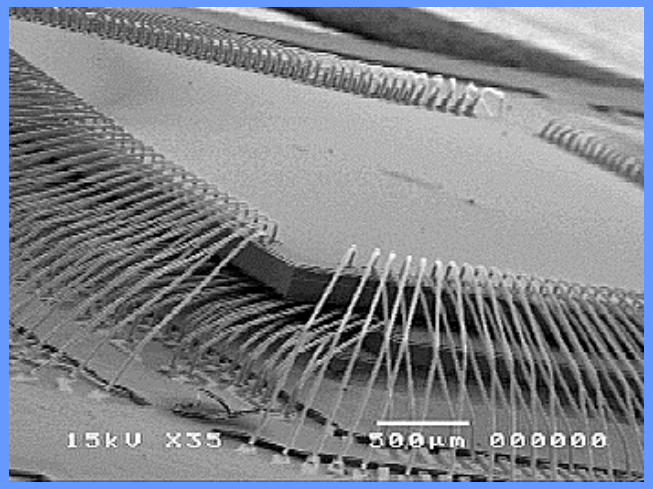
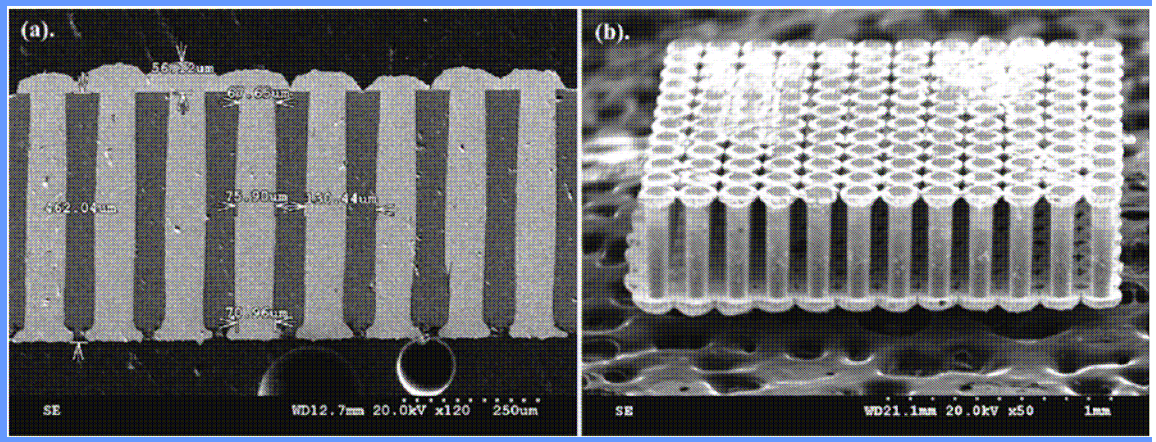
# 3D-IC's - Real or Imaginary: BOTH!
# And what would speed adoption?



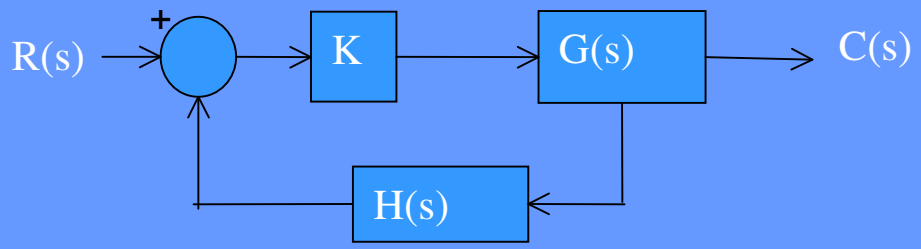

# NOT Photo shopped : So why Both?

# Perfect analogy is a complex number: a + bi

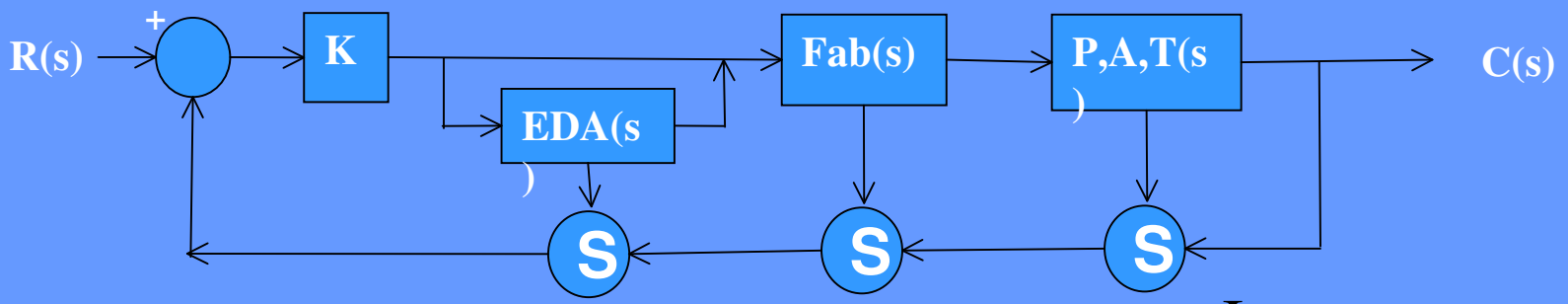
**Used to describe many complex situations where solution has 'real' and 'imaginary' units:**

