Lecture 2 — 8/26

* Fluent v12 Tutorial #1 emailed to class
* Access to ECG 150 activated

① geometry file — missing

* just build it yourself

② Mesh — New DesignModeler

Workbench

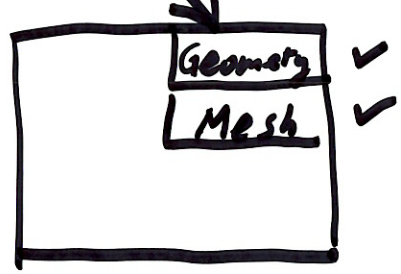
CAD — Geometry ✓

Mesh ✓

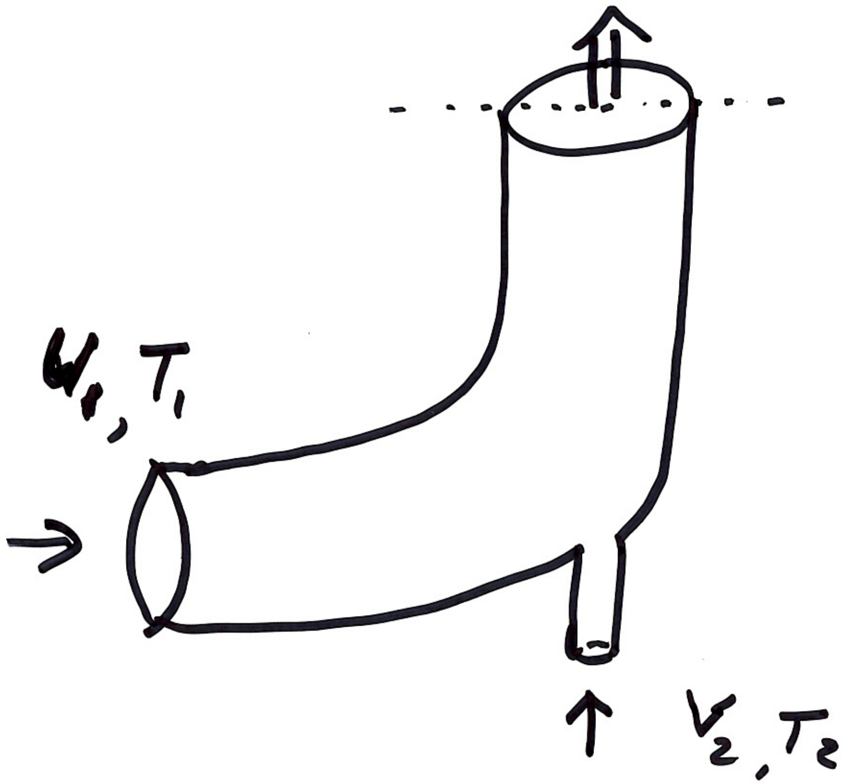
Fluent → Setup / Run ✓

CFD-post — Results ✓

right click

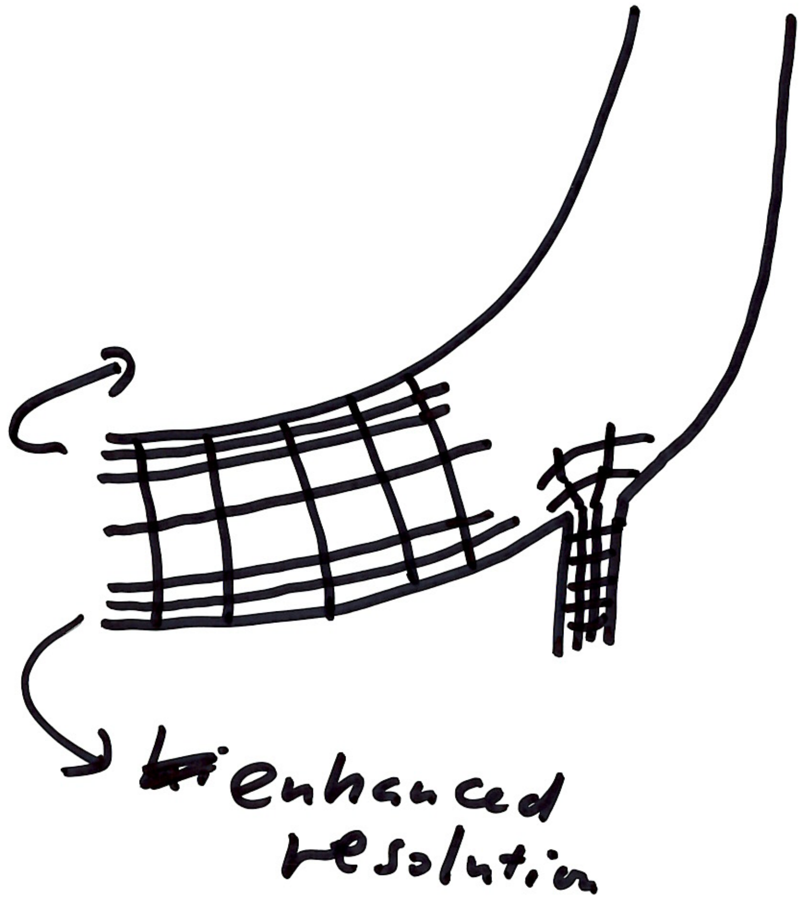


Tutorial #1



"half pipe"

