SmartFactory:
The Challenges of Open and Low Cost ICT in the Small Manufacturing Industry.

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Materials Science and Manufacturing – MST Competence Area
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SmartFactory Agenda

• Introduction
  Who we are
  What we do

• SmartFactory - Architecture
  Analysis
  Requirements
  Design

• SmartFactory – Implementation

• SmartFactory - Future
Introduction

Who we are
What we do
Introduction

• Operating Unit: Materials Science and Manufacturing

• MST Competence Area

• 2 Main Activities:
  • Digital Manufacturing
    • Cooperation with MIT’s Centre for Bits and Atoms
    • FabLab
  • Affordable Automation
    • Robotics / Mechatronics
    • Automation & Control
Introduction
Past Activities

Water & Waste water Industry

Rooiwal Plant, Live Data & Graphs

http://rooiwal.sst.csir.co.za
Introduction
Improve Manufacturing Competitiveness

- Competitiveness Fund Assessments (for DTI by M&Mtek)
- Technology Roadmap, Automotive industry (Innovation Fund)
- National R&D Strategy
- Advanced Manufacturing Technology Strategy (AMTS)
- All agree: use of ICT is the key to increase industrial competitiveness.
Introduction
Available Systems

• **Established automation and control solutions**
  • provided by Siemens, Honeywell, etc.
  • standards like PROFIBUS, PROFINET, etc. (Proprietary)
  • large industrial customers
  • high performance at a high price

• **Enterprise Resource Planning (ERP)**
  • provided by SAP, Baan, PeopleSoft, etc.
  • large industrial and other corporate customers
  • high performance at a high price
Introduction
BUT: Smaller companies neglected

- Automation and control
  - affordability
  - simpler requirements
  - non real-time monitoring and basic control

- ERP
  - affordability
  - simpler requirements
  - less complex processes and corporate governance policies
  - Example: use of Excel
Introduction
The Dream

• Create an ICT solution for SMME’s.
  • ERP
  • SCADA
  • Automation & Control

• Replace High-Cost Imported Technologies

• Building competences and skills in the CSIR and S.A.
  • A collaboration between CSIR & Universities
SmartFactory - Architecture

Analysis
Requirements
Design
SmartFactory - Architecture Analysis

- Business Systems
- Data Collection & Representation
- Sensors, Communication & Local Control
SmartFactory - Architecture Requirements

• **Ease of Installation – Plug-and-Play**
  • High tech behind the scenes, simple appearance
  • Anyone with some computing skills can install

• **Ease of use**
  • Extremely low learning curve
  • Use should be intuitive, if not daily in use, should easily be recalled

• **Low-Cost / Affordable**

• **Open Standards / Open Source**
  • Encouraging cooperation with others

• **Modular and Scalable**
  • Able to scale with company size
SmartFactory - Architecture Technologies

- Wireless Technologies
  - 802.11b
  - Mobile Mesh

- Open Source Building Blocks
  - FreeBSD / Linux
  - PostgreSQL
  - HTML based SCADA
  - Compiere ERP + CRM

- Open Hardware
  - Commodity PC’s
  - Embedded SBC’s
  - Custom Interfacing Electronics
SmartFactory - Architecture Design

Central Server
- Complete ERP-CRM
- Web-based SCADA
- Apache
- SCADA Engine
- PostgreSQL database
- Linux
- Mobile Mesh
- IP
- 802.11b driver
  - miniPCI 802.11b card
  - Ethernet Interface
- IBM compatible x86 PC

One of many networked user workstations
- Any Web Browser
- HTML
- HTTP
- Any O.S.
- IP
- Network Interface
- Any Hardware

Company Network

CAN Node
- Message Engine
- Local Control Engine
- Linux
- Mobile Mesh
- IP
- 802.11b driver
  - miniPCI 802.11b card
- IBM compatible x86 PC
- Interfacing Driver
- Custom Hardware
- Machine Interface Hardware

Production Machine
- Sensors
SmartFactory
CAN Node Options - 1
SmartFactory
CAN Node Options - 2

- Open Source PLC
SmartFactory - Architecture
CAN Node – Result

- Standard SBC
- 802.11b PCI Card
- Custom Interfacing Electronics
- Custom HMI
- Low Cost
SmartFactory - Implementation

“Getting our hands dirty”
SmartFactory - Implementation Automotive Manufacturer

- GMT (Global Material Technologies), in Babelegi, manufacturers of Iron Products for Automotive & Building Industry.

- Manufacturing Process:
  - Steel Rods from ISCOR
  - Wire Draw Machine -> Smaller & Consistent Diameter.
  - “Shave” steel from wire -> Steel Wool
  - Hammer Mill, creates powder
SmartFactory - Implementation
Wire Draw Draw Machine

- Sense Temperature of the Accumulators
- Measure Production; how many tons/day
- Measure Wire Diameter & Ovalness (9 Points)
- Operator Report Down-Time Reasons

Intermediate Product: 3mm Wire
“Dead Block”
SmartFactory - Implementation
Wire Sensor

- Low Cost
- Easily Manufactured
- Medium Accuracy
SmartFactory - Implementation Sensor Recipes

Production Sensor:
• HALL Sensor I.C. + Glass Fibre Rod + Epoxy + Signal Cable
• Extremely low cost

• SmartFactory Website to contain recipes for simple sensors: www.smartfactory.org.za
SmartFactory - Implementation Lessons Learned

• Factory Installation is NEVER generic, unclear requirements causing delays & lots of learning.

• Never enough I/O

• Select appropriate O.S & Hardware for CAN-Node

• Keep SCADA functionality limited

• Remote Link is indispensable
SmartFactory - Future
SmartFactory - Future

- Establishment of Cooperative Research Network with Universities
- AMTS is funding SmartFactory as a “Flagship Project”
- PRIME used to fund Students in Industry
SmartFactory - Future Further Development

- Smaller Node Hardware
- More versatile HMI Options
- Plug and Play software on SCADA level
- “Building Block” Configuration Software (GUI)
SmartFactory - Future Research Opportunities

- Distributed Sensing, Sensor Mesh networks
- Energy Harvesting

**ZIGBEE MESH NETWORKING**

Above the PHY and MAC layers defined by IEEE 802.15.4, ZigBee enables reliable and secure mesh, star and cluster-tree network topologies with interoperable application profiles.

Mesh networks allow for high levels of reliability and scalability by providing routes through the network.