Realtime monitoring the IVF laboratory: Practical aspects

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Disclosure

I declare that no commercial or financial interest has influenced the content of this presentation

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All is well… till disaster strikes you!

- Remember captain Smith (15 april 1912)

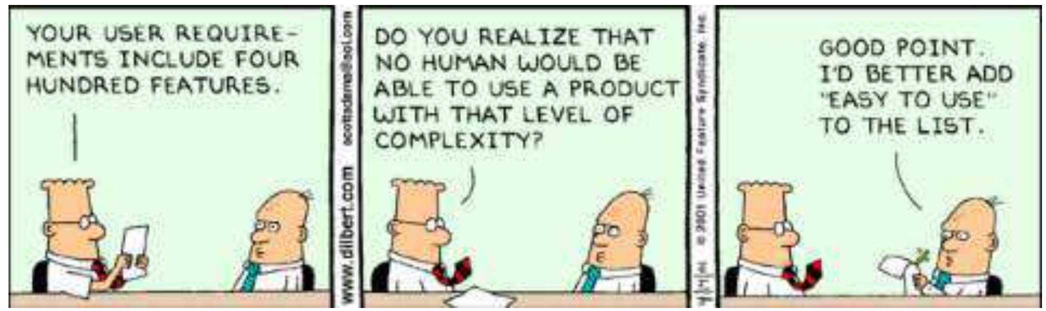
- Murphy’s law: if anything can go wrong, it will go wrong

Real time monitoring: why?

- Economical aspect – prevent loss
- Guidelines
  - → ESHRE (Hum Reprod Vol 23, no 6, 2008)
- Regulatory aspect
  - → 2006/86/EC (annex I - Equipment and materials C - §2)
  - → HFEA code of practice
- Accreditation
  - → ISO 15189

Outline

User requirement specifications



Things to consider before installation

What to monitor? - examples

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Outline

User requirement specifications (or how to design your perfect system)

- → Data logging
- → Functional requirements
- → Sensors
- → GUI
- → Alarms
- → Reports
- → Security
- → Validation

Data logging – 21 CFR Part 11 requirements

- Tamper proof
- Accurate time and date stamps
- Alarms and events
- User actions and details (e.g. setpoint changes)
- User notes
- Electronic Signatures
- Login/Logout

http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?CFRPart=11

Functional requirements

- Scalable (single room to ...)
- Accurate and effective control of equipment
- Centralized and remote control
- Real time monitoring
- Intelligent alarm capability-early warning of process deviations
- Secure management and storage of data
- Audit trails
- Predictive maintenance planning

Available sensors/interphase

Analog

- Temperature
- Gas level (CO_2 – O_2 - VOC)
- RH
- Air pressure/diffential pressure
- Luminescence
- Particle counters
- Air Flow patterns
- Vibration
- Noise
- Water leak detection

Digital signals (true/false)

- Door status
- Fire detectors
- HVAC status
- Alarm signals

Digital signals

- RS 232
- RS 485

Why independent sensors?

- Verification of equipment functioning
- Detects equipment sensor drift
- Verification of manufacturers' performance claims
- Transparent and unbiased
- Audit trail – historical overview
- Detects environmental factors
  → Electrical failure

GUI

Web based vs client server

→ Web based system are more flexible and can be more easily accessed remotely (secure internet)

→ multi platform, Windows, Linux, Apple OS, Android?

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GUI

- Area overview
- Individual room overview
- Individual sensor view
- Grouping by type (temp, CO_2, ...)

- Historical display – trending

- Remote real-time visualisation

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GUI

- Access control with password protection for individual user accounts, inactivity timeout and password expiry
- Alarms
- Trends
- Alarm set point configuration
- Control parameter configuration
- Calibration facilities
- Maintenance facilities

