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AEROSPACE

FRG's Rotex Space Robot for D2 Mission Described *93WS0336A Stuttgart BILD DER WISSENSCHAFT* *in German Mar 93 PLUS supplement pp 28-29*

[Article by Prof. Dr.-Ing. Gerhard Hirzinger: "A Robot With Touch"]

[Text] The Rotex hand is feeling its way to work. Besides the astronauts, a new type of robot "made in Germany" is part of the crew for the D2 mission.

The stated goal of manned space flight is to set up space stations. Probably, such stations will only be manned on a part-time basis. During the unmanned phases, the experiments then will run automatically or they will be remotely controlled from the ground. However, using robots to relieve astronauts from doing stereotypical work has advantages.

To relieve humans in space effectively or to be able to replace them, machines require a multifaceted sensory analysis system and a certain amount of intelligence. Polished remote control methods are necessary to operate these machines remotely from the ground.

We addressed this complex task for the D2 mission together with other German Aerospace Research Institutes, the Institute for Robot Research of the University of Dortmund, the Fraunhofer Institute for Production Systems and Construction Technology in Berlin, the University of Paderborn, and the companies Dornier, Erno-MBB, and Isra. The result is Rotex, the robot arm on board the space shuttle during the D2 mission. Rotex has six pivot joints as do most industrial robots. A wrist joint is part of the gripper and rotates the gripper about the axis of the robot arm.

The device is permanently installed in a closed chamber together with various pieces of equipment for experiments such as bayonet mounts and holders. Rotex is to control this equipment during the flight. The astronauts can access the module by way of a door. When the door is opened, an emergency shutoff system immediately shuts down the robot.

Our design provides two different modes for the space robot: one interactive control mode known as teleoperation, and program-controlled, automatic operation. In the first mode, an operator on board or on the ground issues control commands that are executed immediately. These commands specify a rough action for the robot. The robot then refines and executes this action under the control of its sensor control loops. For automatic operation, on the other hand, the robot has already been programmed for a task on the ground or it is run through the task in the teaching mode on the computer graphics system. The stored sequence can then be repeated on board as often as necessary.

During the D2 mission, Rotex will usually grasp a rigidly attached object to manipulate it. For example, this may be to open a bayonet mount, remove it, place it onto a mating piece and close it. Another task would be to grasp three blocks and place them one on top of the other. This handling of static objects corresponds to assembly tasks on earth. Grasping a free-floating object in weightless conditions has completely different requirements. During the D2 series of tests, it will be a block. During future applications, it may be a satellite that is to be brought into the cargo bay for repairs.

As the gripper moves toward an object, rangefinders respond and control the process. A laser sensor on the wrist determines, using angular measurements, the distance to an object up to 30 centimeters away. In the immediate vicinity starting at 3 centimeters, when the object is between the jaws of the gripper, four additional laser sensors per gripper jaw take over range finding. All objects in the vicinity of the robot and, of course, the robot itself, have been surveyed precisely. For this reason, the signal patterns are known.

In the case of static objects, position errors always result in the situation that the robot pushes with its gripper against the object, thus applying force. If, however, the robot knows from the set sensor pattern that it may not apply force in certain directions during this task, it changes the gripper position and the arm position until all undesired forces are reduced to zero.

Two different measurement methods serve this purpose. On the one hand, a ring of membranes with attached strain gauges are used. If the membranes flex due to a force, the length of the strain gauges changes thereby changing the electrical resistance. In the second system, light-emitting diodes emit light from the center of a ring radially outward. This light reaches position detectors after passing through apertures. The ring with the light sources and the rings with apertures and detectors are connected to one another by way of spiral springs. If a force acts on the inner ring, the light sources move. During this process, the points on the detectors migrate from their position of rest.

Both sensors are located in the wrist of the gripper. They measure the forces and moments acting on the hand. Measurement via the membranes is much more precise than the optoelectronic method. However, the construction is also much stiffer. The natural elasticity of the hand during gripping cooperates with the flexibility of the spring suspension system. For this reason, we also converted the same system into a compact form for an entry device used with the 3D computer graphics systems. The operator specifies motion in three spatial directions and rotations about the three axes using a track ball that contains the optoelectronic force-moment sensor.

