Honeywell Turbo Technologies

Rob Gillette
President and CEO
Transportation Systems
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Today’s Review

- Transportation Systems
- Turbo Technologies Overview
- Ride & Drive Preview
- Ride & Drive
Honeywell Today

- 108,000 employees in nearly 100 countries
- A *Fortune* 60 company – $25 billion in sales
- One of 30 select companies in the DJIA
### Transportation Systems

#### Profile

| 2004E Revenue: $4.2 - 4.3B | 13 - 14% Op. Margin |

#### Strengths

- Turbo Technology
- Global Presence
- Strong Brands
- Installed Base

#### Turbo Technologies

- 51%

#### Consumer Products Group

- 28%

#### Friction Materials

- 21%

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**Strong Growth Driven By Turbo Technology**
Turbo Technologies

Sales by Region
- Europe: 64%
- Americas: 22%
- Asia: 12%

Sales by Segment
- Passenger Vehicles: 67%
- Comm’l Diesel: 33%

$2.4 billion in sales (est 2004)
- Leader in technology and innovation
- Aerospace heritage and synergy

Global Leader in Engine Boosting
What is Turbocharging?

- Turbine driven compressor
- Propelled by engine exhaust gas
- Increases air flow and density

**Increases Power Density**
Boosting Opportunity

Turbocharged Segment

<table>
<thead>
<tr>
<th>Year</th>
<th>Millions</th>
<th>10% CAGR</th>
</tr>
</thead>
<tbody>
<tr>
<td>'04</td>
<td>15.5</td>
<td>15.5</td>
</tr>
<tr>
<td>'09</td>
<td>24.7</td>
<td>24.7</td>
</tr>
</tbody>
</table>

Overall Auto Market

<table>
<thead>
<tr>
<th>Year</th>
<th>Millions</th>
<th>2.5% CAGR</th>
</tr>
</thead>
<tbody>
<tr>
<td>'04</td>
<td>63.5</td>
<td>63.5</td>
</tr>
<tr>
<td>'09</td>
<td>71.8</td>
<td>71.8</td>
</tr>
</tbody>
</table>

Source: Power System Research

Boosted/Non-Boosted Vehicles

<table>
<thead>
<tr>
<th>Company</th>
<th>Volumes (Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMW</td>
<td></td>
</tr>
<tr>
<td>Hyundai</td>
<td></td>
</tr>
<tr>
<td>Peugeot</td>
<td></td>
</tr>
<tr>
<td>DaimlerChrysler</td>
<td></td>
</tr>
<tr>
<td>Volkswagen</td>
<td></td>
</tr>
<tr>
<td>Renault-Nissan</td>
<td></td>
</tr>
<tr>
<td>Toyota</td>
<td></td>
</tr>
<tr>
<td>Ford</td>
<td></td>
</tr>
<tr>
<td>GM</td>
<td></td>
</tr>
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</table>

Comm’l Vehicles

<table>
<thead>
<tr>
<th>Volumes (Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>12</td>
</tr>
</tbody>
</table>

Source: Power System Research

Untapped Opportunity for Turbocharging
Turbo Applications

• Heavy Duty
• Light Trucks
• Passenger Cars

Fuel Economy, Emissions and Performance
Why Turbocharge?
**Turbo Benefits**

**Turbo Diesel**
Great driving experience with 30 - 50% better mileage than gasoline vehicles

**Turbo Gasoline**
10 - 20% better mileage compared to non-boosted engines with equal or better performance

*Performance and Fuel Economy*
Turbo Benefits - A Comparison

European VW Golf

Acceleration
0-60 miles in seconds

<table>
<thead>
<tr>
<th>Engine Type</th>
<th>0-60 mph (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3L I5</td>
<td>8.8</td>
</tr>
<tr>
<td>1.8T</td>
<td>7.2</td>
</tr>
<tr>
<td>1.9TDI</td>
<td>8.6</td>
</tr>
<tr>
<td>2.0</td>
<td>10.6</td>
</tr>
</tbody>
</table>

Fuel Consumption
(city 45%, highway 55%)

<table>
<thead>
<tr>
<th>Engine Type</th>
<th>MPG (City)</th>
<th>MPG (Highway)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3L I5</td>
<td>25.7</td>
<td>28.3</td>
</tr>
<tr>
<td>1.8T</td>
<td>28.3</td>
<td>45.9</td>
</tr>
<tr>
<td>1.9TDI</td>
<td>45.9</td>
<td>26.4</td>
</tr>
<tr>
<td>2.0</td>
<td>26.4</td>
<td>26.4</td>
</tr>
</tbody>
</table>