Alarms

Functional alarms

→ Absolute – immediate alarm – real time

→ Delayed alarms

→ Continuous alarm

- measured value beyond minimum/maximum over a certain time

Technical alarms

→ Sensor break

→ Equipment failure

→ Network failure

→ Maintenance and calibration alarm

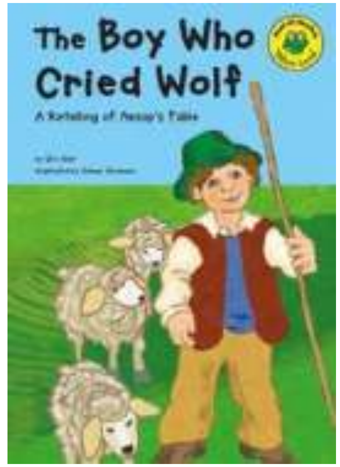
Notification

- Audible
- Visible
- Telephone – email – SMS

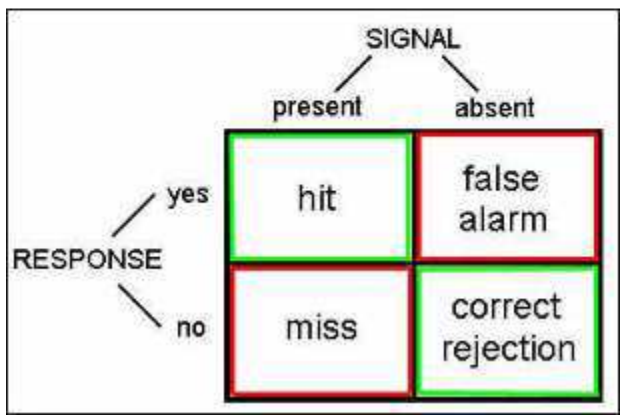
- Automatic cascading
- Bi-directional, alarm acknowledgement logged

False alarm – missed alarm

Alarm fatigue



Costs



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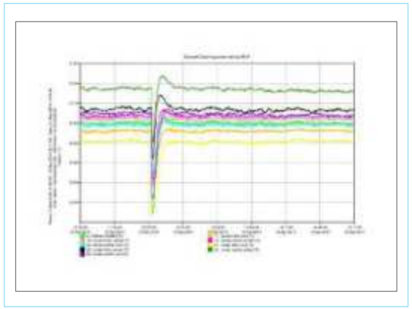
Reports

Reports for full compliancy

→ Graphical reports
→ Numerical reports
→ Multi parameter graphs
→ Statistical analysis (mean, min, max, SD)
→ Data exportable to spreadsheet



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Security

Wireless vs wired

→ Wired: harder to install, more reliable, insensitive to long distances
→ Wireless: easy to install, flexible, can be unreliable

2015: the redundancy in wireless networks makes these devices almost as reliable as wired units, and greatly reduces installation cost

→ Data from multiple locations
→ Clean rooms can be hard wired, remote location can be wireless

Best of both worlds

→ Probe to controller: wired
→ Controller to server: wireless/network

Remote access: secure VPN access combined with multiple firewalls, user-based security.

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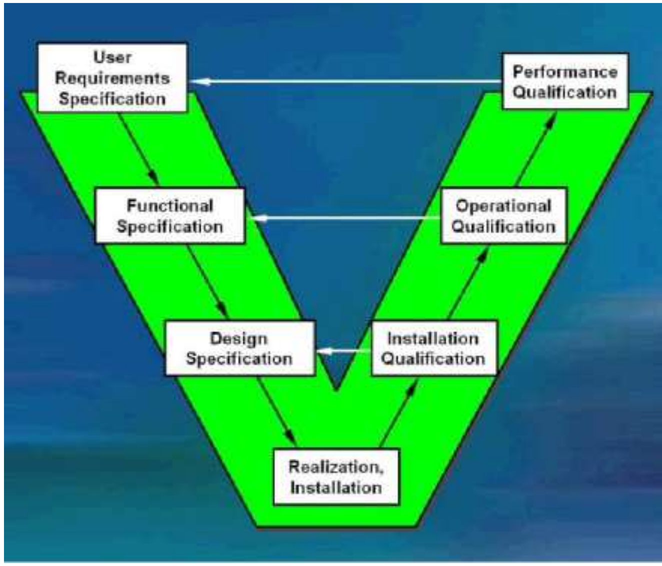
Validation

Manufacturer

- → User Requirement Specification
- → Functional Specification
- → Design Specification
- → Hardware Testing
- → Code Review
- → Factory Acceptance Test



