

ARCHIVED REPORT

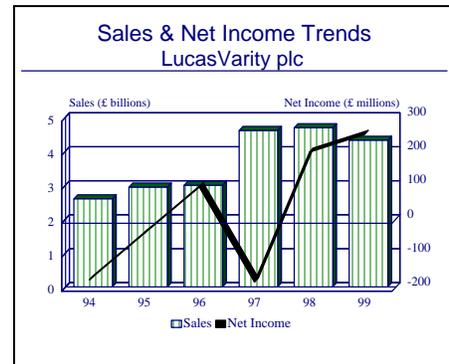
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LucasVarity plc - Archived 8/2001

Outlook

- LucasVarity is now fully absorbed into its new parent company, TRW
- Lucas Aerospace – now TRW Aeronautical Systems – forms a key group of the new TRW Aerospace and Information Systems unit
- TRW is committed to its highly profitable defense businesses, maintaining that defense and aerospace are integral elements of TRW and will not be sold



Headquarters

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Founded in 1872 and incorporated in 1879 under the name of Joseph Lucas, Lucas Industries is a worldwide organization producing equipment for all forms of land, sea and air transport systems. Activities are conducted through a number of operating companies, including Lucas Aerospace, set up in 1971 to manage the group's interests in the field of aviation. Lucas has supplied aircraft components to the defense industries since 1910, and Lucas Aerospace is now a leading European-based manufacturer of aircraft, turbine engines, missile and vehicular equipment and components.

Lucas Aerospace's technology pedigree can be traced from pioneering work with the first aircraft to be powered by a jet propulsion engine and flown by powered flight controls. Today, the company manufactures such equipment as missile and aircraft actuator systems and wing-mounted weapons launchers.

Lucas has continued to meet the international aerospace and defense market's needs through technological advances which are built on a fairly extensive foundation of proven designs.

Through quality and high manufacturing efficiency, Lucas has established a strong position in all of its chosen markets. The company is steadily balancing its business activities between aerospace (including defense) and non-aerospace manufacturing segments in order to protect its sales and profitability. Such diversification efforts are expected to further enhance the company's capabilities both in the existing manufacturing markets and as well as in other commercial markets, such as civil aircraft, automotive, communications, and electronics markets.

In September 1996, Lucas Industries and Varity Corporation merged to form LucasVarity plc. The new company is one of the top ten automotive component suppliers in the world as well as a major supplier to the automotive, aftermarket, industrial and aerospace markets worldwide.

In March 1999, TRW acquired LucasVarity of the UK in a deal valued at \$7 billion. The combination of TRW and LucasVarity has created a global supplier of high-technology automotive and aerospace systems and services.

Following this purchase, LucasVarity has been wholly absorbed into TRW's structure.

refer to the TRW report located in *Defense & Aerospace Companies, Volume I*.

NOTE: *This is the final update of the LucasVarity report. For details on the company's operations please*

Structure and Personnel

(pre-acquisition)
Edmund Arthur Wallis
Chairman
Victor Rice
Chief Executive
Tony Gilroy
Chief Operating Officer

Neil Arnold
Group Finance Director
W.K. Maciver
President, Lucas Aerospace

Product Area

Prior to the acquisition by TRW, LucasVarity provided advanced-technology systems, components and services to the world's aerospace, automotive and other selected markets. The company managed its operations in the following business portfolios:

1. Aerospace
 - 1.1 Engine Control Systems
 - 1.2 Power Generation
 - 1.3 Flight Control
 - 1.4 Cargo Systems
 - 1.5 Hoists and Winches
 - 1.6 Missile Actuation
2. Automotive
 - 2.1 Light Vehicle Braking Systems
 - 2.2 Diesel Systems
 - 2.3 Electrical & Electronic Systems
 - 2.4 Aftermarket Systems

Aerospace. Lucas Aerospace provides flight control and actuation systems, fin control actuation systems for the Advanced Short Range Air-To-Air Missile (ASRAAM) and the Advance Interdiction Weapon System (AIWS) missiles, communications and electronics, engine and electronic systems, and worldwide customer support.

Automotive. Lucas' remaining units provide automotive supplies such as car and truck braking systems, powertrain systems, diesel fuel injection systems, diesel engines, electrical products and wiring systems, electronics, switch controls, and aftermarket parts.

Facilities

TRW Aeronautical Systems, Lucas Aerospace, Stratford Road, Solihull B90 4LA, England. Telephone: (44 0121) 451 5700. Web Site: <http://www.lucas-aerospace.com>

Corporate Overview

TRW was the US' ninth largest defense contractor in FY99. With the purchase of LucasVarity, TRW now segments its businesses into four major sectors: Automotive, Space & Electronics, Systems & Information, and Aeronautical. TRW's overall sales for these groups during 1999 was \$17 billion. Of that total, Automotive accounted for 67 percent of the company's revenues; Space & Electronics 11 percent; Systems & Information 17 percent; and Aeronautical 5 percent.

New Products and Services

Trent Engine Controls. In January 1998, Lucas Aerospace division reached a risk and revenue sharing agreement with Rolls-Royce plc to provide the control systems on the latest derivatives of the successful Trent family of engines. This major agreement is expected to produce total sales of at least £2 billion for Lucas Aerospace over the life of the project. Lucas Aerospace will provide complete systems, including electronic engine controls, fuel metering units and actuation equipment for the Trent 8104 and, in addition to these components, the fuel pump for the Trent 500 and 600.

As part of this agreement with Rolls-Royce, Lucas Aerospace will invest about £75m and will take between a 3 and 5 percent share of the three engine programs' total revenues, dependent upon the engine involved.

