

# RCV Engines Limited - UK

RCV Engines Limited - © 2004  
India – AutoExpo 2004



The Development of a Rotating Cylinder Valve  
4-stroke Engine for 2-Wheeler Applications

# RCV 4-Stroke Engines for 2-Wheelers

## Presentation Contents

- 2-Wheeler Engine Requirements
- The RCV Engine Concept
- RCV 2-Wheeler Engines
- RCV Handheld Engine Concept
- Future Development Plans



# 2-Wheeler Engine Requirements

# Overview of the Global Market

- Global market exceeds 25 million units with major markets for all capacities, as follows:
  - ◆ China 40%
  - ◆ India 20%
  - ◆ ASEAN 16%
  - ◆ EU 10%
  - ◆ USA 5%
- Utility models less than 150cc account for more than 90% production
- 2-stroke engines were popular in utility applications – but have been replaced over the last decade by 4-strokes with lower exhaust emissions at a cost premium
  - is there an effective 2-stroke replacement ?

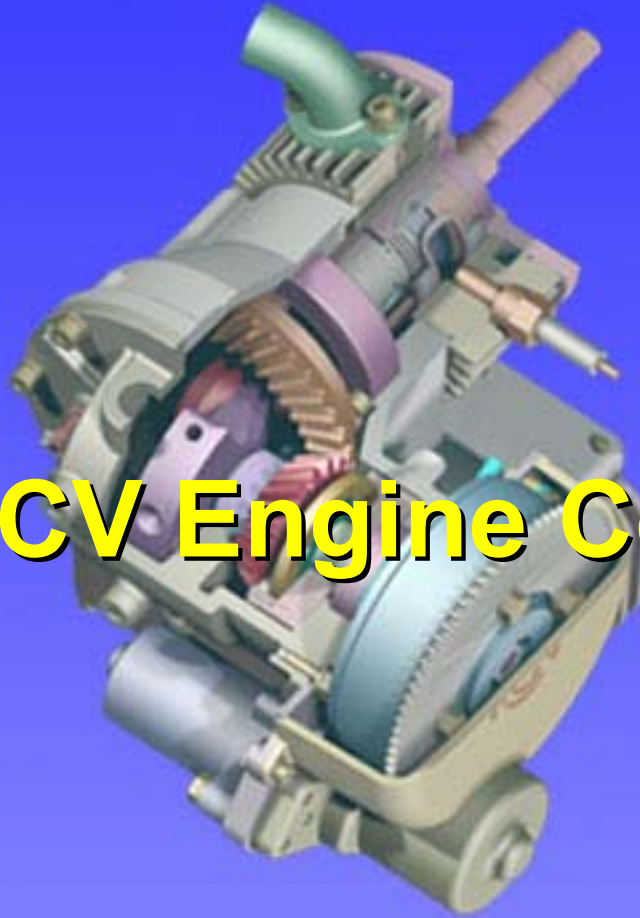
# Future Legislative Events

- Exhaust emissions legislation will continue to drive 2-wheeler engine development
  
- Future Legislation (CO, HC, NOx)
  - ◆ EURO3 - new drive cycle with cold start + OBD + durability + anti tampering
  - ◆ India 2005 – 1.5 g/km CO,  
– 1.25 g/km HC + NOx
  
- CO<sub>2</sub> Legislation
  - ◆ Legislation not defined - will be monitored from 2006 in Europe - reduction required could be 25%?
  - ◆ Fuel consumption is important for utility motorcycle markets – such as India

# Utility 2-Wheeler Engine Requirements

|               | Criteria                  | Requirement                                    |
|---------------|---------------------------|--|
| SPECIFICATION | Cost                      | Lowest manufacturing cost                      |
|               | Emissions                 | Achieve legislation at minimum additional cost |
|               | Fuel/oil                  | Deposit control - service intervals            |
|               | Noise                     | Legislative requirements - good sound quality  |
|               | Oil consumption           | Low consumption with no leaks                  |
|               | Power                     | High power with wide torque band               |
|               | Production                | Repeatable performance in production           |
|               | Reliability requirement   | >30,000 km                                     |
|               | Temperature               | -10°C to +40°C with easy starting              |
|               | Weight                    | Low weight - for economy and handling          |
| FUNCTION      | Abuse                     | Over-speed and dirt tolerance                  |
|               | Environment               | Extreme and diverse conditions-water and dust  |
|               | Maintenance               | Good serviceability with simple tools          |
|               | Multi product application | Scooter, step-through and motorcycle           |
|               | Package                   | Compact to suit all existing vehicles          |

# The RCV Engine Concept



# RCV – Introduction

- RCV Engines is a UK based company established in 1997 to commercially exploit the Rotating Cylinder Valve engine concept invented by Keith Lawes
- RCV commenced production with a model aircraft engine, today RCV manufactures a range of methanol fuelled engines from 10cc to 20cc with more than 6,000 engines operating in over 50 countries worldwide
- RCV are currently developing prototype gasoline and JP8 fuelled engines for unmanned air vehicles (UAV), hand held tool and 2-wheeler applications





