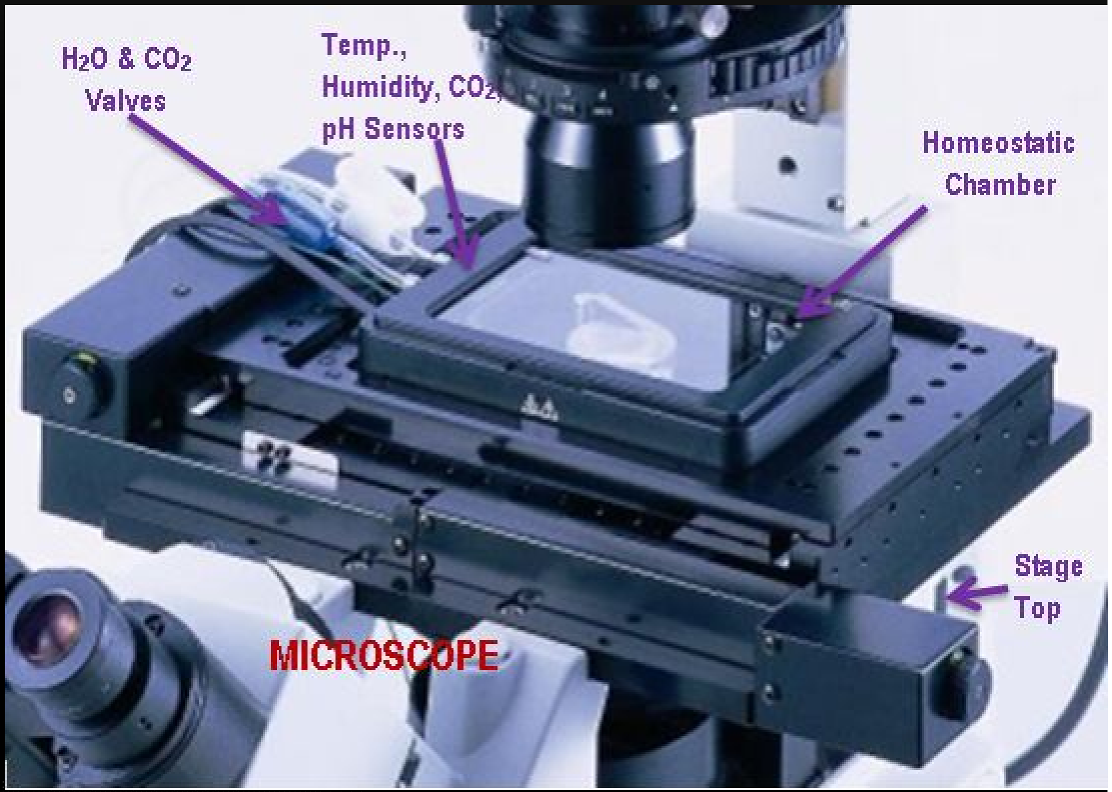
PHASE THREE: DESIGN EMBODIMENT

- Engineering Analyses
- DoX
- BoM
- Engineering Economics
- DFMEA

HOMEOSTATIC ENVIRONMENT CHAMBER

Essential Conditions:

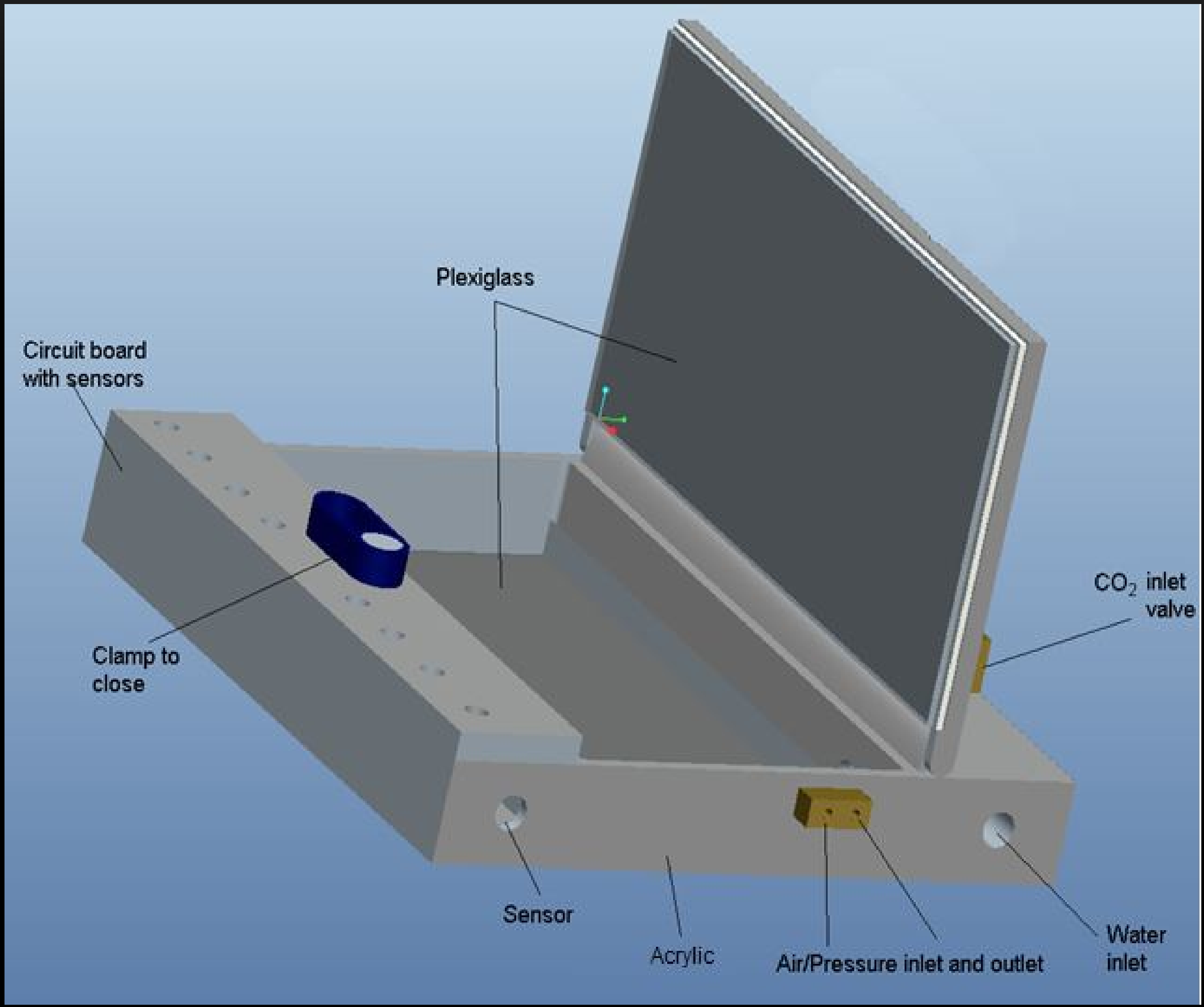
- Formulation of Parameters
  - CO_2: 5% ± 0.1%
  - pH: 7.4% ± 0.04%
  - Temperature: 37°C ± 2°C
  - Humidity: 95% ± 0.01%