Plant Expansion/Organization Update

TRW Realigns After LucasVarity Deal. In April 1999, following the acquisition of LucasVarity, TRW announced it would realign into two sectors, TRW Automotive and TRW Aerospace and Information Systems. The new aerospace unit will incorporate Lucas Aerospace and TRW's Space, Defense and Information Systems business. The operations will have roughly \$6 billion in sales with 35,000 employees in locations around the world. TRW Aerospace and Information will consist of four groups: TRW Space and Electronics; TRW Systems and Information Technology Group; TRW Aeronautical Systems Group (formerly Lucas Aerospace); and TRW Telecommunications.

Mergers/Acquisitions/Divestitures

Diesel Systems Sold. In January 2000, TRW completed the sale of its Lucas Diesel Systems and associated aftermarket business to Delphi Automotive Systems. The transaction is valued at approximately \$875 million before tax. As previously announced, the sale of this non-core business is part of TRW's overall strategy, following the 1999 acquisition of LucasVarity, to reduce debt by \$2.5 billion by the end of 2000.

Fabrication Unit Sold. In August 1999, Lucas Aerospace, sold its Burnley, UK-based fabrication business to MB Aerospace Ltd. of the UK, a subsidiary of Motherwell Bridge Holdings Limited. The amount of the sale is undisclosed.

SAMM Acquired. In June 1999, Lucas Aerospace purchased French flight systems supplier SAMM, a subsidiary of the PSA Peugeot Citroen group, for an undisclosed amount. According to TRW, the acquisition is part of the company's strategy to double its turnover and improve its global ranking from a top five player to top three player in a consolidating market. SAMM is a high-tech niche flight systems supplier serving Airbus Industrie, with a 1998 turnover of \$68 million and \$9 million operating profit.

TRW Sells Four Auto Units. In May 1999, TRW announced that it will divest the following four automotive operations: the engine businesses, consisting of TRW Engine Components and Lucas Diesel Systems operations; TRW Nelson(R) Stud Welding; and the LucasVarity Wiring companies. Net proceeds from these divestitures, estimated to be \$1.2

billion to \$1.5 billion, will be applied to reduce debt incurred to finance the acquisition of LucasVarity. The company has established a goal of reducing its net debt during the next 18 months by approximately \$2.5 billion, including divestiture proceeds.

LucasVarity Sells Heavy Vehicle Braking Business. In February 1999, LucasVarity plc completed the sale of its Heavy Vehicle Braking Systems (HVBS) division to Meritor Automotive Inc of the United States for £235 million (\$390 million) in cash. In LucasVarity's fiscal year 1997, HVBS had total sales of approximately £175 million (\$290 million) and net assets of approximately £65 million (\$110 million). Headquartered in Dayton, Ohio, it employs around 1,800 people and has seven production and technical facilities throughout the United States and Europe.

TRW Acquires LucasVarity. In January 1999, TRW and LucasVarity plc jointly announced that TRW would launch an all-cash tender offer to acquire all of the outstanding common shares of LucasVarity in a transaction that values LucasVarity at approximately \$7 billion. This was the largest cash acquisition in the history of the automotive supply industry. The offer, at £288 per share (approximately \$47.35), represents a premium of 41 percent over the closing share price of LucasVarity on December 31, 1998.

With total revenues of nearly \$19 billion, the combined entity will be an industry leader in integrated vehicle control systems and modules (which include steering, suspension, anti-lock brakes, traction control and active vehicle stability). TRW is already the global leader in most of its automotive products, including occupant restraint safety systems (airbags, seat belts, crash sensors, and "smart" systems). In addition, the technological capabilities and customer base of TRW's space, defense and information technology businesses will be enhanced with the addition of the LucasVarity aerospace business. The deal was completed in March 1999.

VarityPerkins Sold. In March 1998, LucasVarity completed the sale of VarityPerkins, which represents 100 percent of the Diesel Engines segment, to Caterpillar Inc of the United States for gross proceeds of £803 million in cash.

Teaming/Competition/Joint Ventures

TAECO. This is a joint venture with Taikoo Aircraft Engineering Company (TAECO) in the People's Republic of China. This venture, which commenced operations in 1996, is owned 65 percent by Lucas and 35 percent by TACEO. The goal of the operation is to repair and overhaul engine and flight-control systems, electrical power generation and other aerospace

equipment. In addition, a further joint venture was concluded during 1994 with the China National Aero-Technology Import and Export Company (CATIC) which will involve the manufacture in China of engine and flight-control systems, electric power systems and cargo-handling systems.

FiatAvio. In May 1993, Lucas signed a Memorandum of Understanding with FiatAvio of Italy under which the companies will collaborate on gear systems for helicopter transmission applications. The agreement will combine the individual strengths of both companies to produce advanced gear systems.

Sumitomo. Lucas has developed systems in partnership with Sumitomo of Japan for contracts with Mazda, Mitsubishi and Toyota. The company also has the same type of relationship with Tokico of Japan for contracts with Nissan.

SAGEM. A joint venture in engine management systems has been formed with SAGEM of France to strengthen support for existing clients.

Eaton Corp. Lucas Automotive and Eaton Corp had formed a joint-venture, which was intended to manufacture braking systems for commercial vehicles.

ECET. Lucas Aerospace is cooperating with ECET to supply its single Thyristor Ignition System in France. ECET handles the marketing of the Lucas system in France, and also the manufactures the system in France.

Lockheed Martin. Lucas Aerospace is involved with Lockheed Martin Missiles and Space of Company Palo Alto, CA, in the codevelopment of long-life cryogenic coolers for space applications.