# Rotary Valve Engines - Background

- Sleeve and rotary valve engines have been developed since the 1920's for improved mechanical durability, reduced noise and unrestricted engine breathing
- Sleeve valve engines had advantages of:
  - ◆ Reduced losses compared to poppet valves
  - ◆ Reduced piston friction
  - ◆ Improved detonation resistance
- Rotary valve engines by Cross and Aspin showed advantages of improved volumetric efficiency but with problems of high oil consumption and poor valve durability
- GV Technology (SAE 891793) overcame these issues with a rotary valve conversion of the Yamaha XT500 engine which achieved vehicle fuel consumption reductions of 30% with improved torque.
- Non of these sleeve or rotary valve technologies have demonstrated a production or packaging advantage

# RCV – the Concept

- Cylinder rotates around piston at half crankshaft speed
- Single port in the rotating cylinder passes fixed radial inlet and exhaust ports to provide the valve function
- The rotating cylinder is effectively combined with the rotary valve in a single component – hence the name **RCV**
- The RCV concept is simple with compact package and reduced component count compared to a 2-valve 4 stroke

**CYLINDER GEARED TO CRANKSHAFT**

**POWER TAKE OFF EITHER FROM CYLINDER OR CRANKSHAFT**

**ROTATING CYLINDER VALVE AND SEAL**

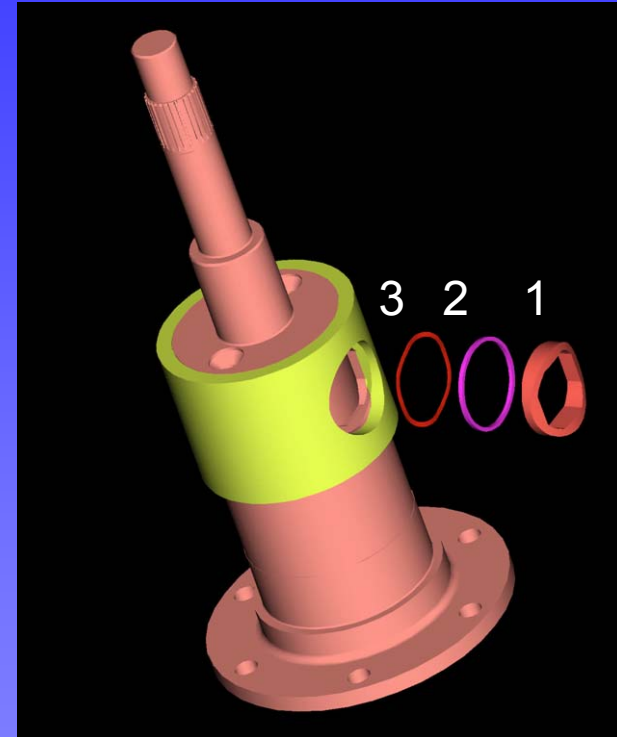


Illustrated is:

**RCV 49cc CYLINDER OUTPUT ENGINE**

# RCV - Valve Seal Design

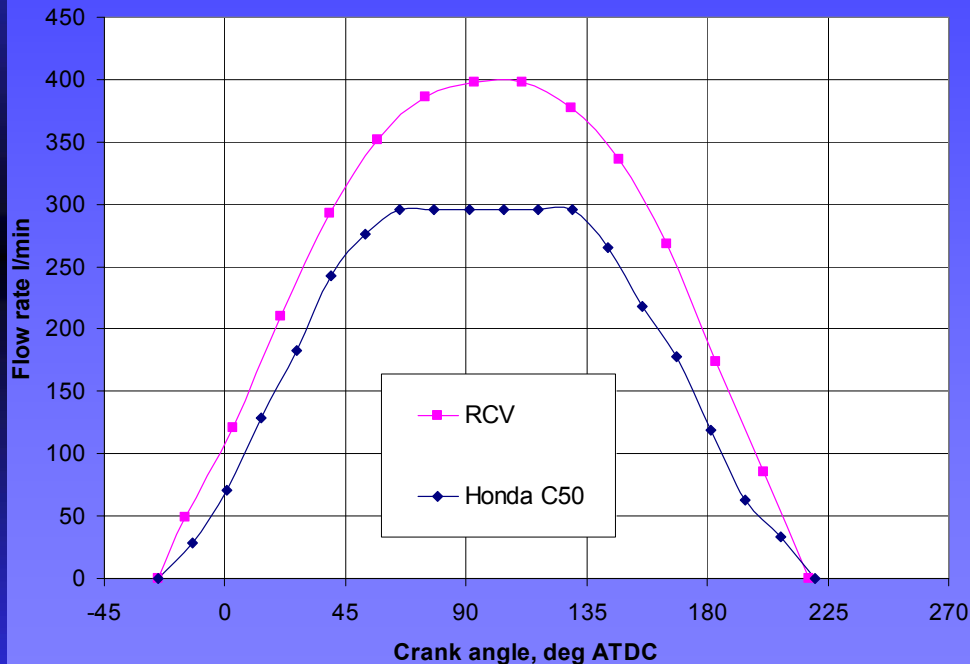
- RCV have developed a floating seal concept with minimum blow-by, wear and friction. A floating seal can accommodate production tolerance variations and thermal distortions
- The seal incorporates:
  - 1) Solid compression seal – dynamic seal using wave spring and cylinder pressure
  - 2) Piston ring type seal - forms seal at rear of compression seal
  - 3) Wave spring – provides static sealing force
- Compression seal based on similar material to piston rings – similar operating environment