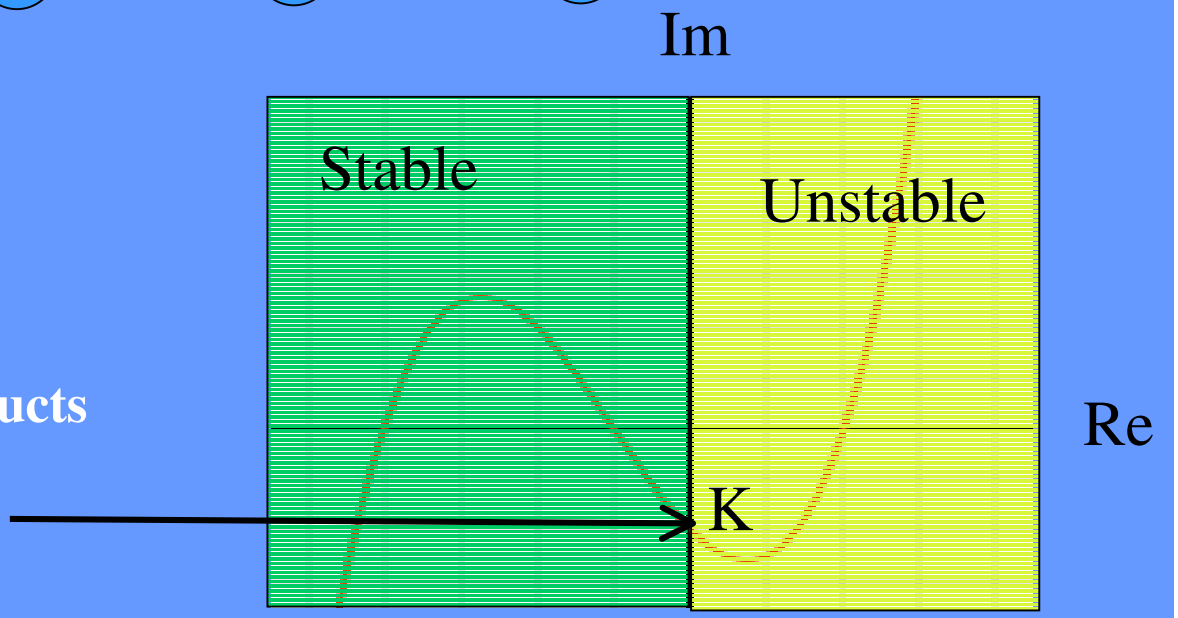
- **Engineering**
- **Electromagnetism**
- **Quantum physics**
- **Applied mathematics**
- **Chaos Theory**