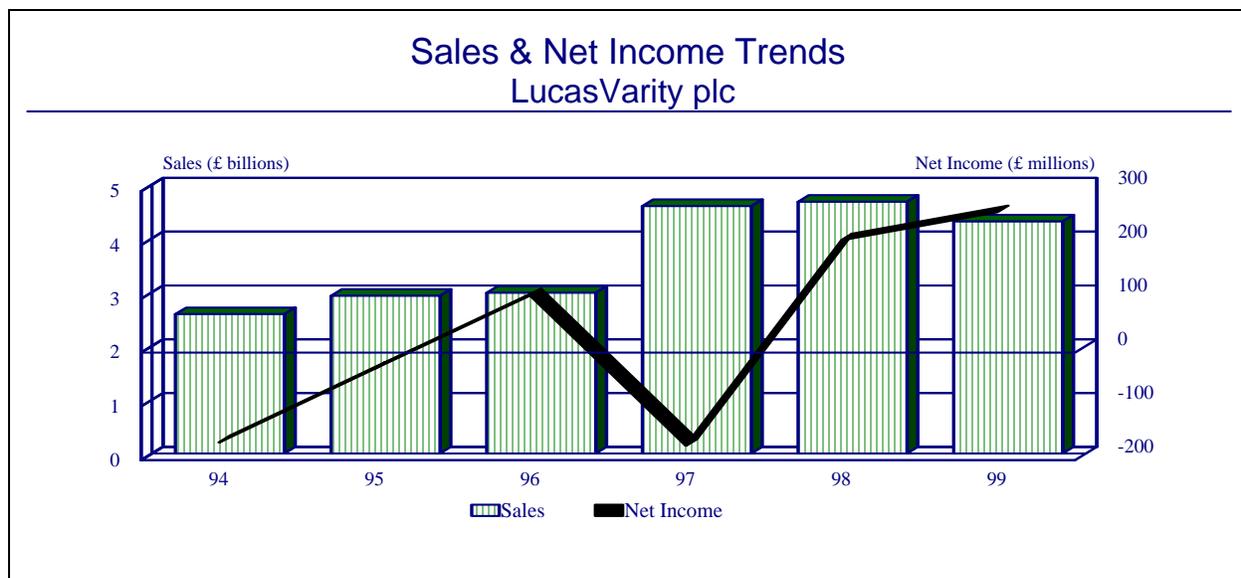
McDonnell Douglas/Honeywell. Lucas Aerospace is working closely with Douglas Aircraft and Honeywell to develop a smart actuation system for future aircraft. This new advanced flight-by-light system contains advanced smart quadruplex actuators. Signals from the Honeywell flight-control panel are sent via an optical ARINC 629 databus, which in turn receives inputs from the Douglas cockpit. These three companies have successfully demonstrated this system.

Vickers. Lucas was selected to participate with Vickers on the Canadair Regional Jet Integrated Motor-Pump packages. Lucas ElectroSystems Business unit designs and manufactures the electric motor which is to be integrated with Vickers' hydraulic pump to create the motor-pump package that supplies the aircraft with hydraulic power.

Financial Results/Corporate Statistics

For year ended January 31, 1999, (its final year as an independent company) LucasVarity posted net income of £261 on sales of £4.3 billion. The loss in 1997 is attributed to various costs associated with the Varity merger in late 1996. The loss in 1995 was due to costs associated with settling the dispute between Lucas Aul and the US Government. Latest-year statistics are provided below. US dollar figure translated as a 1998 average at the rate of £1 = \$1.6564.

Y/E January 31	1995	1996	1997	1998	1999	1999
(£ millions)						US\$
Turnover	2932.2	2988.6	4600	4681	4312	7142
Net Income	-30.0	106.3	-173.8	209	261	432

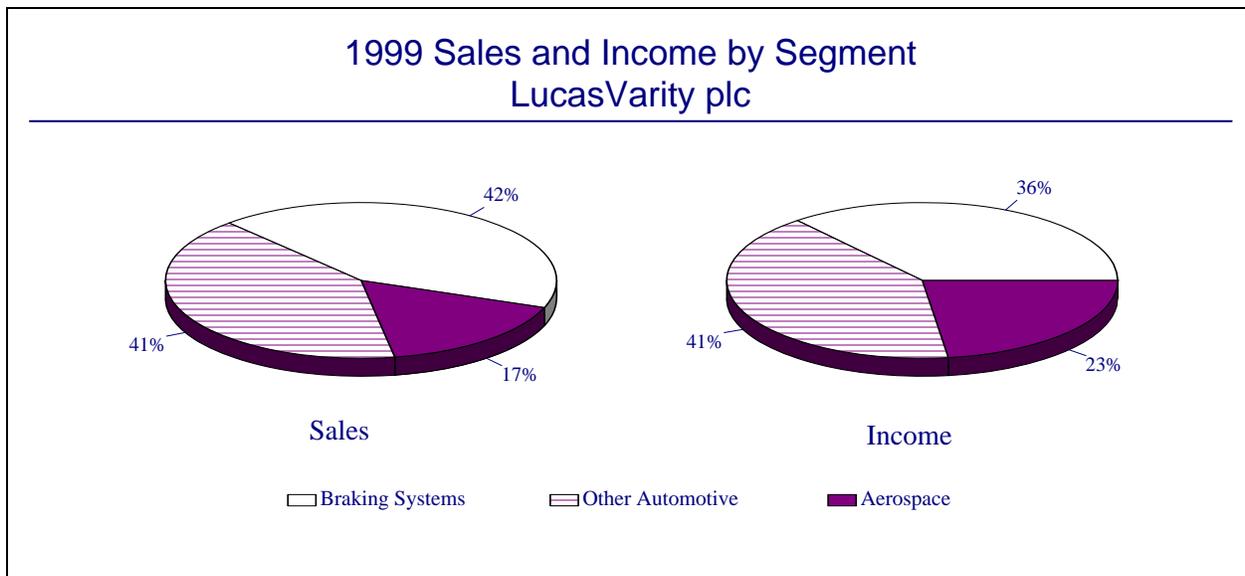


Industry Segments

A breakdown of the firm's sales and income by business segment is given below.