RCV 49cc Prototype  
Engine Valve Seal

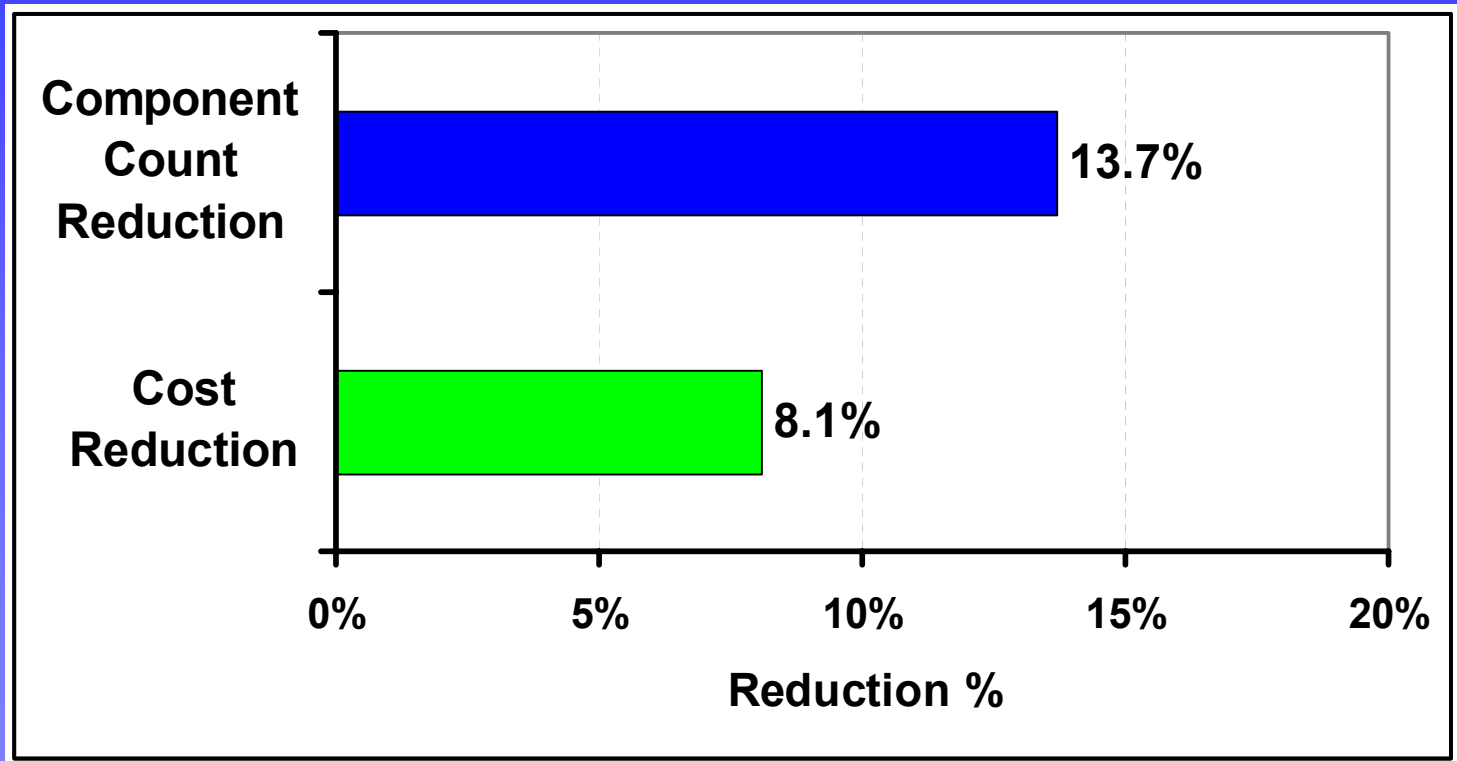
# RCV 49cc Prototype Engine Valve Flow Performance

Pressure drop v crank angle  
All flows measured with an input pressure of 72mm H<sub>2</sub>O