Homeostatic Environment Chamber Placed on Stage Top of Microscope

Source: DSS Imagetech

DRAWINGS



208mm x 110mm x 25mm

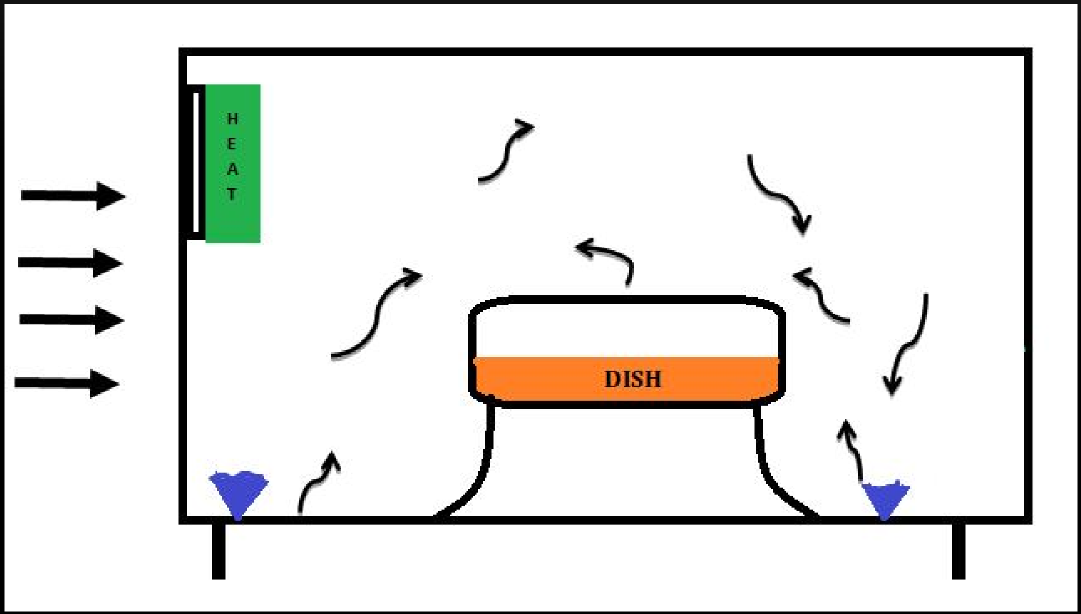
ANALYSIS

Topics	Subcomponent	Parameter
Heat Transfer	Heater	Temperature
Measurement System	Sensors and Controllers	Measurement of Parameters
Thermodynamics	Humidity Sensor	Relative Humidity
Chemistry	Chemically Balance	pH Scale CO_2 Concentration
Materials Science	Chamber	Acrylic
	Gasket	Urethane Adhesive
Electrical Circuit	Connecting Sensors, Controllers & Heating Element	Circuit

HEAT TRANSFER

Assumptions:

- Steady-State
- One-Dimension
- No Heat Generation
- Neglect Radiation



HEAT TRANSFER CALCULATIONS

Heat Equation: $\frac{d}{dx}\left(k\frac{dT}{dx}\right) = 0$

Boundary Conditions: $T(0) = T_{S,1}$ & $T(L) = T_{S,2}$

Temperature Distribution: $T(x) = \left(T_{s,2} - T_{S,1}\right)\left(\frac{x}{L}\right) + T_{S,2}$

Thermal Resistance for Convection: $R_{t,conv} = \frac{(T_S - T_\infty)}{q} = \frac{1}{hA}$

Thermal Resistance for Conduction: $R_{t,cond} = \frac{(T_{S,1} - T_{S,2})}{q_x} = \frac{L}{kA}$

Conduction Heat Transfer Rate: $q_x = -kA\frac{dT}{dx} = \frac{kA}{L}(T_{S,1} - T_{S,2})$

Heat Flux: $q''_x = \frac{q''_x}{A} = \frac{k}{L}(T_{S,1} - T_{S,2})$

$k\left(\frac{W}{mK}\right)$ = Thermal Conductivity

T_s (°C) = Surface Temp.

T_∞ (°C) = Ambient Temp.