SALES	1996	1997	1998	1999
(£ millions)				
Braking Systems	1502	1554	1550	1808
Other Automotive	1771	1841	1812	1746
Diesel Engines (discontinued)	640	655	663	-
Aerospace	472	510	648	716
Corporate/Other	41	40	8	0
TOTAL	4426	4600	4681	4270

OPERATING INCOME	1996	1997	1998	1999
(£ millions)				
Braking Systems	116	121	134	149
Other Automotive	163	169	162	170
Diesel Engines (discontinued)	55	59	59	-
Aerospace	45	49	75	95
Corporate/Other	-60	-62	-29	-37
TOTAL	319	336	401	377



Strategic Outlook

A year after its \$7 billion acquisition by TRW, LucasVarity is now fully absorbed into its new parent company.

The original deal was primarily driven by the complementary nature of LucasVarity's and TRW's automotive business. In this industry the newly combined companies grab a commanding position with roughly \$13 billion in sales. With the addition to TRW of LucasVarity's product lines, the company's automotive growth will come from integrated vehicle control, including steering, suspension and anti-lock brakes; occupant safety restraint systems, including seat belts, steering wheels and air bags; and related electronics, aftermarket and fasteners.

With its newfound size, and the debt associated with such a transaction, TRW has, as expected, begun to divest some operations. As mentioned above, the driving force behind TRW's acquisition of LucasVarity was the automotive operations. LucasVarity's aerospace units were a nice coincidental fit. As TRW seeks to recoup some the cash it has expended in the past few years, the possibility of some form of asset sale is likely. So far TRW has announced that it intends to sell four non-core automotive units. Such a move may mean that the company intends to keep a presence in both the automotive and aerospace markets.

While TRW's aerospace and defense operations have shrunk due to the LucasVarity acquisition, the company maintains that it is committed to the field. According to company officials, TRW is committed to its highly profitable defense businesses, maintaining that defense and aerospace are integral elements of TRW and would not be sold.

TRW proved its point in mid-1999 when it announced the acquisition of French flight systems provider SAAM from Peugeot Citroen. This purchase is aimed at making the former Lucas Aerospace (now TRW Aeronautical Systems) a leader in the field of flight control systems. In addition to expanding the company's presence on the Continent, SAAM also provides TRW Aeronautical Systems with a foothold in the helicopter market, a market in which the unit had little presence before.

Over the years, TRW's management has shown that it is a willing and able participant in the defense industry. One of the key motivators for its commitment has been to help counterbalance the downturns in the automotive industry which is highly susceptible to the vagaries of the world economy. And although the acquisition is not a perfect synergistic fit with TRW's existing aerospace operations, many of which are "black" and thus cannot be exported, it may open up new avenues of growth in the industry.

Prime Award Summary

Unavailable

Program Activity

Business Interests. Some important aerospace and government programs currently under way at Lucas Industries plc are listed below. The briefs are intended to provide a listing of programs that are of major importance to the company. For detailed information or analysis of specific aerospace and defense programs or equipment, please refer to the appropriate FORECAST INTERNATIONAL binder (for example, AIRCRAFT, MILITARY VEHICLES, WARSHIPS, MISSILES, ELECTRONICS and GAS TURBINES). The company's activities encompass the following product areas:

- Braking systems
- Powertrain systems
- Electrical products and wiring systems
- Electronics and switch controls
- Aftermarket parts and switch systems
- Engine and electronics systems
- Flight control and actuation systems
- Aircraft systems
- Communications and electronics
- Customer support
- Fluid power systems and distribution
- Sensing and actuation electronic control systems
- Automated assembly and test systems
- Actuators for missiles

Aircraft Programs

N-250 Fly-by-Wire Control System

Lucas, together with Liebherr of Germany, has been assigned responsibilities for developing a fly-by-wire control system for the Indonesian-produced IPTN N-250 commuter aircraft. The 50-seater turboprop will have computer-controlled signaling to the flaps, ailerons, spoilers, elevators and rudder.

Airbus A320/321/330/340

Airbus Industrie's A320 and A321 are twin-turbofan-powered, narrowbody commercial passenger transport aircraft. Hispano-Suiza (in conjunction with Lucas Aerospace) provides the thrust-reverser assemblies. The A330 and A340 are twin-engine, high-capacity, medium-/long-range, widebody commercial transport aircraft. Lucas provides the A330 aircraft's slat transmission actuation system (through DASA/MBB and Liebherr). The company developed advanced digital control equipment for the main and auxiliary power-generating systems for the A330/A340 aircraft.

Jetstream 41

This is a privately sponsored development effort aimed at producing a 29- to 40-seat pressurized regional/commuter passenger transport aircraft. Deliveries began in 1993. Lucas provides the starter/generating system for the Jetstream.

EH-101

This is a joint European program for three-engine, medium-lift, multirole military and commercial transport and special helicopter development. Development is being undertaken by EH Industries Ltd (EHI), a company jointly controlled by Costruzioni Aeronautiche Giovanni Agusta SpA and Westland Group plc. Full-scale engineering development is under way. This helicopter was expected to be in service by the mid-1990s. The UK Royal Navy has placed an order for 44 EH-101 Merlin anti-submarine warfare (ASW) helicopters, with service entry planned for 1999. The Canadian government has canceled its order for 43 EH-101s. Order for 16 by the Italian Navy is pending. Lucas/Magneti Marelli provide the electrical generating system. Lucas Aerospace also produces the aircraft's electric blade de-icing system.