- Large unrestricted port area (290mm<sup>2</sup>)
- 50% higher flow area compared to a typical 4 stroke 2 valve engine
- High flow capacity enables valve overlap to be minimised without sacrificing power
- Typically torque levels are 85% of max between 3000 and 9000 rpm
- Still larger areas are possible, up to 400mm<sup>2</sup>

# RCV Crankshaft Output Engine Cost/Component Count



- RCV Estimates – based on a bill of materials comparison of a 125cc 4 stroke 2 valve air cooled scooter engine converted to a crankshaft output RCV engine

# RCV - Technical Advantages

- Reduced friction and fuel consumption
  - ◆ Rotating cylinder provides continuous piston lubrication
  - ◆ Elimination of valve train – net advantage considering seal losses – efficiency benefits particularly at part load
- Improved volumetric efficiency
  - ◆ Unrestricted port with large effective valve area
- Efficient 4 Stroke combustion system
  - ◆ Exhaust emission legislation compliance with conventional 4 stroke motorcycle after-treatment technology
- Improved Assembly and Maintenance
  - ◆ Cylinder height similar to a 2-stroke engine
  - ◆ Low component count; simple assembly
  - ◆ No cam chain or valve lash clearance to adjust
  - ◆ No valve bounce at over-speed operation



# RCV 2-Wheeler Engines

# RCV 2 – Wheeler Engines

- RCV have been developing prototype engines for 2-wheelers since 1999
- RCV initially developed a cylinder output 49cc engine for scooter applications
- RCV have overcome several development issues and tested both cylinder output and crankshaft output versions of the 49cc engine



# RCV – Prototype Motorcycle Engines

## 49cc Prototypes



- Series 1 – cylinder output proof of concept
- Series 2 – cylinder output vehicle application
- Series 2A – crankshaft output
  - ◆ 4.3 bhp achieved
  - ◆ Excellent valve durability

# RCV - Motorcycle Engines

## Crankshaft Output Concepts

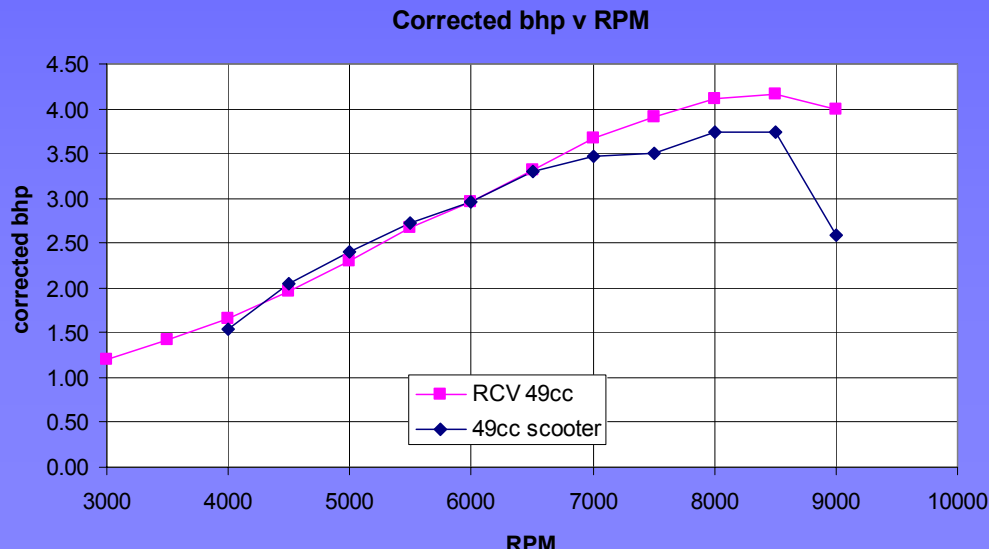
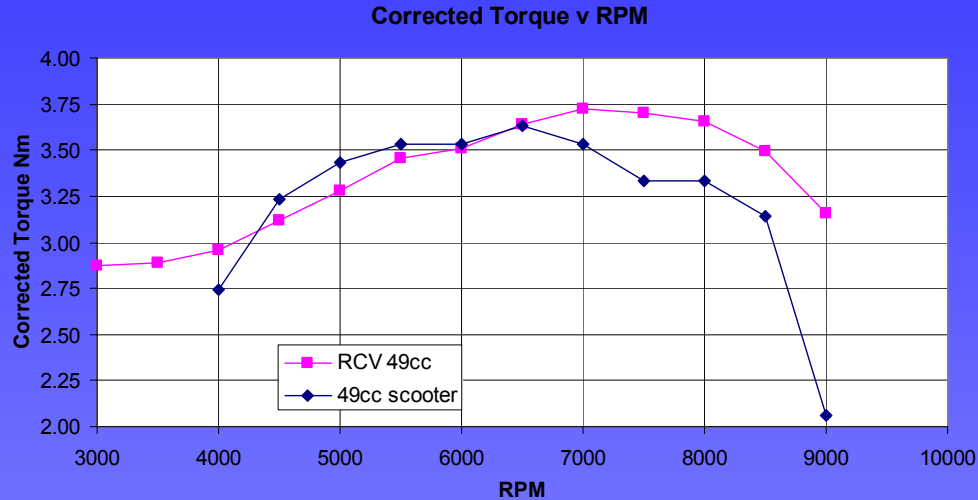