DesignModeler



inflation

Governing eq. (fluid/thermal) in the context of CFD

CFD — Fluent

Cons. of momentum → Newton's 2nd law (Lagrangian):

$$\frac{d\vec{v}}{dt} = \frac{\vec{F}}{m}$$

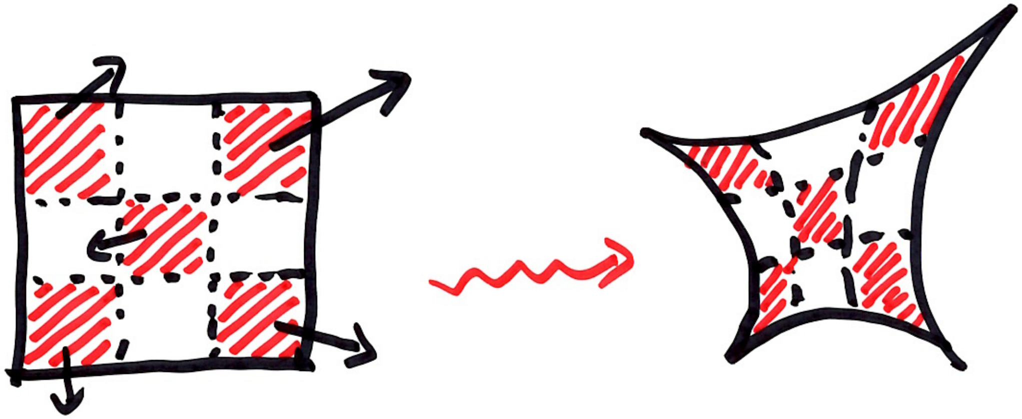
Cons. of mass:

$$\frac{dm}{dt} = 0$$

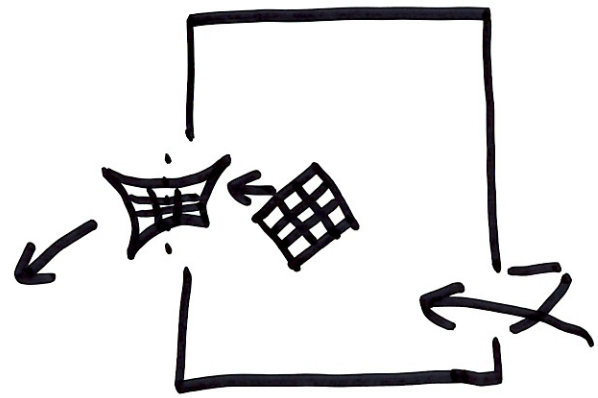
(Thermal) Cons. of energy

(Cons. of concentration of chemical constituents
etc. etc.)

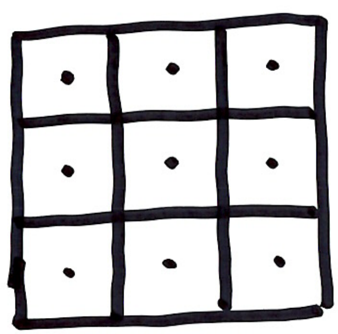
For CFD → "Eulerian" "flow field"



$t=0$ $t = 1s$



"Lagrangian"



cell/node

fixed in space

"Eulerian"