F-16 Fighting Falcon

This single-engine, single-seat, high-performance fighter/attack aircraft is one of the United States' longest running aircraft production programs. Lucas Aerospace provides subcomponents to this aircraft.

F-22 Advanced Tactical Fighter (ATF)

This is the single-seat fighter, powered by twin augmented turbofan engines, being developed as a follow-on to the current generation of air superiority aircraft. The prime contractors are Lockheed Aeronautical Systems Co, Burbank, California; General Dynamics, Ft. Worth, Texas; and Boeing, Seattle, Washington, USA. Demonstration/validation was completed in December 1990. The Lockheed team was selected in early 1991 to enter full-scale development. This aircraft is expected to be operational by the beginning of the next century. Lucas will provide the nose wheel steering unit.

JAS 39 Gripen

This is Sweden's next-generation single-engine, single-seat, all-weather, multirole, high-performance combat aircraft. JAS Industry Group, a Swedish consortium consisting of Saab-Scania AB, Saab Aircraft Division

(65 percent), Volvo Flygmotor AB (16 percent), Ericsson Radio Systems AB (15 percent) and FFV Aerotech (four percent), is manufacturing this aircraft. Deliveries began in 1994. Lucas provides the Gripen's auxiliary/emergency power system and rotary actuators for leading edge flaps.

Eurocopter/Kawasaki BK.117

This is a six- to ten-passenger, twin-engine, single-main rotor commercial utility helicopter. DaimlerChrysler Aerospace manufactures this helicopter. Production is continuing in Germany and Japan. The BK.117M is an armed gunship variant. The aircraft can be fitted with eight Euromissile HOT launchers; a SFIM APX-M 397 roof-mounted, stabilized sight; and digitized weapon electronics. A Lucas chin-mounted turret, housing a Browning 12.7 mm automatic machine gun, is controlled by a helmet-mounted sight. The gunship model is fitted with a high-skid landing gear to accommodate the gun turret. Most recent M offers the FZ-100 system including a Crouzet reflex sight, and an SFIM stabilized optical sight for the copilot/gunner.

SAAB 340 and T-4

A pressurized twin-turboprop, 30- to 37-passenger regional/commuter transport aircraft. Saab-Scania AB produces the aircraft, and the avionics equipment available for the Saab 340 includes a Lucas Aerospace electroluminescent flight deck instrument-panel array. Lucas also supplies the fly-by-wire flight-control system through Sumitomo of Japan for the Kawasaki Heavy Industries-produced twin-turboprop-powered, tandem-seat intermediate/advanced military training T-4 aircraft for the Japanese Air Self-Defense Force.

Panavia Tornado

Panavia Aircraft GmbH manufactures this twin-engine, two-seat, high-performance, all-weather multirole strike and air combat fighter. Lucas/Siemens provide the integrated electric drive system. The Tornado is produced by Panavia Aircraft GmbH, Munich, Germany, a consortium consisting of British Aerospace plc (42.5 percent); DaimlerChrysler Aerospace (42.5 percent); and Aeritalia Societa Aerospaziale Italia SpA (Alenia) (15 percent). British production is at Preston, Lancs; German production was at Munich; Italian production is at Turin. Some 946 aircraft had been produced and another 48 for Saudi Arabia will be manufactured through 1999.

UH-60/S-70 Black Hawk

This is United Technologies Corporation, Sikorsky Aircraft's primary-production twin-engine, single-main rotor, medium-lift military transport helicopter. Production is still continuing in the US. Lucas Aerospace provides the high-performance hoists.

B-737/757/767

Lucas supplies actuation systems for various aircraft. In April 1992, Boeing awarded a contract to Lucas for thrust-reverser synchronous locking mechanisms. This new system will prevent future in-flight deployment of thrust reversers. These thrust reversers will be used on selected engines powering Boeing 737, 757 and 767 aircraft.

Electronic Programs

PRC-77

This is a man-portable, short-range VHF FM receiver/transmitter being produced by Lucas. These combat radios are used for manpack and vehicular applications, and are in service with the US Army and Marine Corps, and other armed forces overseas.

Engine Programs

AlliedSignal LTS 101

This is a two-shaft, axial-centrifugal flow free turbine turboshaft engine. The prime contractor/manufacturer is Textron Inc, Textron Lycoming (formerly Avco Lycoming Williamsport Division). Lucas Aerospace is a major subcontractor. Production is continuing for civil and military helicopters in the four-tonne class. A single annular reverse-flow combustor is equipped with eight atomizing fuel nozzles. Dual ignition systems have been provided by AlliedSignal Aerospace Company Bendix Engine Controls Division and Simmonds Precision Products Inc, with SL Industries SL Auburn, Cooper Industries Champion Spark Plug Division. Lucas Aerospace SDS3000 Full Authority Digital Electronic Control (FADEC) system is available for improved LTS 101-750s.

Allison AE 2100

This is a large single-shaft axial-flow free turbine turboprop engine designed for large regional/commuter transport aircraft and military intra-theater transports. The Allison Engine Company AE 2100 engine (previously designated GMA 2100) is based on the Allison T406 engine developed for the Bell/Boeing V-22 Osprey tilt-rotor aircraft. Included in the new engine is a Full Authority Digital Engine Control (FADEC) system from Lucas, with the system controlling both the engine and the propeller. The engine is in series production.

Allison GMA 3000 Series

This is a single-shaft, all axial-flow aviation turbofan engine series for short-haul airliners and large business jets. The first prototype engine was delivered to EMBRAER at the end of 1991. The engine has been selected to power the Cessna Citation X aircraft.