Our sensors are compact, light and easy to combine. This is because we developed the modular systems using SMD technology (Surface Mounted Devices). This provides us with a compactness that could not be realized otherwise.

Modular sensory analysis systems mean that all sensors are built according to a common scheme and connect to one power supply and one data bus. This starts with its own processor that controls the operations and communicates with the master computer by way of a high-speed data bus.

To grasp an object floating in free space, the force sensors are initially useless. Indeed, our list of sensors on the gripper is not yet complete. Two miniaturized cameras on the wrist and two permanently mounted monitoring cameras outside the work cell show the operator on the earth what Rotex is doing. The two miniature cameras are to be incorporated into the modular system in the future. However, to do this, an image processing system must also be provided on board. With regard to the image sensors, Rotex must still include the ground station.

This addresses one problem that many people list as an argument in favor of fully automatic systems. The delay of a signal between Spacelab and the ground station is two seconds. The total dead time is thus at least four seconds. We are attempting to solve this problem in two ways. On the one hand, we make use of local control loops. On the other, however, our graphics control system calculates the situation in advance. The computer on the ground constructs an image of what the cameras and the other sensor will probably perceive in two seconds. This image is compared to reality as soon as the actual data have arrived. The sensory analysis system, however, is of no use if not provided with suitable drive systems. On the earth, a robot can usually move a maximum of one-tenth of its own weight. In space, weight is reflected in the transport costs. For this reason, we developed a new type of spindle system for the gripper drive. This system is low in weight and has extremely low friction while allowing high force transmission. In the meantime, it has been patented worldwide and is being used on the earth by a licensee. The great interest in this spindle drive system shows that there are still a few problems in the mechanical systems of robots.

A robot built to space standards by the Dornier company will fly in Spacelab. To save weight, its drives were designed with such close tolerances that it would collapse on the ground without a suspension system.

Until now, we have only been able to implement our designs for a new type of carbon-fiber light-weight structure for the astronaut training model. The use of carbon-fiber compound materials and the combination of control algorithms with neural nets will be part of a comprehensive new development that will be used in future missions. At the same time, it should give new stimulus to the robot industry.

Supplement

The author, Prof. Dr.-Ing. Gerhard Hirzinger, has been working for the German Aerospace Research Institute since 1969. There, he has been Co-director of the Institute for Robotics and System Dynamics since last year.

Financing of Major ESA Programs Examined

93WS0381A Bonn LUFT-UND RAUMFAHRT
in German Jan-Feb 93 pp 12-13

[Article under the rubric "Space": "ESA: Carrier-Rocket and Industrial Policy"; first paragraph is an introduction]

[Text] The ESA Council of Ministers session of 9-10 November 1992 met with considerable response (see LUFT-UND RAUMFAHRT, No 6, 1992) above all because of its resolutions on further planning for the Columbus and Hermes major programs. But beyond this the ESA ministers passed several additional, less spectacular resolutions on carrier-rocket and industrial policy within the scope of the long-range plan.

The commercial success of the Ariane carrier rocket family gave the ESA ministers little reason for radically changing the course followed. The Ariane "is of great importance strategically for ensuring Europe's independent access to space" and must be retained as an "essential part of Europe's space policy."

However, for obvious reasons (Deutsche Bundespost Telekom [German Federal Postal Service Telecommunications Service] had had its Kopernikus 2 launched by means of a Delta rocket), the member countries are being asked "to adhere to the principle of the priority use of the Ariane carrier rocket in their own missions and the missions of European and international agencies in which they take part." This expectation is also addressed to satellite operators that, as is Telekom, for example, are charged with covering the public demand (for telecommunications services, for example) of the partner countries.

The ESA ministers justify this by the declaration concerning the production phase repeated on 21 May 1992. The ESA's director general was thereby charged with making proposals for promoting in Europe "adherence to the principle of the priority use of the Ariane carrier rocket."

That European institutions like Telekom are returning to other carrier systems is due to their often more reasonable launching costs. Because ESA and Arianespace also have misgivings that these prices will not cover the costs, the ESA ministers are hurrying to conclude an agreement with the governments of the space nations concerned in order to ensure fair terms and conditions in the carrier rocket market.