- Cylinder output versions offer the greatest potential for cost savings – but requires the development of a completely new engine with greater risk for manufacturers
- RCV are focusing on crankshaft output versions for 2-wheelers
  - ◆ Retains existing crank-train and transmission
  - ◆ Packaging compatible with existing vehicles
  - ◆ Cylinder height reduction – 40mm for 125cc

# RCV - Development Issues

| ISSUE             | SOLUTION   |
|-------------------|--|
| Blow by           | Floating valve seal + repositioned spark plug    |
| Fuel/oil deposits | Direct cylinder oil cooling                      |
| Oil consumption   | Revised cylinder/crankcase oil distribution      |
| Seal wear         | Use of piston ring technology for seal materials |
| Unstable idle     | Revised seal design                              |

# RCV 49cc Crankshaft Output Engine Performance



## TEST VENUE - RICARDO

- Engine performance verified at Ricardo Consulting Engineers

## PERFORMANCE

- Max torque  
3.7Nm @ 7000 rpm
- Max power  
4.2bhp @ 8500
- Min BSFC 290 g/kWh

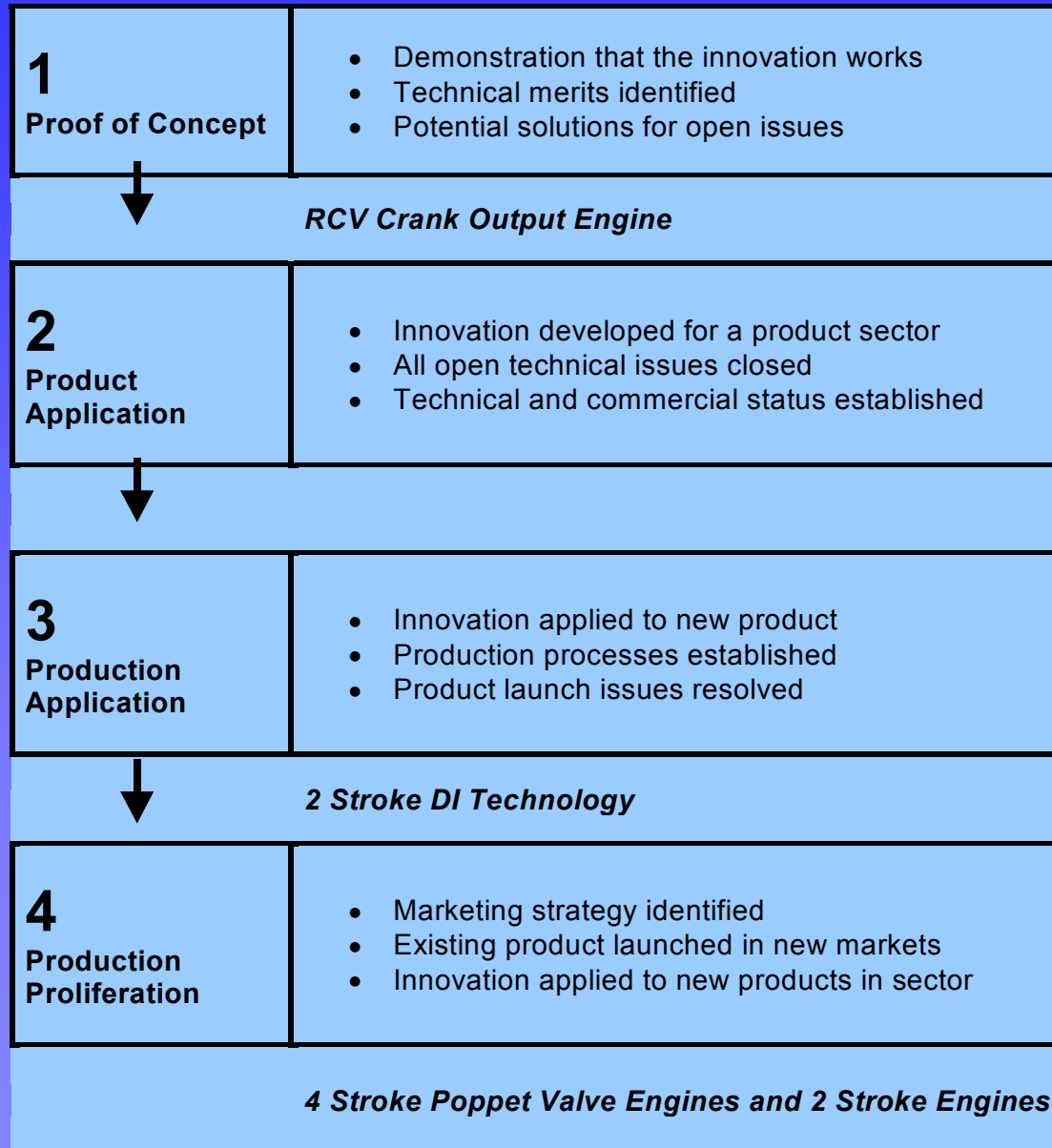
## EMISSIONS AT 3%CO

- HC = 13 g/kWh
- NOx = 12 g/kWh

# Air-cooled motorcycle engines compared to 2 valve SOHC 4-stroke

|              | 2 Stroke | 2 Stroke DI | RCV 4 Stroke |
|--------------|----------|-------------|--------------|
| Cost         | ✓✓       | xx          | ✓            |
| Engine size  | ✓✓       | o           | ✓✓           |
| Emissions    | xx       | ✓           | o            |
| Fuel economy | xx       | ✓✓          | ✓✓           |
| Noise        | x        | x           | ✓            |
| Power        | ✓✓       | ✓✓          | ✓            |
| Servicing    | ✓✓       | xx          | ✓            |
