Engineering Surfaces With Thin Film Coatings:
A case study in sustainable manufacturing

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The Big Picture:

• Manufacturing is at the heartland or core of the innovation system in any advanced economy.

• It creates jobs, knowledge and wealth. It drives innovation.

• In Australia, around 1 million people are directly employed in the manufacturing sector.
Manufacturing: Facts and Figures

• 56%: Composition of manufacturing as a total of world trade in 2010

• 1,000,000: The number of Australians employed directly by the manufacturing sector (2011)

• 9%: Manufacturing as a total % of Australian jobs available (2011)

• 41%: Australian manufacturing sector’s contribution to total national expenditure on R&D (2000 – 2010)

Source: Department of Industry, Innovation, Science, Research & Tertiary Education (Key Facts, Australian Industry 2010-11)
# Australian Industry 2010/11

<table>
<thead>
<tr>
<th></th>
<th>Manufacturing</th>
<th>Mining</th>
<th>Services</th>
<th>Agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of GDP (%)</td>
<td>8.2</td>
<td>7.2</td>
<td>67.5</td>
<td>2.4</td>
</tr>
<tr>
<td>Investment (Annual Growth %)</td>
<td>-6.2</td>
<td>28.8</td>
<td>-3.0</td>
<td>-2.4</td>
</tr>
<tr>
<td>Exports (Industry Share %)</td>
<td>29.5</td>
<td>47.9</td>
<td>17.7</td>
<td>4.9</td>
</tr>
<tr>
<td>Employment (May 2011)</td>
<td>976,300</td>
<td>217,100</td>
<td>9,898,000</td>
<td>334,500</td>
</tr>
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Why Should We Be Concerned About The Decline of Manufacturing in Australia?

• Can an advanced economy prosper without a manufacturing sector?

• Manufacturing is the key driver of innovation – without it, a nation’s ability to innovate declines.

• Essential competencies such as science and engineering will not prosper without manufacturing.

• Manufacturing is a key provider of jobs to the mining sector.
Automotive Manufacturing in Australia

- Manufacturing in Australia is in serious decline
- Automotive job losses in 2012/13 (to end July 2013):
  - Ford: 440 (Broadmeadows and Geelong) – plus closure of operations announced as of October 2016 (a further 1100 jobs)
  - Toyota: 350 (Altona)
  - GM Holden: 500 (Elizabeth)

Image courtesy of Simon Bosch - Melbourne Age
Productivity (USA example): (Low labour cost is only part of the issue)

What took 1,000 workers to produce in 1950 takes 177 workers today

Manufacturing sector:
Number of workers needed to do the work of 1,000 workers in 1950

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Workers</th>
</tr>
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<tbody>
<tr>
<td>1950</td>
<td>1,000</td>
</tr>
<tr>
<td>1960</td>
<td>813</td>
</tr>
<tr>
<td>1970</td>
<td>627</td>
</tr>
<tr>
<td>1980</td>
<td>485</td>
</tr>
<tr>
<td>1990</td>
<td>362</td>
</tr>
<tr>
<td>2000</td>
<td>243</td>
</tr>
<tr>
<td>2010</td>
<td>177</td>
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</table>
## Manufacturing - Direct Labour Cost (USD):

<table>
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<tr>
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<tbody>
<tr>
<td>USA</td>
<td>$17.73</td>
<td>$26.87</td>
</tr>
<tr>
<td>Germany</td>
<td>$25.37</td>
<td>$37.13</td>
</tr>
<tr>
<td>UK</td>
<td>$14.54</td>
<td>$26.04</td>
</tr>
<tr>
<td>Switzerland</td>
<td>$30.06</td>
<td>$51.16</td>
</tr>
<tr>
<td>Taiwan</td>
<td>$6.12</td>
<td>$8.00</td>
</tr>
<tr>
<td>Mexico</td>
<td>$1.98</td>
<td>$4.53</td>
</tr>
<tr>
<td>New Zealand</td>
<td>$11.68</td>
<td>$22.39</td>
</tr>
<tr>
<td>Australia</td>
<td>$15.77</td>
<td>$37.04</td>
</tr>
</tbody>
</table>
So Why Do We Need a Vibrant Manufacturing Sector?

• Manufacturing is at the heartland or core of Australia’s innovation system – in fact this applies to any advanced economy.

• The manufacturing sector employs more scientists and engineers than any other industry sector.

• Each job in manufacturing creates between 2 and 5 jobs in the rest of the economy.

• From a societal and financial perspective, manufacturing is a vital element of advanced economies.
Can the Manufacturing Sector Survive in Australia?

- Yes – but our ‘traditional’ manufacturing base must transform.
- We cannot compete on the basis of labour cost.
- We can compete on the basis of innovation.
- ‘Advanced Manufacturing’ is one way to the future - it can create high value add product - and highly skilled jobs.
What is Advanced Manufacturing
-It depends who you ask….?

- The integration of new innovative technologies into both products and processes

- Manufacturing that entails the rapid transfer of science and technology (S&T) into manufacturing products and processes.”
Developing an Advanced Manufacturing Sector – The German Example

• The German government introduced a feed-in tariff for solar power in 1991 (Australia not until 2008)

• Photovoltaic power capacity is now over 17,000 MW (Australia around 1000 MW – yet we receive 2 x solar irradiation of Germany)

• Germany has created 250,000 new jobs in the renewable energy sector since 1991 – this will shortly exceed the German automotive sector
Case Study: Advanced Manufacturing
The SMR Automotive Example

- UniSA have just completed a project with SMR Automotive (in partnership with AutoCRC) to produce the world’s first plastic automotive mirror.

- A production facility was designed and installed at SMR’s Adelaide manufacturing facility in 2011.

- Initial production commenced in early 2012. The first product is now being exported to Ford USA. Currently operating 3 shifts per day, 5 days per week.
SMR Marketing Video

“Plastic Glass”
Plastic Mirrors: The Manufacturing Process

- An optical quality polycarbonate substrate is compression/injection moulded.
- The first coating layer applied is a resin hard coating (liquid) to provide abrasion resistance. It is applied by dip coating and is then thermally cured.
- A multi-layer thin film coating to impart reflectivity, corrosion resistance, environmental durability and additional abrasion resistance is then applied in vacuum by magnetron sputtering and PECVD.
SMR Production Facility – Adelaide (Lonsdale)
Advantages of a Plastic Automotive Mirror

• The weight of the reflective mirror element is reduced by 50% relative to traditional glass.

• The weight of the entire mirror assembly is reduced by a further 15% (actuator, housing etc).

• As a result, green house gas emissions are reduced.

• Injection moulded plastic opens up new design possibilities.

• The manufacturing process is simplified by part elimination.
Coatings Must Survive In The Real World

In the Automotive industry, car components must withstand extreme environmental conditions.

- Temperature: -40°C to +80°C
- Humidity: 2% to 100%
- Exposure to high salt levels
- Thermal shock
- Abrasion damage (stones, grit etc.)
Advantages of Vacuum Thin Film Coating

• It is an environmentally friendly process that produces minimal waste.

• It is does not use harmful solvents – with appropriate preparation, parts can go direct from injection moulding into the vacuum coating machine.

• It can replace metal (chrome) plating in many instances.
Thank You.