CSIR R&D in emerging manufacturing technologies

Dr Neil Trollip
Tesla Production Line
State of SA Manufacturing sector

CSIR Vision: Catalyse re-industrialisation
Technologies driving FIR / NIR

Fourth Industrial Revolution

- Autonomous robots
- Simulation
- Big data and analytics
- Augmented reality
- Horizontal and vertical system integration
- Additive manufacturing
- The Industrial Internet of Things
- The cloud
- Cybersecurity

Investments are expected to total US$ 907 bn p.a. until 2020
Revenue to rise by US$ 493 bn p.a. until 2020
Costs to be reduced by US$ 421 bn p.a. until 2020

Global

35% expect revenue gains over 20% over the next five years
43% expect to lower costs more than 20% over the next five years

33% of companies say they’ve achieved advanced levels of digitisation today
72% of companies expect to achieve advanced levels of digitisation by 2020
CSIR in Advanced Robotics
Advanced Robotics

Current automation in manufacturing
- Rigid
- Bulky
- Expensive
- Unsafe

Assistive Solutions
- Lightweight
- Affordable
- Flexible
- Human-centered
- Easy-to-use

The cobot market could grow from just over $100m in 2016 to $3bn by 2020 (Barclays Capital)
Advanced Robotics (cont)

Reconfigurable Manufacturing Machines

- Increased production agility for product families
- Mass customisation
- Lower CAPEX costs
- Interconnected and integrated systems

Assistive Robots

- Share a work area and interact directly with humans
- Perceive their environment with the aid of sensors and intelligent algorithms
- Communicate with people multi-modally
- Navigate autonomously and make decisions independently

Factories of the future will be adaptable, reconfigurable and allow humans and robots to work alongside each other
CSIR: Early stage research

Mobile manipulation
- Adaptive, reconfigurable grasping
- Programming through demonstration or behaviour learning

Multi-robot systems
- Navigation and task execution using multiple robots
- Optimal resource allocation strategies
CSIR: Robotics in Maintenance

The Need

- 15 ton injection mould requiring surface repair
- Downtime cost of R120k per minute and 2 day travel time

The Solution

- Mobile industrial laser engineering solution
- Mould and die repair at the factory
- Increase agility and reduce costs associated with unplanned downtime
CSIR: Robotics as Inspection Systems

- Autonomous rail vehicle
  - Early warning system
  - Inspection system
- Different drive trains
  - Latest - batteries & fuel cell technology
- Field testing in progress
SA Additive Manufacturing Strategy

Priority focus areas

- Qualified AM parts for medical and aerospace
- AM in traditional manufacturing sectors
- New AM materials and technologies
- SMME development and support

Capacity development

Education and awareness
CSIR Additive Manufacturing Focus

Process development: Powder blown AM
- TiAl (aerospace applications)
- Ti6Al4V (CSIR produced powder)
- 17-4 PH (aerospace grade stainless steel)

Process development: High Speed Selective Laser Melting (HSAM)
- High speed AM process optimisation in dedicated process cell
- Alloy modification and optimisation studies for AM applications

Application development
- AM applications in power generation industry (Eskom)
Aeroswift

- Collaboration between Aerosud IC and CSIR to design and construct a large area, powder bed AM system, for metallic components
- High speed, versatile system for production of large metal parts (5-10 x faster than best in class commercial systems)
- Build volume: 2m x 0.6m x 0.6m (scalable)
- Pre-heating and environmental control
- Materials: Ti-6Al-4V, stainless steel alloys, Inconel, other metals
CSIR in Micromanufacturing
CSIR Cleanroom Facilities

Cleanroom for soft lithography

Microstructuring onto Si wafers

Microfluidic circuits in PDMS
Cartridge-based Microfluidics

Microfluidics allows for the precise control of extremely small volumes of fluid
An ideal technology for development of point-of-care diagnostics and encapsulation techniques

Microfluidic-based cartridge for blood counting applications developed at the CSIR
Manufactured with micro-milling, micro-injection moulding

Microfluidic encapsulation and droplet fluidics

Φ 30µm
Printed Functionality Capabilities

- Wax printing
- Bio printing
- Inkjet metals printing
- Screen printing
Printed Functionality Applications

- Lateral flow strips for medical diagnostics
- Printed sensors
- Printed batteries powering printed circuits
- Printed electronics
CSIR in Industrial IoT
Internet of Things

“Inter-networking of physical devices, vehicles, buildings and other items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to collect and exchange data”

By 2020 there will be over 26 billion connected devices! (Gartner)
CSIR Industrial IoT Focus

- **Smart warehouse**
  - Optimal routing and placement in simulated warehouse with 3D visualisation

- **IoT augmented awareness**
  - Activity and hotspot detection in a crowd environment

- **Energy saving**
  - Sense consumption and actuate device to optimise usage
CSIR in Augmented Reality
Augmented Reality

A technology which enriches the real world with digital information and media such as 3D models and videos

- Complex assembly
- Maintenance
- Quality assurance
- Expert support
- Training
- Augmented intelligence

“We’ve only begun to scratch the surface of what augmented reality can do for manufacturing” – Engineering.com
Product Life Cycle Management (PLM)

PLM touches all phases of a product’s life and the entire value chain.

- Portfolio Management
- Planning
- Conceptual Design
- Product Engineering
- Manufacturing Engineering
- Simulation & Validation
- Build and Produce
- Disposal & Recycling
- Maintenance & Repair
- In-service Operation
- Sales & Distribution
- Test & Quality
CSIR and PLM

Product Life Cycle Management Technology Centre

PLM Benefits

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Improvement</th>
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</thead>
<tbody>
<tr>
<td>Reduce Time to Market</td>
<td>~ 30%</td>
</tr>
<tr>
<td>Reduce Product Development Cost</td>
<td>~ 20%</td>
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<tr>
<td>Reduce Product Cost</td>
<td>~ 20%</td>
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<tr>
<td>Reduce Cost of Quality</td>
<td>~ 20%</td>
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<tr>
<td>Reduce Change Management Cost</td>
<td>~40%</td>
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</tbody>
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Technology convergence & integration

Societal Challenges

Digital Society

Smartphone

Advanced materials

Microelectronics

Nanotechnologies

Photonics

Biotechnologies: Next?
Technology convergence & integration

CSIR: Corocam / Multicam

Next generation Inspection System
- Internet of Things
- Miniaturisation
- Augmented Reality
- Others?

Advanced sensors
Additive manufacturing
Microelectronics
Photonics
Advanced materials
Design/ergonomics
CSIR Approach: Open Innovation

Closed Innovation

Open Innovation
Demonstration/Learning Factories

- Demonstration platforms for firms interested in FIR
- Experimental platforms where FIR concepts can be tested
- Collaborative product development spaces
- Facilities for technical skills training and hands-on experience
CSIR Learning Factory Concept

- Autonomous robots
- Simulation
- Horizontal and vertical system integration
- The Industrial Internet of Things
- The cloud
- Cybersecurity
- Augmented reality
- Additive manufacturing
- Big data and analytics
Thank you