| Weight       | ✓✓       | ✓           | ✓            |

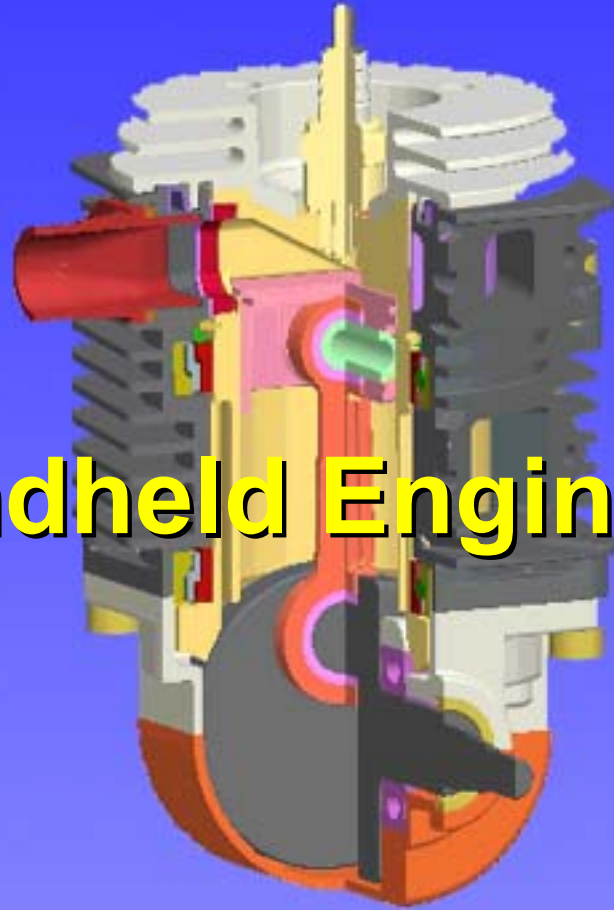
# RCV Technology – Status of Development



# RCV Motorcycle Engine Status

|               | Criteria                  | RCV Status   |
|---------------|---------------------------|--|
| SPECIFICATION | Cost                      | Less components compared to standard 4-strokes   |
|               | Emissions                 | Initial results indicate similar levels to standard 4-stroke - conventional after treatment technology applies |
|               | Fuel/oil                  | Not an issue on development engines - requires confirmation on vehicle prototype                               |
|               | Noise                     | Not an issue with crankshaft output design   |
|               | Oil consumption           | Acceptable oil consumption measured  |
|               | Power                     | Acceptable performance with development potential  |
|               | Production                | Component value engineering outstanding  |
|               | Reliability requirement   | Durability to be confirmed on vehicle prototypes   |
|               | Temperature               | Cold starting performance to be confirmed  |
|               | Weight                    | Competitive weight - aluminium cylinder being investigated   |
| FUNCTION      | Abuse                     | Overspeed not an issue   |
|               | Environment               | To be confirmed by testing   |
|               | Maintenance               | Easy engine to build and disassemble - no valves to adjust   |
|               | Multi product application | Possible with crankshaft output concept  |
|               | Package                   | Similar cylinder height to a 2 stroke  |