User

- → Installation Qualification
- → Operational Qualification
- → Periodic review

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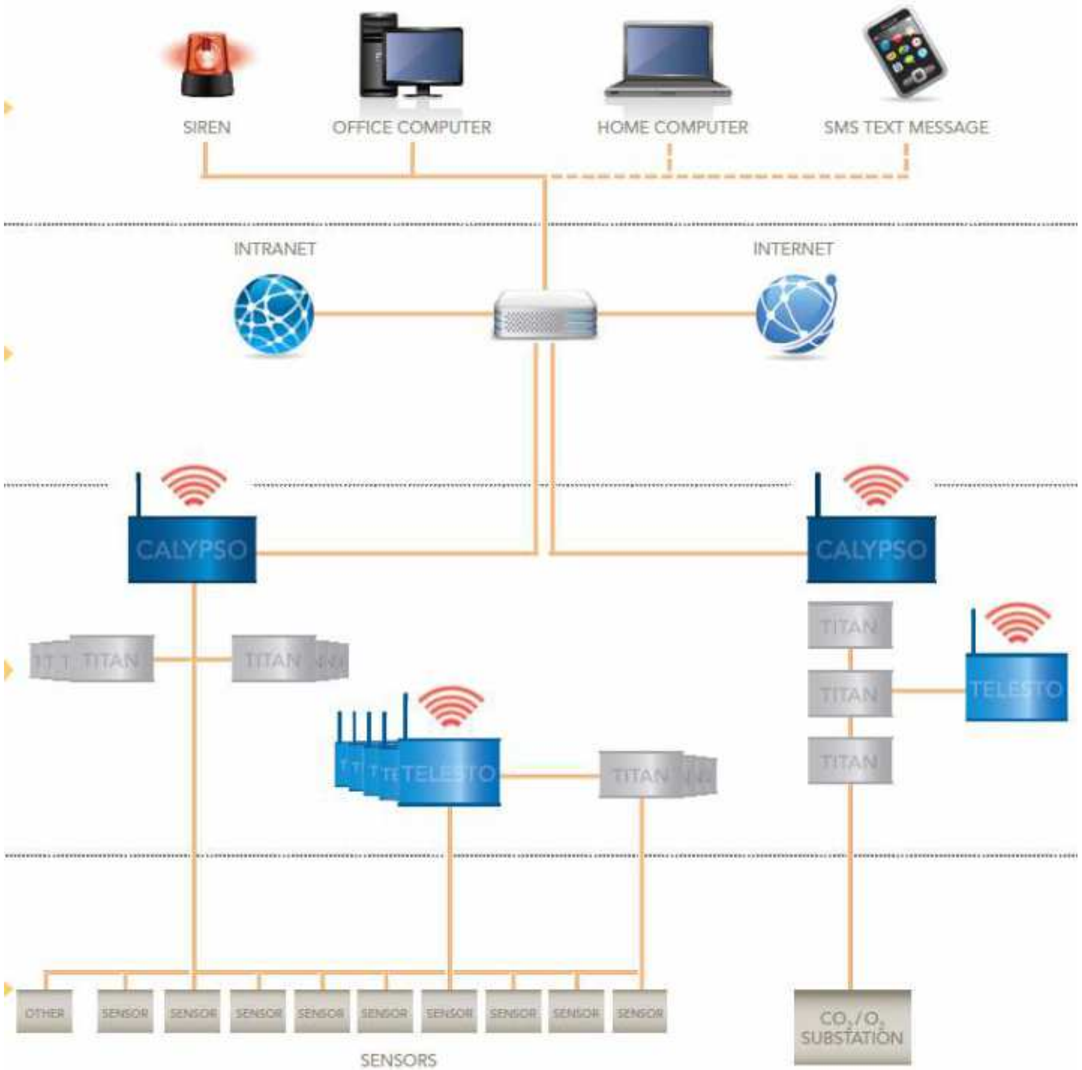
Real time monitoring: architecture



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Outline

User requirement specifications

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During laboratory design phase

- Integration with BMS/EMS (building monitoring systems/environmental monitoring)

- Do not forget!
  → Power plugs +++
  → Network access points +++
  → WIFI
  → UPS

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Which commercial system?

Experience in IVF - Consultancy?