Source: Auto Motor und Sport; Car and Driver

Fun to Drive and Fuel Efficient
Turbo Benefits - “The Turbo Effect”

**Turbo Diesel**

<table>
<thead>
<tr>
<th>Engine</th>
<th>HP</th>
<th>0-60</th>
<th>Fuel Economy</th>
</tr>
</thead>
<tbody>
<tr>
<td>VW Golf</td>
<td>150</td>
<td>8.8 sec</td>
<td>18/32</td>
</tr>
<tr>
<td>2.3L I5 Gas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VW Golf</td>
<td>150</td>
<td>8.6 sec</td>
<td>33/54</td>
</tr>
<tr>
<td>1.9L I4 TDI</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

“Turbo Effect”

<table>
<thead>
<tr>
<th>Engine</th>
<th>HP</th>
<th>0-60</th>
<th>Fuel Economy</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Turbo Effect”</td>
<td></td>
<td>.2 sec</td>
<td>+83% / +69%</td>
</tr>
</tbody>
</table>

**Turbo Gasoline**

<table>
<thead>
<tr>
<th>Engine</th>
<th>HP</th>
<th>Torque</th>
<th>Fuel Economy</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMW 325</td>
<td>184</td>
<td>175</td>
<td>19/27</td>
</tr>
<tr>
<td>2.8L NA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saab 9.3</td>
<td>205</td>
<td>209</td>
<td>23/33</td>
</tr>
<tr>
<td>2 L Turbo</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

“Turbo Effect”

<table>
<thead>
<tr>
<th>Engine</th>
<th>HP</th>
<th>Torque</th>
<th>Fuel Economy</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Turbo Effect”</td>
<td></td>
<td>+11%</td>
<td>+19%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+21%</td>
<td>+22%</td>
</tr>
</tbody>
</table>

Source: VW

Turbochargers Enable Performance and Fuel Economy
Why Now?
Legislation Converging

**European CO₂ Reduction Objectives**

- 165 g/km in 2002
- 140 g/km in 2008 (-15%)
- 120 g/km in 2012 (-27%)

**NOx & Particulates**

- **Japan**
  - Japan 2000
  - Japan 2005

- **Europe**
  - Euro II (1996)
  - Euro III (2001)
  - Euro IV (2005)
  - Euro V (2010)

- **US**
  - Tier I (1994)
  - Tier II (2004)
  - Tier III (2007)

**Increasing Requirement For Clean Technologies**
Global Engine Downsizing Trend

**WW Average (Passenger Car and Light Truck)**

- **Average engine size decreases globally (except in the US)**
- **Average engine Hp increases**
- **Increased engine power density in Europe and Asia**

### Average Displacement
- Europe: 1.9L
- Asia: 1.8L
- US: 3.6L

### Average Horsepower
- Europe: 72Hp/L
- Asia: 71Hp/L
- US: 58Hp/L

*Boosting / Turbo is a Key Enabler*
Diesel - Our Foundation for Growth

Diesel Penetration Over 20 Years

Europe: 56%
Korea: 62%
China: 22%
US: 7%

VNT™ for Passenger Car
AVNT™ for light and medium duty trucks
Double Axle VNT™ for heavy duty trucks

Latest Generation Debuted in 2005 BMW 120D

Diesel Penetration Continues to Increase Worldwide
Modern Clean Diesel

Before

New technologies
- Common rail fuel injection, Variable injection timing, VNT™ technology

Polluting, dirty
- Particulate matter (PM)
- Nitrogen dioxides (NOx)
- Sulfur fuel

Consumer rejection
- Bad impression
- Unsatisfactory performance

Now

New technologies
- 83% PM reduction since 1988
- 63% NOx reduction since 1988
- Ultra low sulfur fuel available in 2006

Increasing consumer acceptance
- Superior performance and no turbo lag
- 1/3 of Americans would consider purchasing a clean diesel vehicle*

* J.D Powers & Associates

New Diesel Technology Drives Consumer Acceptance

Scottsdale, AZ Dec. 2004
North America Heavy Duty Truck Segment

- Strong growth driven by economic recovery
- Variable geometry needed to meet US emissions requirements
- “Pre-buy” cycle boosts shipments through 2006

