CLIMA 2005 / WS 15
Wednesday, October 12, 9-11 a.m., Room Berlin 1

Multisensors and Other New Technology
for Improved Indoor Environment in Buildings

What do we have and what do we need ?
– to Control the Future Indoor Climate

Jens Møller Jensen & Peter Gravesen, Danfoss A/S

Nordic Innovation Centre

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The Focus in Indoor Climate

- There is a **continuously increasing focus** on quality of indoor climate
- The background and objectives vary
  - **Comfort, health, social economy, productivity, trend, business**…
  - **Application, technologies**…
  - **HVAC versus IAQ/IEQ**…
- The **specific technical focus** varies depending on
  - **Opportunities, interest, environment, local policy…**
- The generally common goal is *improvement* – **but the needs and requirements are unclear**

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The Focus in Indoor Climate

- The **range of issues** is wide
  - Modeling, methods, parameter, indicators
  - Materials, sensors, actuators, demonstrators
  - Systems, applications
  - Efficient, energy use, human behaviour, etc. etc.

and there is

- A number **of overall issues to clarify** in order to boost the *general development and spreading* of improved systems
  - What are the **most important factors** in future indoor climate?
  - How do we **obatin simplicity** of **integrated HVAC/IAQ** systems ?
  - How do we **make it affordable**?

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State of the Art? CLIMA 2005 / WS15

- State of the art appears to be **two-fold**

  - State of the Art at **academic levels**
    - Increasing number of hi-tech **sensors**, proposed **methodologies**, control **schemes**
    - Still **uncertainties** as to **what is really needed** and what is hype…
    - **Commercial aspects** often neglected

  - State of the Art in **practice**
    - Degree of **implementation is low**
    - **Adoption** is still **slow**
    - Academic **research results often not suitable** for implementation in concurrent applications
    - Commercial aspects implies **very diversed requirements**

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Technology drivers CLIMA 2005 / WS15

- **Avionics and aerospace**
  - Comfort and safety in cockpit and passenger cabins
- **Automotive**
  - Comfort (and safety) in passenger cabins
- **High end building facilities**
  - Comfort in concert halls and conference rooms
- **Outdoor climate and environmental surveillance**
  - Understanding climatic change and dynamics
  - Pollution control and warning systems
  - Optimisation of agricultural production
- **Military**
  - Early warning systems
  - Intelligence …..

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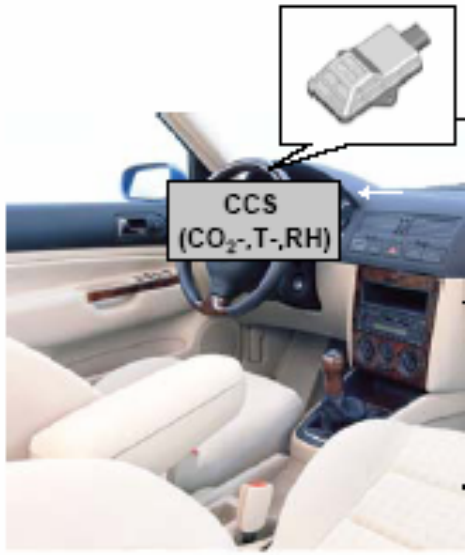
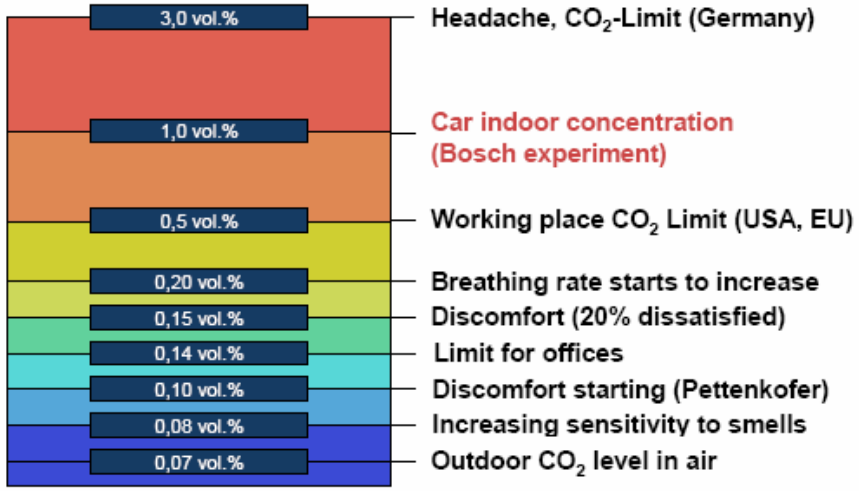
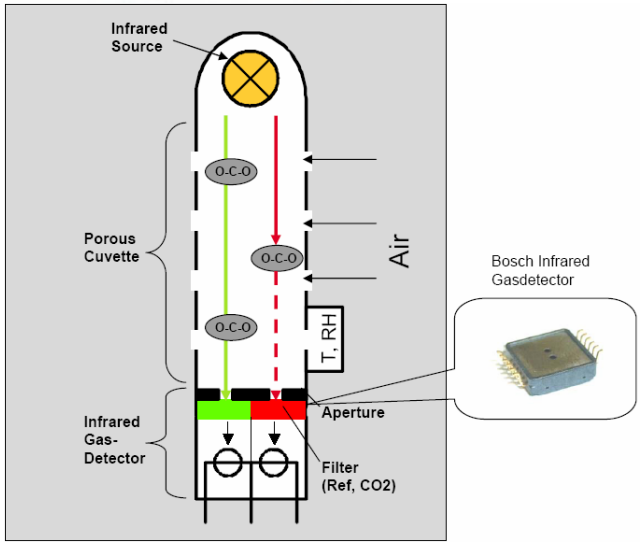
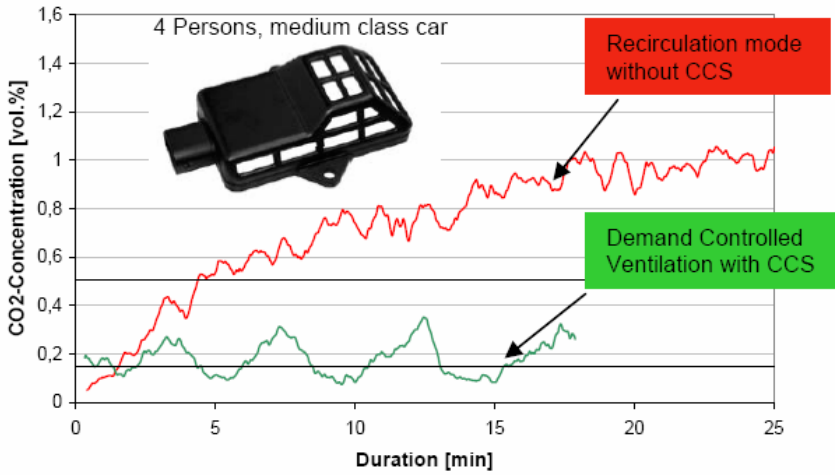
Example 1 - Automotive