**Control systems analysis determine values of K that have Stable vs Unstable operating regions**



# 2.5/3D EcoSystem

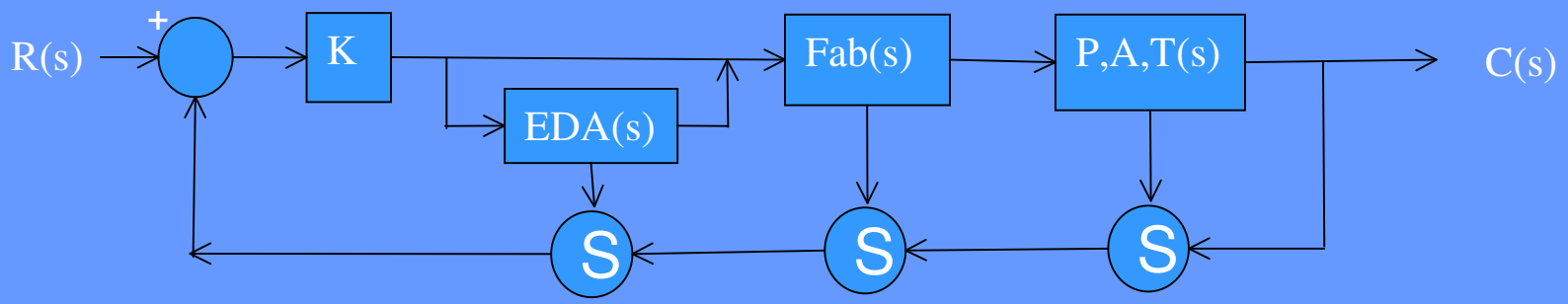



**Today:**
**K: more companies AND products than we think use 3D!**

**Intel uP's/Cache memory**
**Sony Playstation**
**Various Memory ICs**
**Etc**
**(many papers & books cite examples)**

# Accelerate adoption?




## How to enable ALL? → S (Product & Test Eng)

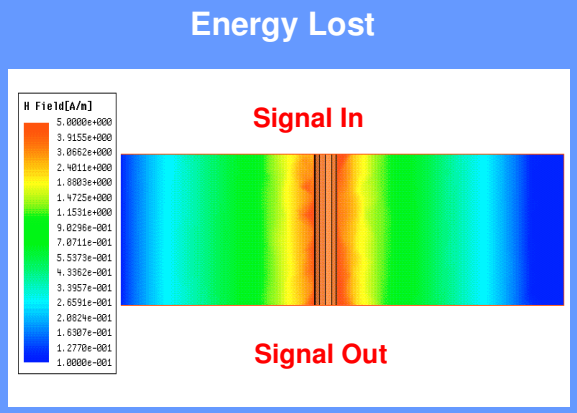
- Improve learning across the ecosystem to drive:
  - Tools to help reduce risk/raise yields (planning, design and verification)
  - Tools to help improve post silicon analysis
  - Cheaper fabrication
  - Cheaper materials
  - Shorter mfg time
  - Publish success stories

# Sphinx 3D EXT Tool (SI/PI planning and analysis)

- **High Density**
  - 1000s of WB, TSV Density $10^6/cm^2$….
- **Inhomogeneous surrounding**
  - molding, Silicon …
- **Direct influence on transistor performance due to proximity**
- **Carries high frequency signals**
- **Parasitics dictate chip performance**
- **Fast for 'what if' or planning purposes**

- **Output:**
  - **Touchstone Output File**
  - **Supports Current Distribution Plotting**
  - **Supports graphical viewing of input file**
  - **Supports spice netlist generation**

- **Additional information under NDA**




*Courtesy: Dr. Ivan Ndip, IZM, Germany*

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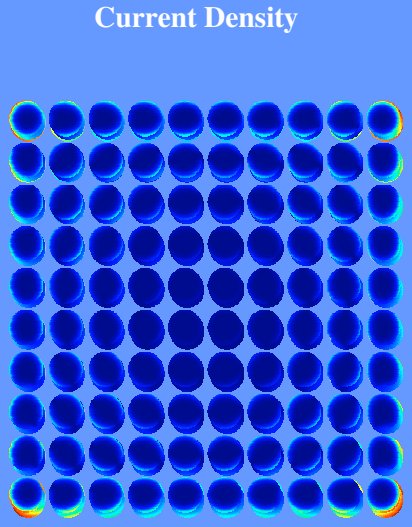
$10^9$ Hz




**All conductors are uniformly excited.**

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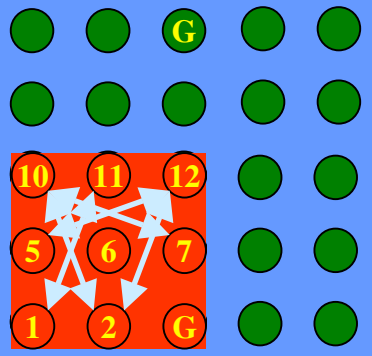
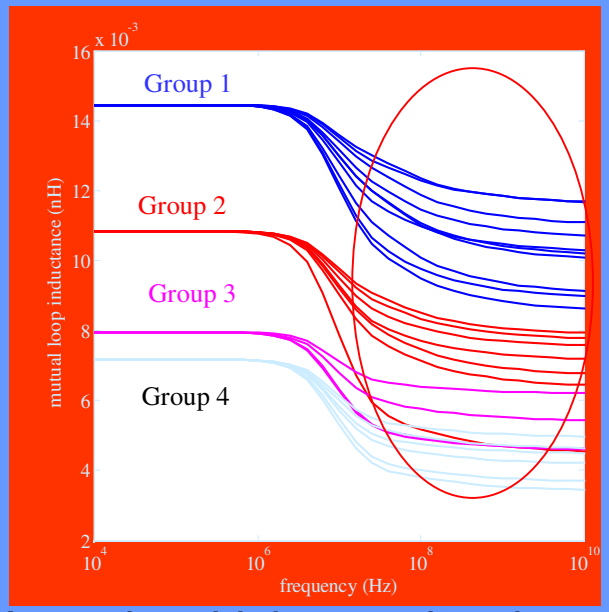
**- At low Hz, all inductances are mainly functions of distance between lines.**
**- At high Hz, inductances decrease according different proximity effects.**




**Accurately models frequency dependence**