Accessories are grouped under the forward compressor casing for ease of access. A Lucas Aerospace Full Authority Digital Electronic Control (FADEC) system is standard equipment.

Allison T406

This is a single-shaft, axial-flow, front-drive free turbine turboshaft engine variant of the Allison T56/501. The prime contractor and manufacturer is Allison Engine Company, with Lucas Western as a major subcontractor. Flight testing is continuing, and the engine is considered production-ready for heavy commercial and military aircraft. The T406 utilizes two Lucas independent Full Authority Digital Electronic Controls (FADECs), with analog backup, to manage the engine fuel. All controls are integrated with the V-22's control system via 1553 databus. An Engine Monitoring System (EMS) is integral to the aircraft's Vibration Structural Life Engine Diagnostics (VSLED) system. The engine incorporates a self-contained lubrication system, featuring scavenging pumps, three-micron filtration, quantitative debris monitoring and a bottom-mounted all-attitude oil reservoir with service scuppers on both sides of the powerplant.

ASEA Brown Boveri GT10

This is a two-shaft, axial-flow, heavy-duty industrial gas turbine. The prime contractor/manufacturer is ASEA Brown Boveri Ltd. Production is continuing for industrial and utility power generation applications. Mechanical drive applications are projected to rise. The Type 10 has a single straight-through annular high-efficiency combustor design, with 18 individual burners spaced around the head of the combustor. Lucas Aerospace provides combustors and fuel injector nozzles, which can handle a wide variety of fuels and permits changeover under load.

BMW Rolls-Royce BR700 Series

This is a two-shaft, high-bypass-ratio aviation turbofan engine family for business jets and regional jetliners. The prime manufacturer is the BMW Rolls-Royce GmbH consortium. Lucas will provide the accessory-mounted gearbox.

Lucas CT 2106

This is a two-shaft, centrifugal-flow Gas Turbine Starter/Auxiliary Power Unit (GTS/APU). The prime contractor/manufacturer is Lucas Aerospace Ltd, Power Systems Division (UK) with assistance from Lucas Industries Inc, Aerospace Division (USA). This system is in series production for the AV-8 Harrier line of aircraft.

Fa.150 Argo APU

This is a small, twin-spool, centrifugal-flow gas turbine machine/engine. The prime contractor/manufacturer is Fiat Aviazione (Fiat Avio) SpA. The system is currently in production. The engine was originally created by Plessey of the UK. It is designed to be very rugged, compact, modular and completely self-contained; it is applicable to airborne or ground auxiliary power-generation systems. The engine produces a maximum 142 shp, and total air mass flow is reported to be 1.78 lb/sec (0.81 kg/sec) at sea level standard day temperature. Fuel flow is 184.8 lb/hr maximum (83.8 kg/sec) with the fuel-control system provided by Lucas Aerospace. The accessory section is also of modular design; its 15 separate accessories can each be replaced in 15 minutes. The APU can be started hydraulically or electrically. The FA.150's axial turbine drives a centrifugal compressor, which supplies bleed air for starting the AMX aircraft's Rolls-Royce Spey Mark 807 engine, as well as a 5 kW generator.

General Electric GE36

This is an advanced counter-rotating, unducted, pusher-type propfan powerplant system. The prime contractor/manufacturer is General Electric Company USA, GE Aircraft Engines. Activity in the program will revive when market conditions improve – or when fuel prices begin to rise dramatically. In May 1985, GE and SNECMA had signed an agreement giving the French company a 35 percent share in the overall program. Under the agreement, SNECMA was to become involved in engine design. In June 1987, SNECMA announced that it was entering into a revenue-sharing agreement with AlliedSignal Inc, AlliedSignal Aerospace Company's Bendix Engine Controls Division, South Bend, IN, USA, to develop and produce the hydromechanical fuel-control unit for the engine. In October 1987, an agreement between GE and the Dowty Group's Dowty Rotol Ltd was announced, whereby the two firms would collaborate in a joint program covering the design, development and manufacture of composite fan blades for the GE36. Other firms involved in the engine effort are Lucas Western's Applied Technology Division, City of Industry, CA, USA, for the gearing mechanism; Moog Inc, East Aurora, NY, USA, for actuators; Timken Company, Canton, OH, USA, for tapered roller bearings; and Woodward Governor Co, Rockford, IL, USA, for pitch drive units.

IAE V2500

This is a two-spool, axial-flow, advanced-technology high-bypass-ratio aviation turbofan engine. The prime contractor/manufacturer is International Aero Engines AG (IAE). This engine is in series production for large commercial and transport aircraft. All accessories are grouped under the fan module. Accessory contractors include: gearbox design and production by Fiat Aviazione; Full Authority Digital Electronic Control (derived from the unit aboard the PW2037) by Hamilton Standard; gear-type fuel pump by Sundstrand/Tijin Seiki (STS); and fuel controls by Lucas. Three main bearing compartments: front (nos. 1, 2 and 3); center (no. 4); and rear (no. 5).

Pratt & Whitney Canada JT15D

This is a two-shaft, axial-centrifugal, medium-bypass-ratio aviation turbofan engine. United Technologies Corporation, United Technologies Pratt & Whitney Canada is the prime contractor. This engine is in series production for small executive/commuter jets and light military aircraft, including models from Cessna, Mitsubishi and Beech aircraft.

The JT15D has a fully annular reverse-flow combustion system with outer casing of heat-resistant steel and flame tubes of nickel-based alloy. SL Auburn or Champion igniter plugs and UNC (formerly Bendix) or Lucas Aerospace exciters. The accessory drive gearbox, mounted under the front casing, is driven by a bevel gear shaft from the HP compressor shaft. The fuel pump delivers fuel through a fuel-control unit, flow divider and dual manifolds. Integral oil system with gear-type oil pump. Starting is by air turbine starter or electric starter/generator. Fuel control system by Aviation Electric, Hamilton Standard (electrical control unit and hydromechanical unit) or Bendix Avelex; Sundstrand, TRW, Vickers or Argo-Tech fuel pump; Lucas-Rotax or Lucas flow dividers.