Source: Bosch Medical Service







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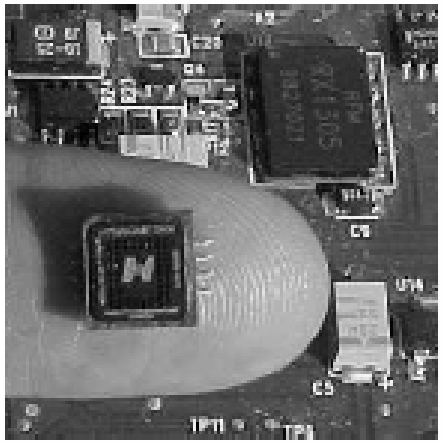
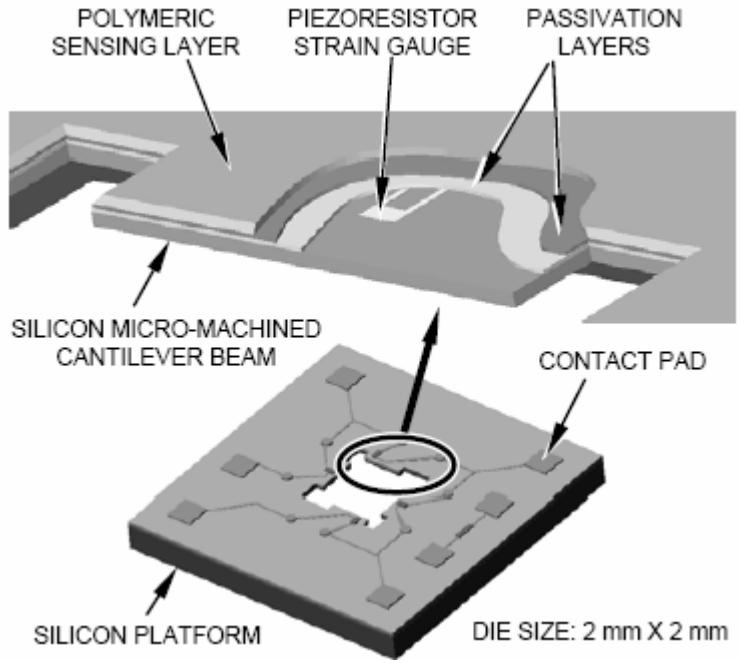
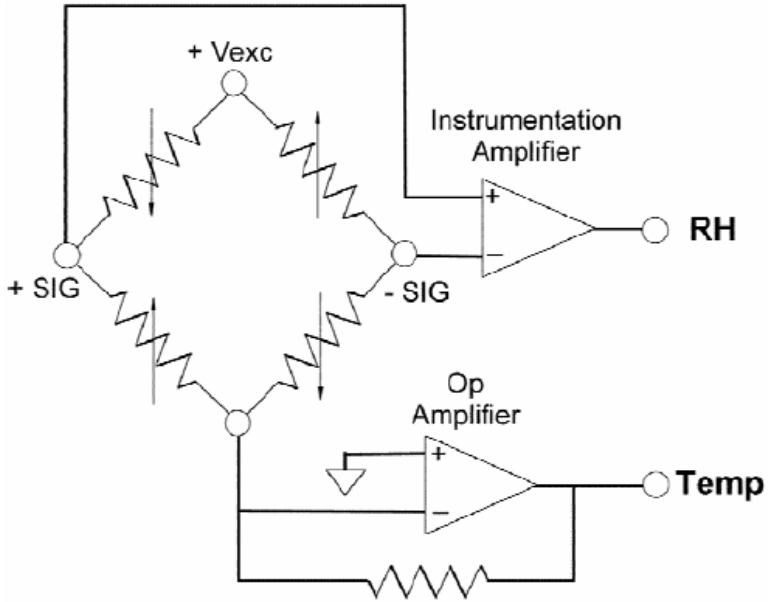
Example 2 - MEMS multisensor