As far as the further study of carrier rocket designs going far beyond the Ariane program is concerned (the Sanger, for example), the ESA ministers were very concise: The member countries are being asked to attend further to setting up a program for the investigation of future European space transportation systems, which is known by the acronym FESTIP [Future European Space Transportation Investigation Program]. A decision concerning starting the project would not be able to be made until then.

The ESA Council of Ministers also has to take a position on the more difficult question of the total return factor, which is to ensure that the industries of the member countries are to secure orders as much as possible at the level of the ESA

contributions of the country concerned. However, this ideal situation is very difficult to realize in certain programs, because sufficient industrial capacity is lacking in many countries. So, cases of exceeding and falling short happen as a rule.

Special steps have already been introduced to offset falling too short of the return factor. The ESA ministers are now authorizing for the period of 1991 to 1993 the thus far already accepted lower limit of 0.95, but they are setting it somewhat higher at 0.96 for the next three-year period of 1993 to 1996. But there is agreement that "as before, a total return factor as close as possible to the ideal value of 1 is to be aimed at for every country."

This perennial theme of ESA will surely become substantially more complex in the future if the countries of eastern Europe, primarily Russia, and Japan are included in new cooperation structures, as the ESA ministers are definitely encouraging.

The financing of ESA's major programs is still not totally guaranteed. While the Envisat-1/METOP-1 missions are completely subscribed for, there are still deficits for the DRS and Hermes programs (see below).

Envisat-1/METOP-1 Missions

Participant	Envisat-1 Mission, %	Preparation of METOP-1, %
Austria	1.00	1.00
Belgium	4.00	4.00
Denmark	0.5-1.00	0.5-1.00
France	25.00	25.00
Germany	17.40	18-22.00
Italy	12.00	16.00
Netherlands	2.14	4.60
Norway	1.30	1.50
Spain	7.00-8.00	7.00-8.00
Sweden	5.10	3.35
Switzerland	4.00	4.00
United Kingdom	21-25.00	14.60
Canada	2.7-5.00	-
Finland	1.20	-
Total	104.34-112.14	99.55-105.05

DRS Program

Participant	Stake, %
Austria	1.50
Belgium	4.00
France	20.00
Germany	12.00
Italy	45.00
Netherlands	2.00
Spain	Up to 4.00
Sweden	1.80
Switzerland	0.10*
United Kingdom	1.00
Finland	0.40
Total	Up to 91.80

*This stake corresponds to Switzerland's contribution of 2 percent to the earlier Phase 1 of the DRS part of the DRTM program.

Hermes Program

Participant	Stake, %
Austria	[0.50]
Belgium	5.80
Denmark	0.45
France	43.50
Germany	22.00
Italy	12.10
Netherlands	6.00
Spain	Up to 4.10
Sweden	0.50
Switzerland	2.00
Canada	2.00
Total	Up to 98.95

The financing has still not been settled above all for the Columbus program. According to ESA, proper completion will not be possible until after complete coverage.

Columbus Program

Participant	Docked Laboratory, %	Polar Platform, %	Preliminary Missions, %	Future Station, %	Average Stake in Overall Program, %
Austria	-	-	[1.00]	-	0.90
Belgium	3.80	9.45	5.00	3.02	5.00
Denmark	1.00	1.00	1.00	1.00	1.00
France	10.00	23.60	[10.00]	[20.00]	12.74
Germany	38.00	17.80	15.00	35.00	31.99
Italy	31.00	8.80	14.00	12.00	25.00
Netherlands	0.50	4.00	1.0-3.00	4.00	1.26-1.43
Norway	0.48	0.30	-	-	0.40
Spain	Up to 3.00	Up to 6.0	-	-	0-3.29
Sweden	1.00	1.00	-	-	0.90
Switzerland	-	-	[2.00]	-	0.18
United Kingdom	Up to 1.00	22.60	-	-	4.41-5.12
Total	Up to 89.78*	Up to 94.55	49-51.00	75.02	

*The contribution deficit was made up for as follows: a) by expense cutting to the tune of 5 percent of the overall financing of 2.5168 billion accounting units, and b) by voluntary extra contributions in order to raise the covered part to 95 percent of the overall financing. There is also agreement that the level of the contributions actually to be paid by the participating countries concerned in the period 1993-1995 will not be affected by the increase in contribution shares.