CFD

Fluent: Finite Volume

generic argument

Lagrangian → Eulerian

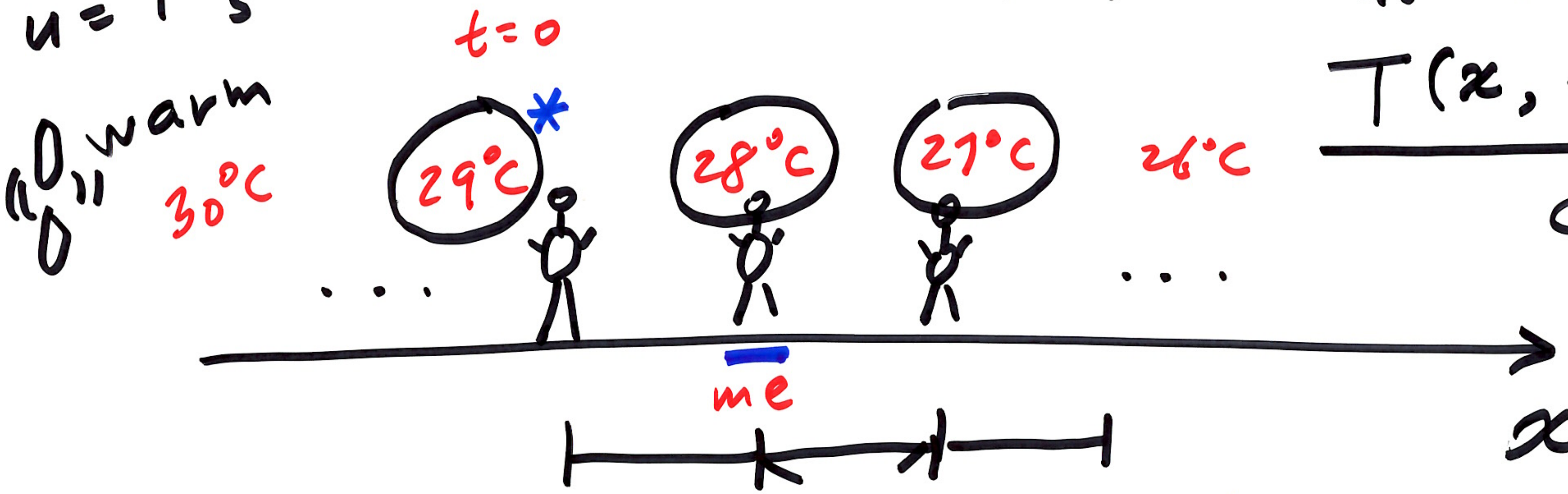
(T) air parcel temperature

$T(x,t)$

at $t=0$

$T(x, t=0)$

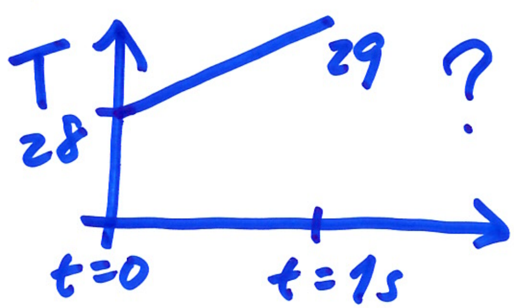
$\Rightarrow$ $u = 1\ \frac{m}{s}$



p.o.v. of observer riding on *-parcel

$\frac{dT}{dt} = 0$

p.o.v. of an observer fixed in space



$? = \left(\frac{\partial T}{\partial t}\right)_x = 1°C/s$ (m)

$\underset{\sim}{u} = 1 \frac{m}{s}$

temp. gradient

$-1 \frac{°C}{m} = \left(\frac{\partial T}{\partial x}\right)_t \approx \underset{\sim}{\frac{\Delta T}{\Delta x}}$

1-D

3-D ∇T

$u \frac{\partial T}{\partial x}$ → $(1 \frac{m}{s}) \cdot (-1 \frac{°C}{m})$

$= -1 \frac{°C}{s}$

$$\boxed{\frac{dT}{dt} \equiv \frac{\partial T}{\partial t} + \underbrace{u \frac{\partial T}{\partial x}}}$$

0    $1 °C/s$ $-1 °C/s$

3-D

any scalar → $\frac{dT}{dt}$

$$\underbrace{\frac{dT}{dt}}_{(L)} \equiv \underbrace{\frac{\partial T}{\partial t} + \overbrace{u\frac{\partial T}{\partial x} + v\frac{\partial T}{\partial y} + w\frac{\partial T}{\partial z}}^{\vec{V}\cdot\nabla T}}_{(E)}$$

$$\frac{dT}{dt} \equiv \frac{\partial T}{\partial t} + \vec{V}\cdot\nabla T$$

"heuristic"

(L)

$T(x, y, z, t)$ associated with a parcel

riding on the ~~local~~ location of

$x(t), y(t), z(t)$

$T(x(t), y(t), z(t), t)$

$$\frac{dT}{dt} \equiv \frac{\partial T}{\partial x}\boxed{\frac{dx}{dt}} + \frac{\partial T}{\partial y}\boxed{\frac{dy}{dt}} + \frac{\partial T}{\partial z}\boxed{\frac{dz}{dt}} + \frac{\partial T}{\partial t}\boxed{\frac{dt}{dt}}$$

$\frac{dx}{dt} \to u$, $\frac{dy}{dt} \to v$, $\frac{dz}{dt} \to w$, $\frac{dt}{dt}$ "1"

chain rule — Calculus

total (Lagrangian) material

$$= \frac{\partial T}{\partial t} + u\frac{\partial T}{\partial x} + v\frac{\partial T}{\partial y} + w\frac{\partial T}{\partial z}$$

(E)

Cons. of mass

$$\frac{d\mathfrak{m}}{dt} = 0$$

$\mathfrak{m} = \rho V$ — ρ: density, V: volume

continuity eq.
(Eulerian)

nominally eq. for the density field (compressible flow)

<u>Tutorial 1</u>

"pressure-based solver"

incompressible ↪ ρ vanishes