q (W) = Heat Transfer Rate

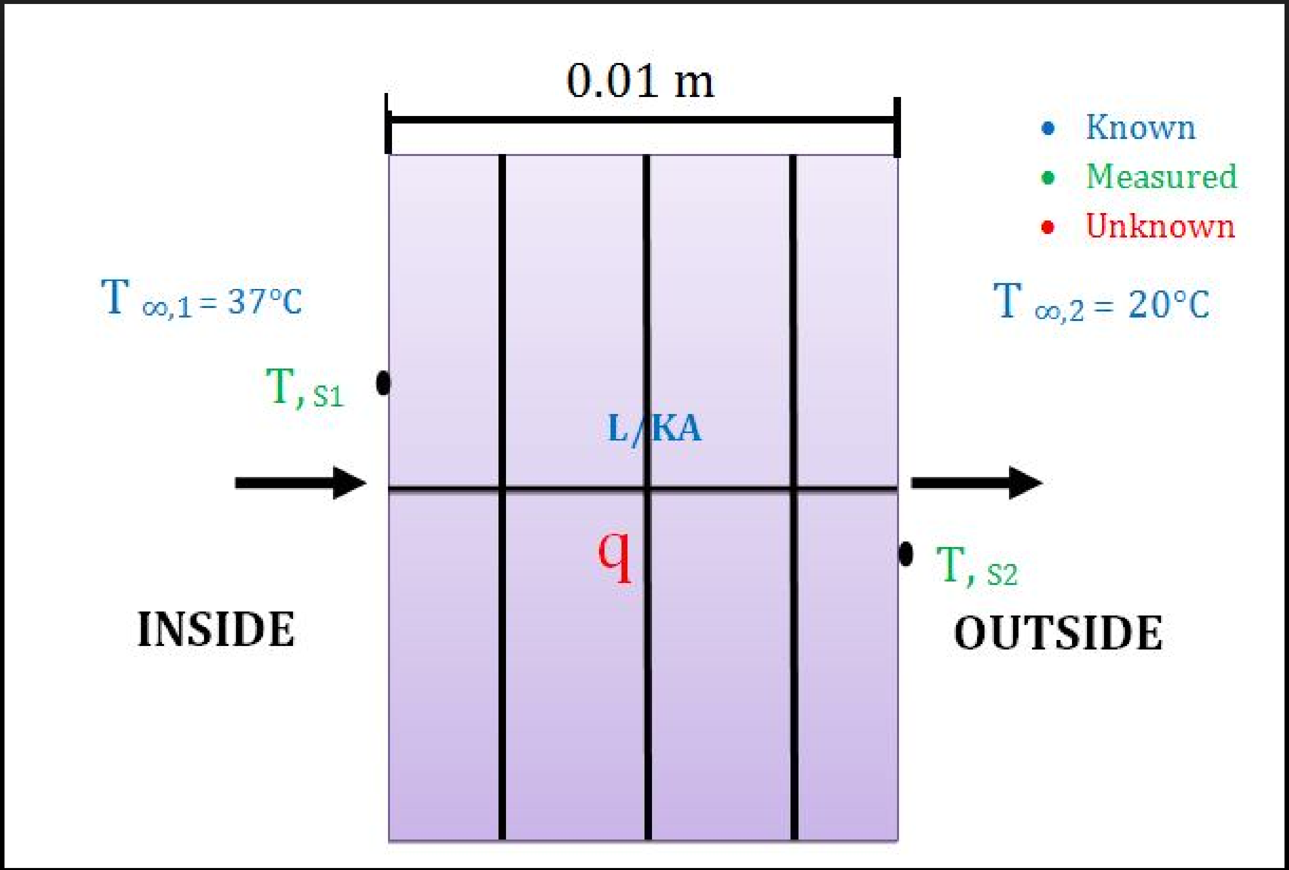
A (m^2) = Area

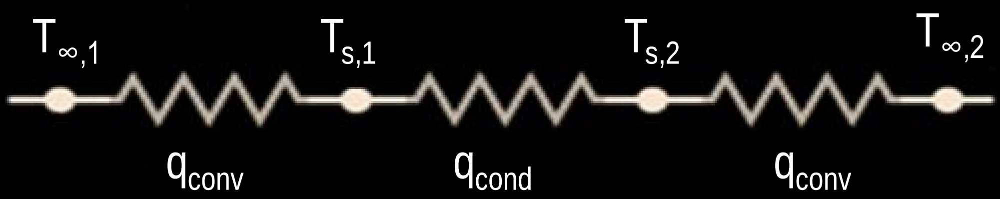
L (m) = Length of Material

q“$\left(\frac{W}{m^2}\right)$ = Heat Flux

h $\left(\frac{W}{m^2K}\right)$= Heat Transfer Coefficient

HEAT TRANSFER

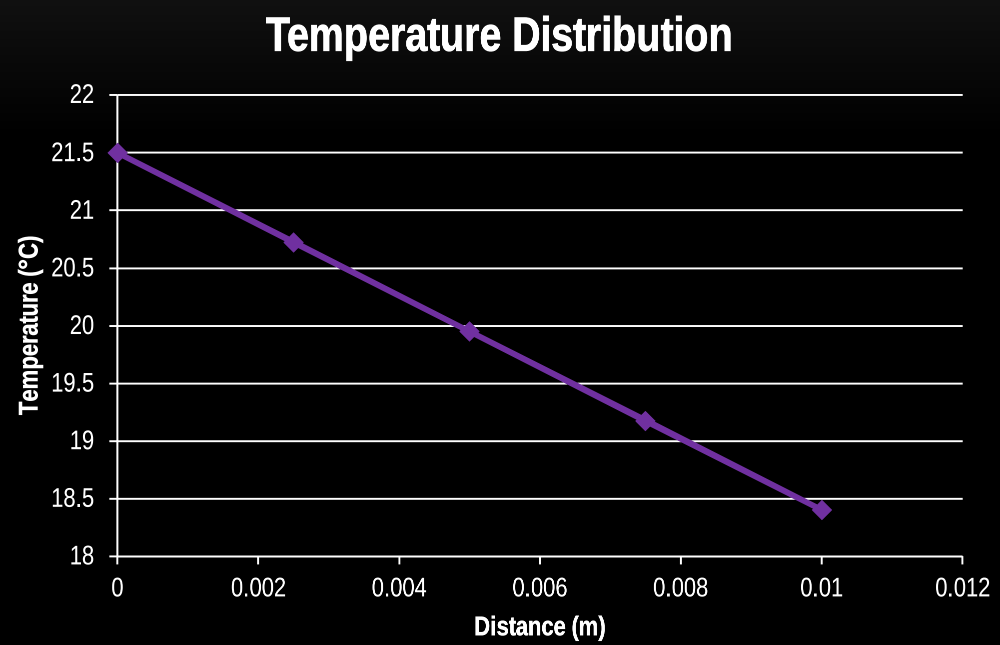




Assume:

$h_1 = 4 \frac{W}{m^2 K}$

$h_2 = 10 \frac{W}{m^2 K}$



Temperature Distribution: $T(x) = (T_{s,2} - T_{s,1})(x/L) + T_{s,1}$

$T_{S,1} = 21.5°C$

$T_{S,2} = 18.4°C$

$L = 0.01$ m