Technology and Strong Market Drive Growth
US Dieselization

- Ability to charge a premium in premium car and light truck/SUV
- Real world fuel economy meets expectations
- Efficiency without compromising performance
- Torque benefit for larger vehicles
- Strong vehicle residual values

**Diesel Now Associated with Ultimate Driveability**
Gasoline - Growing Interest Worldwide

Technology Breakthrough will Lift Gas Turbo Adoption

Global Turbo Gasoline Segment

- 8M Turbo (20% of gas engines)
- 5M Turbo (12% of gas engines)
- 3.4M Turbo
- 1.6M Turbo

Source: PRI, PSR, Martec

Future Direction

Wastegate

Variable Geometry
Asia Growth

Overall Boosting Demand
(Units)

<table>
<thead>
<tr>
<th>Year</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>3.3M</td>
</tr>
<tr>
<td>2008</td>
<td>6M</td>
</tr>
</tbody>
</table>

CAGR 13%

Honeywell Turbo Forecast
(Units)

<table>
<thead>
<tr>
<th>Year</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>1.3M</td>
</tr>
<tr>
<td>2008</td>
<td>3M</td>
</tr>
</tbody>
</table>

CAGR 18%

China
- Light duty truck growth
- Adoption of Euro II standards
- Fuel consumption regulations to be increased 15% by 2010

Japan
- Strong overseas growth in diesel
- Gasoline boosting opportunity driven by CO₂ regs beyond ‘08
- New long-term emission standard from 2H/05

Korea
- Continued increase in passenger car diesel adoption
- Tax incentives fuel diesel growth

Diesel Adoption, Emissions Drive Growth
India

Turbodiesel Vehicle Production

<table>
<thead>
<tr>
<th>Year</th>
<th>Light Vehicles</th>
<th>Commercial Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>143K</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>501K</td>
<td></td>
</tr>
</tbody>
</table>

03-08 CAGR 28%

Honeywell Turbo in India

- Business won with Tata and Mahindra
- Developing facility in Pune
- 300K unit volume opportunity

- Favorable fuel price differential
- 2005 Euro III implementation
- Focus on export market
- Euro IV favors VNT technology

Fast Growing Diesel Segment
Why Honeywell?
Technology Evolution

Step Change: Turbine Side

Step Change: Compressor Side

2-Stage Turbos

Variable Geometry Compressor Turbos

e-Turbo™ Electrically Assisted Turbo

Step Change: Control and Response

Performance

2004

2008

Wastegate

VNT™ Variable Nozzle Turbine

Step 1

Step 2

Step 3

Entering Market

Robust Technology Roadmap
Latest Generation VNT

- Improved power
- Lower fuel consumption and emissions
- Higher torque and improved transient response
- Improved braking power

Continued Improvement of Groundbreaking Technology
Two-Stage Turbo

- Employs twin turbos to boost low- and high-end performance
- Significantly increases power density of engine
- Higher power, transient response

**Increasing Performance Through Staged Boosting**
Variable Geometry Compressor

- Applies variable geometry to compressor side of turbo
- Wider flow range increases efficiencies
- Can be used on full engine range

Moving From Turbine to Compressor Side
Electric Boosting

- Employs electric motor to eliminate turbo lag
- Full integration with engine management system
- Complements hybrid engines and fuel cells

*Provides “Boost on Demand”*
Hybrid Technology

• Fuel-economy most pronounced during stop/start driving

• Variety of hybrids exist; all rely on internal combustion engine
  — Most fuel efficient version would be turbodiesel-hybrid

• Niche vehicle or mainstream technology?
  — Hybrid penetration in Japan less than 5% after many years
  — Cost/benefits analysis on hybrids vs turbodiesel still unclear
  — Mature adoption of turbodiesel to limit European penetration

Hybrid Cost/Benefits Unclear
Diesel versus Hybrid

**Escape Hybrid vs. Jeep Liberty Diesel**

- **Price ($000s)**
  - Escape Hybrid: TD
  - Jeep Liberty Diesel: H
  - Range: 20 to 30

- **0-60 mph (seconds)**
  - Escape Hybrid: 8
  - Jeep Liberty Diesel: 12

- **Towing Capacity (lbs.)**
  - Escape Hybrid: TD
  - Jeep Liberty Diesel: H
  - Range: 1000 to 5000

- **City Fuel Economy (US mpg)**
  - Escape Hybrid: TD
  - Jeep Liberty Diesel: H
  - Range: 20 to 40