- → most laboratory directors have little experience in building IVF laboratories or implementing monitoring systems
- → Integrating devices into a complete solution is a difficult task
- → Making the wrong decisions can result in a huge cost and a non-functioning monitoring system

Support

- → support needs to be quickly and reliably
  - telephone 24/7
  - remote support

Calibration

- ISO 15189 requirement
  - → Calibration - ISO 17025
  - → Traceability to international standards
- On site
- Service/maintenance contract
  - → Check Accuracy & stability of sensors
  - → Check/change batteries
  - → Hardware + software maintenance

Outline

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Real time monitoring @ UZ Brussel

Parameter	Matrix	Frequency	Device
VOC	Laboratory Air	Continuous	PID VOC meter
T°	Laboratory Air	Continuous	BMS/EMS Pt100
T°	Incubator	Continuous	Pt100
T°	Refrigerators/freezers	Continuous	Pt100
T°	Cryostorage	Continuous	Pt100
LN_2 level	Cryostorage	Continuous	Pt100/pressure sensor
CO_2	Incubators	Continuous	NDIR gasanalyser
O_2	Incubator	Continuous	ZrO_2 sensor
O_2	Air	Continuous	ZrO_2 sensor
Door status	Freezer	Continuous	Digital contact
True/false	Cryostorage, incubator alarms	Continous	Alarm contact
RH	Air	Continuous	BMS/EMS

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Other monitoring @ UZ Brussel

Parameter	Matrix	Frequency	Device
T°	Heated stages	1 – 2 / year	Thermocouple in dish
pH	Culture media	Each batch/shipment	POC
Osmolality	Culture media	Each batch/shipment	Osmometer
O_2	Incubators	Weekly	ZrO_2 sensor/gasanalyser
RH	Incubators	NA	

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TVOC monitoring

- PID detection
- 0-10 ppm
- 4-20 mV output

www.ionscience.com

www.mtg-de.com

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Incubators & independent monitoring

Incubator	Design	Monitoring
Standard	Large volume, easy access	Easy
Mini	Small chambers	Difficult
	No sensors build in	Needs special sensors
Desktop	Small chambers	Independent sensors possible
	(Alarm contact)	Equipment alarm
Time lapse	Without independent sensors	Not possible
	With independent sensors	Easy
	(Alarm contact)	Equipment alarm

Standard inc: T°, CO_2, (O_2 , RH, door contact)

Bench top/time lapse: T°, CO_2, incubator alarm

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NDIR CO2 sensors

- Vaisala

- Planer

Cryogenic storage

- Real-time liquid level & temperature measurements
- Filling action
- Lid movements
- Power failure
- Technical system alarm

- Environment: O_2

Other

- Fridges, freezers: T°, door alarm
- Rate controlled freezers

- To consider:
  - → Particle counting
  - → Optical spectroscopy counting simultaneously detect the number and size of particles from air (‘real-time’ microbiological assessment.)

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Monitoring Costs

To Alarm or Monitor? A cost-Benefit Analysis Comparing Laboratory Dial-Out Alarms and a Real-Time Monitoring System. Mortimer D., Di Berardino T. Alpha Newsletter august 2008

Table 3: Summary comparison of the costs of using either alarms with "human" equipment monitoring or automated real-time monitoring systems (see Tables 1 and 2 for details).

System	Small Lab	Medium Lab	Large Lab
Alarms & manual monitoring, Year 1	€14,349	€38,822	€83,754
add Years 2 & 3 (inc. 3% inflation)	€65,797	€147,476	€311,412
Automated real-time system	€56,309	€104,227	€256,392
Savings by the end of Year 3	***€9,488***	***€43,249***	***€55,020***

"it is clear that, even for a small laboratory, an automated system can represernt not just increased functionality, but a modest saving within three years"

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Real time monitoring: conclusions

1. It is a requirement
2. It is feasable
3. All parameters can be monitored/alarmed
4. Can avoid equipment failure cost
5. It is affordable

Become a winner!

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References

CAS dataloggers	www.dataloggerinc.com
Esco PROtect	www.escoglobal.com
KETAN – Shivani Scientific	www.shivaniivf.com
OCTAX – MTG	www.mtg-de.com
ReAssure - Planer	www.planer.com
XiltriX - IKS	www.iksinternational.com

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