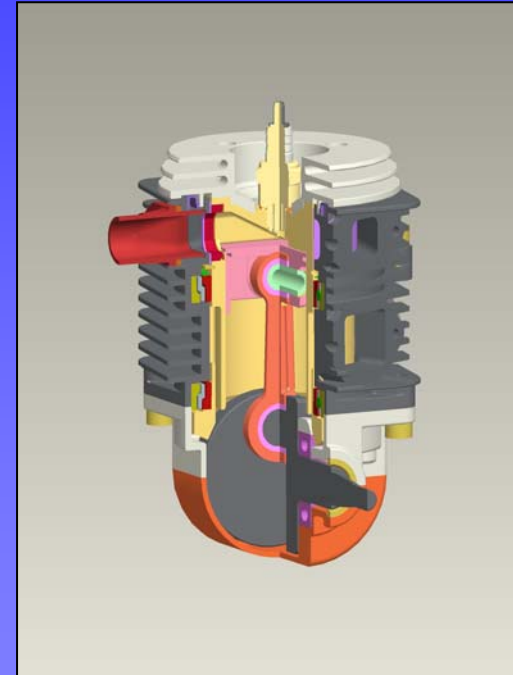
# RCV Handheld Engine Concept



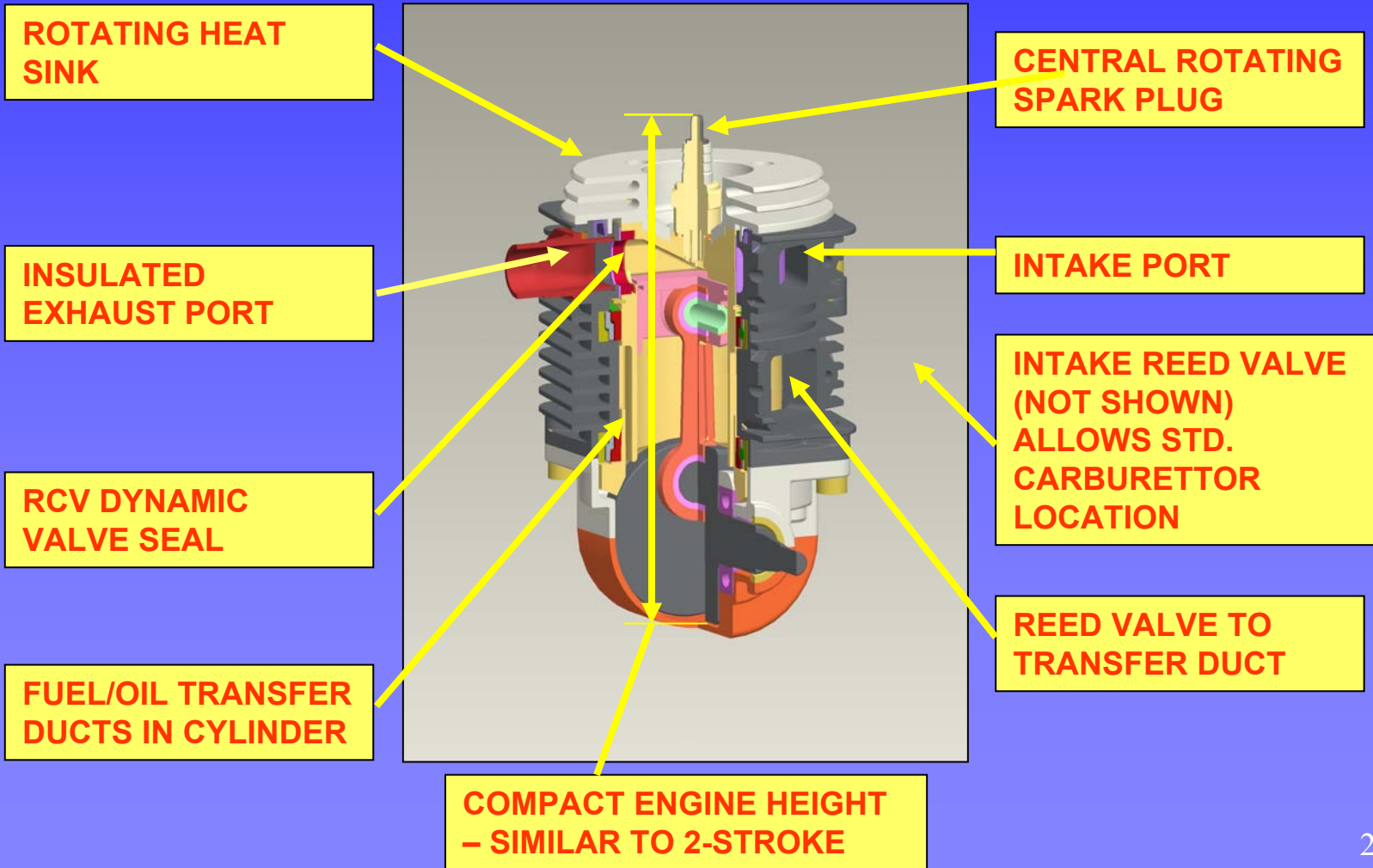


# RCV Handheld Engine Concept

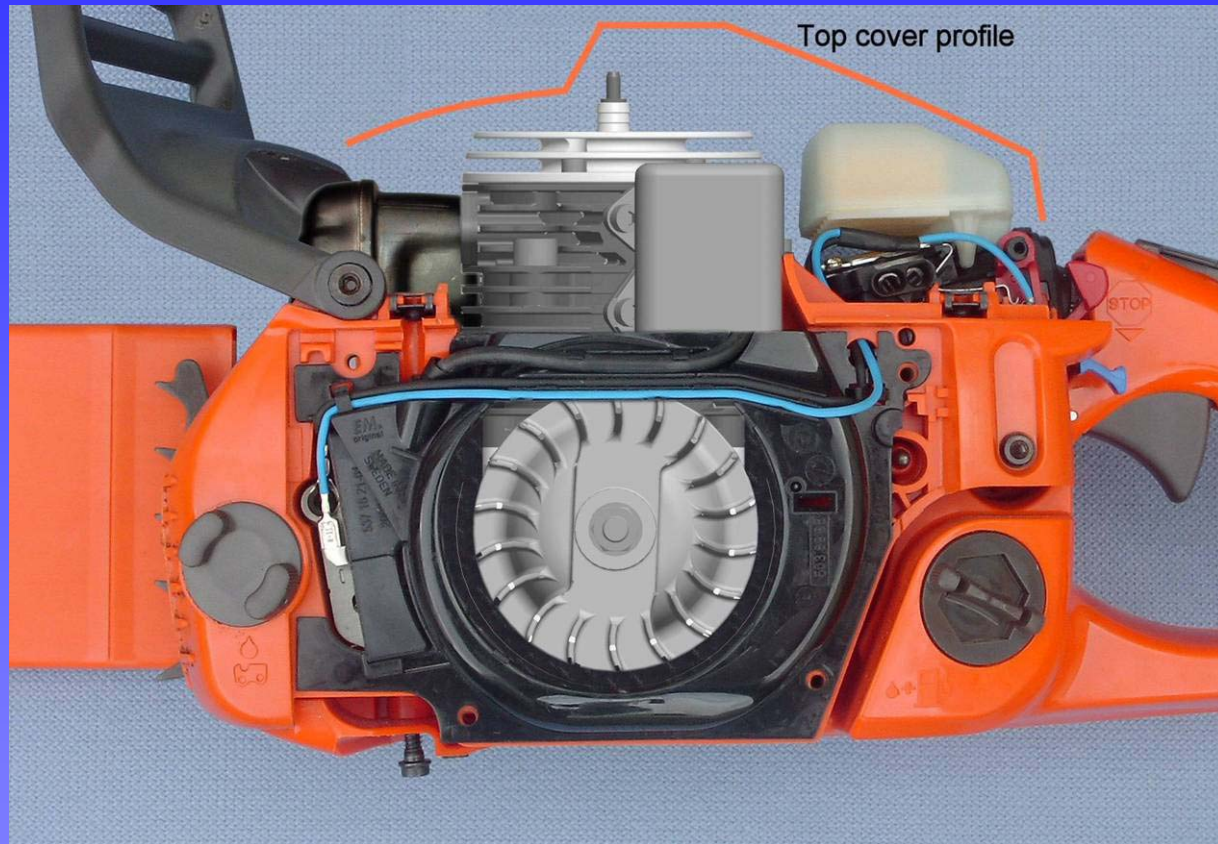
- 4 Stroke cycle – EPA Phase 2 emissions potential
- Fuel/mix lubricated allows multi-position operation
- Crankcase supercharged – high power to weight ratio
- RCV valve – high engine speed potential
- Compact packaging – fits in 2 stroke package
- Low maintenance and easy to service



# RCV Handheld Engine Features



# RCV Handheld Engine Concept



- RCV handheld engine concept packages into an existing chainsaw layout with carburettor and exhaust positions unchanged

# Future Development Plans



# RCV – Development Plans 2004

## ■ RCV 2-Wheeler Engines

- ◆ Proof of concept phase completed
- ◆ 125cc motorcycle demonstrator to be built to establish technical and commercial advantages

## ■ RCV Handheld Engines

- ◆ Proof of concept engine prototype to be built
- ◆ Poppet valve 4-stroke technology is unsuitable for chainsaw applications where 2-strokes have emissions issues and catalysts create a fire hazard

# Summary

**RCV have developed a new 4-stroke engine concept with benefits over current 2-stroke and 4-stroke engine designs**

- Application possibilities include: 2-wheeler, forest & garden, industrial, generators, marine, & aero products
- RCV have ongoing development plans aimed at reducing the technology risk for commercial production applications
- The advantages of RCV technology are:
  - ✓ Low cost
  - ✓ Fuel efficient
  - ✓ High Power
  - ✓ Low maintenance
  - ✓ Protected by international patents
  - ✓ Compact package

## ***Conclusion***

***RCV 4-stroke technology has the potential to become an effective 2-stroke replacement with improved fuel efficiency compared to traditional poppet valve 4-strokes***