Pratt & Whitney Canada PW100 Series

This is an advanced-design, two-spool, centrifugal-flow, free turbine turboprop engine. The prime contractor/ manufacturer is United Technologies Corp, United Technologies Pratt & Whitney Canada. Major subcontractors include Lucas Aerospace Ltd Power Systems Division. A single annular, reverse-flow combustor designed for high-temperature operation is composed of sheet metal liner and outer liners with 14 piloted, air-blast atomizing fuel nozzles. PW115 and PW120 for the EMB-120, Dash 8, and ATR-42 are supplied with Simmonds dual output ignition units, while the PW124 for BAe ATP and Fokker 50 incorporates Lucas Power Systems' high-energy ignition exciters.

Pratt & Whitney Canada PW901A

This is a twin-shaft, centrifugal flow, free turbine gas turbine airborne auxiliary power unit (AAPU). The primary contractor/manufacturer is United Technologies Corp, United Technologies Pratt & Whitney Canada. Among the major subcontractors is Lucas Aerospace Incorporated Power Systems Division (which supplies the electric start motor). PW901A is in series production to fulfill the need for heavy, wide-bodied commercial and military transport aircraft.

Rolls-Royce RB 211

This is a three-spool, high-bypass-ratio aviation turbofan engine designed and produced by Rolls-Royce plc, Civil Engine Group. The RB.211-524G, -524H and -535E4 are in series production. These engines are for large commercial transport aircraft (and possible military variants thereof). The single annular chamber includes a steel outer casing and a nickel-based Nimonic alloy liner. Combustion is by 18 airspray atomizing burners. Ignition is by two Lucas high-energy ignition units with SL Auburn plugs in No. 8 and No. 12 burners. The -535C-37 is certified with two Simmonds Precision ignition units. The steel annular jet pipe is equipped with a target-type thrust reverser. Rolls-Royce supplies the entire engine pod, complete with thrust reverser and accessories. New -524 and -535 engines use cascade reversers from Lucas. The -535 employs a new fan, core exhaust mixer. The RB.211-22B and 524 series use a Lucas FFR 101-105 fuel control system, with a Lucas combined high-/low-pressure fuel pump type PAC 101. Accessories are grouped under the fan casing and driven by a radial drive from the HP shaft. The -535C/E4 is certified with a Woodward hydromechanical fuel control. Dunlop Aviation Division supplies IP and HP bleed valves and solenoid control valves for -524G/H.

Rolls-Royce Industrial RB.211

This is a two-spool, simple-cycle, axial-flow aero-derivative industrial gas turbine machine and gas generator. The prime manufacturer is Rolls-Royce plc, Industrial and Marine Division. This engine is in serial production for use in electrical power generation, mechanical drive, to include gas compression. Marine propulsion is proposed. The RB.211 has a single fully annular combustion chamber with steel outer casing and Nimonic 263 liner. Eighteen airspray burners with atomizers. Dual Lucas high-energy ignition units with General Motors Corp AC Rochester Division plugs in #8 and #12 burners. A gaseous fuel system is supplied by Rolls-Royce in Canada.

Rolls-Royce Spey/Tay

This is a two-spool, low-bypass-ratio, axial-flow augmented/nonaugmented aviation turbofan engine being manufactured by Rolls-Royce plc, Civil Engine Group. This engine is for light/medium civil transports, military transports and attack/fighter aircraft. Typically, the fuel system includes a Plessey LP pump, Marston Excelsior fuel heater, and a Lucas fuel-control unit. Ten straight-flow burners are housed in a steel annular casing, each with a single duplex nozzle and Nimonic flame tube. High-energy ignition units in chambers 4 and 8 by Lucas or Bendix Avelex; igniters by Lucas or SL Auburn.

Rolls-Royce Turbomeca Adour

This is a two-shaft, axial-flow, augmented/nonaugmented aviation turbofan engine being developed/produced by Rolls-Royce Turbomeca. This engine is in series production for military fighter/attack/trainer aircraft. Accessories are grouped under the high-pressure compressor case at approximately 150 degrees. Gearbox is driven via a tower shaft and bevel gear system off the high-pressure shaft just forward of the compressor. Integral starter/generator and fuel system supplied by Lucas Aerospace, including fuel control and pump.

Rolls-Royce Turbomeca RTM 322

This is a two-shaft, axial-centrifugal flow, free turbine turboshaft engine. The prime contractor/manufacturer is Rolls-Royce Turbomeca Ltd. Full-Scale Engineering Development phase nearing completion. This system will be used by medium/heavy civil and military helicopters. The combustor is an annular reverse-flow type unit with a possibility of future incorporation of GE-type short rolled ring combustor for length reduction and durability. Lucas ignition. SFC at max continuous thrust is approximately 0.444 lb/hr/shp (270 g/kWh). The accessory gearbox is top-mounted, connected to the front of the compressor via a tower shaft and bevel gear system. Lucas/ELECMA SDS 500 Full Authority Digital Electronic Control (FADEC) is mounted just behind the accessory gearbox to one of the mounting pads. Engine has two main engine anti-friction bearings and chambers.