HYGROMETRIX





Applications

- Environmental monitoring and control
- Avionics and aerospace
- Dehumidification, industrial drying
- HVAC
- Precision instrumentation

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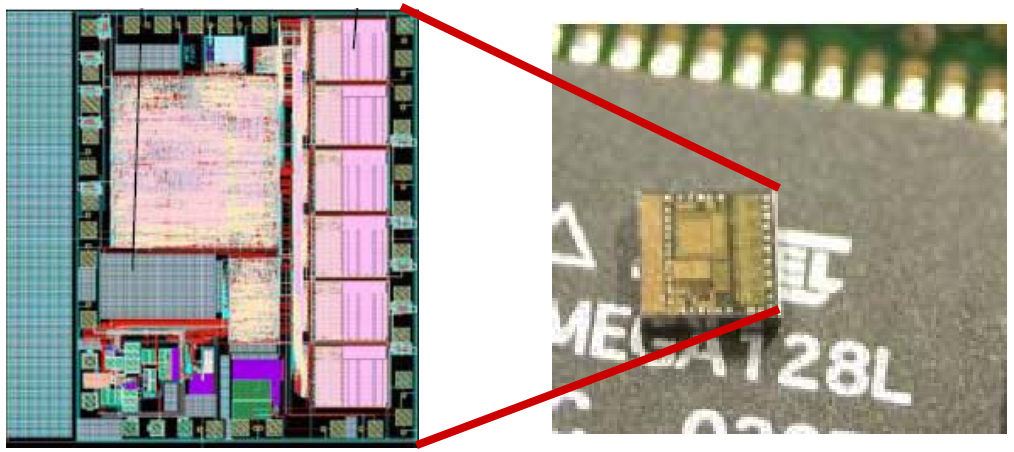
Example 3 - Low power wireless

Low Cost translates to minimal "Real-Estate" on µC/Radio chip

3K RAM = 1.50 mm²
CPU Core = 1 mm²
RF COMM stack = 0.50 mm²
SmartDustRADIO = 0.25 mm²
SmartDustADC = 0.02 mm²

Adopted from UC-Berkeley: BSAC



Low Power relates to: "Total Energy = Sleep + Warm-Up + Active"

Low power sleep mode	: 1 µW (400+ years on AA battery)
Low power duty mode	: 150 µW per MHz
Low power radio	: 1 mW @ 100Kbps ; 90dBm receive sensitivity, (10 nJ/bit)
Low duty cycle	: Low sample rate (minutes), fast sampling (10 ms)
Low power sensor	: < 1µJ/sample (e.g. 100 µW for 10 ms)
Fast warm-up from sleep	: Comparable or less than sampling time.

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Segmentation of the Field CLIMA 2005 / WS15

- In practice, the field of applications has (at least) two segments

  - **Building Management Systems**
    - **Well-known application area** yet there are still major unsolved problems
    - The overall driver is **economy**
    - Investment and pay-back - How can pay-back be quantified ?

  - **Residential systems**
    - Early-stage application area – lack of mature systems and knowledge
    - The overall driver is … **economy, comfort, health, prestige**…
    - Investment and payback…or?
    - Divided into **new** and **retro-fit** applications

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Future needs CLIMA 2005 / WS15

- **General**
  - **Integration**
  - Well established *and effective* system **control strategies**
  - Identification of general **suitable markers**
  - General component- and system (self-organised) **communication**
  - More **dedicated components** (Low cost, Low power)

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Future needs CLIMA 2005 / WS15

- **Building Managent Systems**
  - Better system integration
  - Affordable sensors integrated into HVAC/IAQ system components
  - Long-life (10 yr+), low-power, communicating sensors – preferably wireless
  - Firm identification of general markers for good indoor climate

- **Residential systems**
  - True integrated systems
  - Easy-to-install self-configuring HVAC/IAQ system components
  - Affordable long-life (10 yr+), low-power, wireless sensors
  - Firm identification of *very* general markers for good indoor climate
  - Documentation of system effects and pay-back

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