- **Highway Fuel Economy (US mpg)**
  - Escape Hybrid: TD
  - Jeep Liberty Diesel: H
  - Range: 20 to 40

Source: Corporate Information, Car & Driver, AutoSite, Wards Communications

**Diesel Offers Superior Value for LT/SUV**
Honeywell Competitive Advantage

People/Expertise

• Aerodynamics
• Mechanical wheel design (HCF, optimization)
• Reliability build up
• Cooling optimization/material

Technology

• Air bearings
• High temperature alloys
• Coatings
• Assembly/welding

Markets

• Automotive controls
• Electronics
• Power generation

Honeywell Technology Applied to Turbo
Global Footprint

Broad and Diverse Resources
Turbo Productivity Engine

- Manufacturing/supply base transitioning to emerging regions
  - Most incremental new volume in Bucharest, Mexicali and Shanghai
- Focus on our core competencies, outsource the rest
  - More than 60% of cost is materials: supply base drives productivity
- Lean initiatives ensure maximum shop floor utilization

Supporting Worldwide Growth
Summary

• Why Turbocharge?
  - Optimizes engine performance
  - Fuel economy
  - Emissions reduction

• Why Now?
  - Legislative mandates
  - Worldwide diesel and gasoline market demand
  - Recent technological advances

• Why Honeywell?
  - Technology leader
  - Expertise, competitive advantage
  - Global presence and customer base

Enjoy the Ride!
Why Wait?

Here’s a look at the vehicles you’ll be driving!
Ford Falcon (Australia)

4.0L DOHC Gas Turbo

I6 24V DOHC

322 hp @ 5250 rpm
332 lb.-ft @ 2000 to 4500 rpm

6.2 s 0-62 mph
21 / 28 mpg (AUS)
Ford Falcon (Australia)

4.0L DOHC
Gas Turbo

I6 24V DOHC

322 hp @ 5250 rpm
332 lb.-ft @ 2000 to 4500 rpm
6.2 s 0-62 mph
21 / 28 mpg (AUS)
Ford Focus RS (England)

2.0L Gas Turbo
I4 16V DOHC

211 hp @ 5500 rpm
229 lb.-ft @ 3500 rpm

6.4s 0-60 mph
20/37 mpg (Euro)
Volkswagen Parati (Brazil)

1.0L Gas Turbo
I4 16V DOHC

110 hp @ 5500 rpm
114 hp @ 2000 rpm

9.8 s 0-62 mph
27/39 mpg (Brazilian)
Jeep Liberty I4T (Honeywell prototype)

2.4L Gas Turbo
I4 16V DOHC

<table>
<thead>
<tr>
<th>Performance</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horsepower</td>
<td>241 hp</td>
</tr>
<tr>
<td>Torque</td>
<td>243 lb.-ft</td>
</tr>
<tr>
<td>0-60 mph</td>
<td>9 s</td>
</tr>
<tr>
<td>MPG</td>
<td>18/24</td>
</tr>
</tbody>
</table>

Scottsdale, AZ Dec. 2004
Smart Roadster

700 cc Gas Turbo
L3 SOHC

80 hp @ 5250 rpm
81 lbs.-ft. @ 3000 rpm
10.9s 0-62 mph
37/53 mpg (Euro)
BMW 530d

3.0L Turbo Diesel

7.1 0-62 mph
25 / 43 mpg (Euro)

I6 24V DOHC

218 hp @ 4000 rpm

368 lb.-ft @ 1750 rpm
Volkswagen Passat TDI

2.5L Turbo Diesel
V6 24V DOHC

180 hp @ 4000 rpm
279 lb.-ft @ 1500 rpm

9.6 0-62 mph
19/37 mpg
Mercedes Benz E 320 CDI

3.2L Turbo Diesel

V6 24V DOHC

218 hp @ 4000 rpm

368 lb.-ft @ 1750 rpm

7.7 0-62 mph

27/37 mpg
Smart City-Coupe CDI

0.8L Turbo Diesel
I-3 6V SOHC

40 hp @ 4200 rpm
74 lb.-ft @ 1800-2800 rpm

15.4 0-62 mph
60 / 75 mpg (Euro)
**VW Touareg**

**5.0L Turbo Diesel**

**V10 5.0l DOHC**

- 313 hp @ 3750 rpm
- 552 lb.-ft @ 2000 rpm
- 6.2s 0-60 mph
- 17/23 mpg
Questions