Solar Mars

This is a two-shaft, axial-flow industrial gas turbine machine. The prime contractor/manufacturer is Caterpillar Inc, Solar Turbines Incorporated. This system is in production for mechanical drives, including gas compression and pumping, and electric power generation. A single annular combustor uses the vortex principle to premix fuel and air to achieve low emission. Firing temperature about 1,800°F (982°C). Combustor, which was developed in conjunction with Lucas of

England, has 21 externally replaceable fuel injectors. Borescope ports. Liner is Hastelloy X, casing is 410SS.

Military Vehicle Programs

Automotive Components

In the automotive sector, Lucas manufactures braking systems, powertrain systems, electrical products and wiring systems, electronics and switch controls, aftermarket parts and switch systems.

Armored Vehicles

Lucas products can be found in the Chieftain, Centurion tank, Challenger 1 tank, AMX 10RC armored vehicles, Warrior armored vehicle, AMX 30 tank and the M113 armored personnel carrier.

FV4034 Challenger

This is the British Royal Army's primary main battle tank. The Challenger was initially developed and manufactured by Royal Ordnance. Vickers Defence Systems now is responsible for Challenger production and the development of Challenger 2 at its facility at Leeds, Yorkshire, United Kingdom. In the original Challenger, a David Brown Vehicle Transmissions TN37 epicyclic gearbox is used; this unit has four forward and three reverse gear ratios. Borg-Warner supplies the torque converter while Lucas provides CAV gearbox-management system.

Missile Programs

AAAM

This is to be the US Navy's new long-range air-to-air missile. Presently, this contract is being competed between teams of the H & R Company, a joint venture of General Motors Corporation Hughes Aircraft Division and Raytheon Corporation Missile Systems Division, and a contractor team of General Dynamics Corporation Pomona Division and Westinghouse Corporation Defense and Electronics Division. Lucas Aerospace is a major subcontractor to the H & R Company team.

Aim-7 Sparrow

This is a medium-range air-to-air missile system developed and produced by Raytheon Company Missiles Division. Raytheon is the prime contractor for the overall system, airframe, and guidance and control section. Lucas Aerospace is a major subcontractor producing rocket motor cases.

AGM-88 HARM

This is the United States armed forces' standard high-speed anti-radiation missile, developed and produced by Texas Instruments, Lucas Aerospace, Electric Actuators Division, Hockley, Birmingham, United Kingdom,

supplies the system's actuators. Production is continuing, and will probably be extended due to the expected award of a major supplemental buy by the US Defense Department.

Alarm

This is the United Kingdom's newest anti-radiation missile, developed and produced by British Aerospace Dynamics Group, Air Weapons Division. As one of the main subcontractors, Lucas Aerospace provides the ALARM's standard fin control actuation systems.

ASRAAM

This is a next-generation short-range air-to-air missile system under development at British Aerospace. Lucas Aerospace will provide the missile's actuation system. British Aerospace will once again commence development of an advanced short-range air-to-air missile for the Royal Air Force (RAF) under a joint effort with Hughes. This program is no longer a multinational effort, but will produce a missile specifically for RAF requirements. Operational and technical problems have pushed back the in-service date for ASRAAM with the RAF back by a year.

Erint 1

This is a ballistic missile interceptor under development at Loral Vought Systems. Lucas Aerospace, Aurora, Ohio, is to provide the aerodynamics control actuators and control electronics (fins actuation system). Full-scale development of the system is under way.

MIM-104 Patriot

Lucas Aerospace provides the launcher actuation system for the Patriot air defense missile system. The Patriot is still in production. In 1992, Raytheon's Missile System Division had selected Lucas to supply the case and nozzle for rocket motors used in the Patriot missile.

Sea Skua

This British Aerospace system, a helicopter-launched, anti-ship missile, is currently in production for the British Royal Navy and export orders. Lucas Aerospace provides subcomponents for the Sea Skua.

Starstreak

This is a new high-velocity, short-range, surface-to-air missile system being developed by Short Brothers Ltd. Lucas Aerospace is among the company's major subcontractors. Production is under way.

Ordnance Programs

Multiple Launch Rocket System

This is a tracked multiple-launch rocket system. The European production effort is headed by MLRS Europäische Produktions Gesellschaft GmbH, located at Taufkirchen in Germany. The 227 millimeter Multiple Launch Rocket System is in serial production in the United States and Europe. The firms involved in the licensed manufacture of the 227 millimeter rocket include SNIA BPD Difesa e Spazio of Italy; Lucas Aerospace, ICM and Royal Ordnance of the United Kingdom; Dynamit Nobel, Diehl and DASA of Germany; and Société Nationale des Poudres et Explosifs and Aerospatiale of France.

Unmanned Vehicle Programs

Mobile Advanced Robotics Defence Initiative (Mardi)

An experimental tele-operated tracked robotic ground vehicle which is being sponsored by the Ministry of Defence through the British Defence Research Agency. British companies involved in this program include Alvis; British Aerospace; GKN Defence; Hunting Engineering; Lucas Aerospace; Marconi Radar and Command Systems; Northern Telecom; Royal Ordnance; SD-Scicon; Sema Group; STC; Vickers Defence Systems; Westland Dynamics; Whitton Group plc; and Bristol and Southampton universities. Demonstrations are being conducted. These demonstrations are expected to be followed by the development of technology to eventually produce an autonomous version.

Warship Programs

Stingray

This is an aircraft- or surface vessel-launched lightweight acoustic homing torpedo tasked with the destruction of submarines. Marconi Underwater Systems Ltd and British Aerospace are the primary contractors. Lucas Aerospace is a major subcontractor. This torpedo is currently in service.

Tigerfish

This is a submarine-launched electrically powered acoustic homing torpedo tasked with the destruction of submarines. Again, the prime contractors are Marconi Underwater Systems Ltd and British Aerospace Naval Electronic Systems & Equipment Division. This system is in service. Lucas Aerospace is a major subcontractor.

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