Germany: Launch Delays Threaten D2 Experiments

93WS0393B Frankfurt/Main FRANKFURTER
ZEITUNG/BLICK DURCH DIE WIRTSCHAFT
in German 16 Mar 93 p 8

[Article by "ap.": "Launch Delay Threatens D2 Experiments. DLR: The Biology Projects Above All Are Causing Concern"]

[Text] Cologne—The now already nearly four-week launch delay of the German D2 space mission is threatening some of the experiments painstakingly planned in many years of work. "If the spacelab has still not been launched on 21 March and the date happens to be delayed still further to 25 March, then a host of steps will be necessary," reports Manfred Keller, D2 project scientist at the German Research Institute for Aerospace (DLR) in Cologne.

The wait for the space shuttle's lift-off has substantial consequences above all for the time-specific experiments in the fields of biology and physics. For example, the scientists, in past weeks, had to breed again entire generations of tadpoles in very different stages of development in order to have ready recently hatched amphibians for the expedition under weightlessness.

The frog and fish larvae are to spend their first days of life absolutely in space, where they will be under constant observation. Experts expect to gain from this new knowledge concerning the adaptability to changed environmental conditions of the nervous system and sense organs of vertebrates—and accordingly of humans too. It can be problematic also for the many biology experiments with plant and animal cell cultures, bacteria, spores and fluids that for the most part have only a

limited life and are expected to have to be replaced up to the actual launch. The garden cress that the seven astronauts are taking along in a glass container for test purposes also numbers among the "short-lived material of the D2 mission."

But experiments in earth observation and mapping of the Milky Way will probably also have to be newly readjusted and rearranged up to the lift-off. That is to say, different angles of view are to be expected as the result of the earth's motion.

And still another difficulty is giving the scientific teams plenty of headaches: the chemical exchange of the test fluids in the containers in which they are being stored. For example, rubber material can so change over the course of time that it destroys cell cultures. Sodium ions could even separate from the surfaces of the glass containers that are filled with water and thus change the outcome of an experiment, if not possibly completely jeopardize it.

DLR's Space Robot To Be Tested During D-2 Mission

M13004130593 Munich SUEDEUTSCHE ZEITUNG
(UMWELT WISSENSCHAFT TECHNIK insert)
in German 25 Mar 93 p II

[Article by Tom Sperlich: "A Robot for the Rough Work—An Artificial Arm Will Be Tested During the D-2 Mission"]

[Text] An astronaut in the control station on earth uses a computer monitor to control a robot carrying out maintenance tasks on the outside of the space station. An everyday occurrence in space in 2013? The ground work

for robots in space is already under way. The ultimate aim is an intelligent robot that will mount and repair parts fully automatically without human supervision or, for example, collect space debris.

The intention is for at least one robot to support the astronauts in their routine work in the Columbus laboratory on the international space station Freedom. The first robot in space is Rotex, a gripper arm, developed chiefly by the German Aerospace Research Institute (DLR) in Oberpfaffenhofen near Munich, and by Dornier. Rotex, which is to be tested during the D2 mission, will perform tasks like connecting and disconnecting plugs, assembling and dismantling mechanical parts, and grasping free-floating objects—skills needed for recovering a satellite, for example.

Rotex operates in two different ways: Firstly, the robot arm can move automatically in response to a program-controlled instruction. The robot has several procedures stored in its memory, which it can repeat to order on board. Alternatively, Rotex can be controlled directly—"interactively"—by a human operator on earth or in space. In the latter case, a graphical representation of the artificial arm is displayed on a computer screen in the DLR control station. When observed through special spectacles, the robot appears to be three-dimensional. These stereo spectacles are also used by the astronauts in space, who use a small TV monitor and a special controller to control the arm's movements. The controller, which is also used in the earth station, is a type of control sphere that can be rotated in all directions.

One problem that arises when the robot arm is controlled from earth is the time lag. It takes two seconds for a signal from the Spacelab to reach earth, so it takes at least four seconds for the controller on earth to react and send up a command. In order to overcome the time lag, the scientists at DLR use a trick. Graphic control calculates the situation in advance, then the computer produces an image of what cameras and other sensors will probably see two seconds later. This image is compared with reality as soon as the actual data are received.

"We also use the reported movements and sensor signals from the real system to improve the simulation and make it more realistic—thus creating a closed circuit," explains Gerhard Hirzinger, director of the DLR's Institute of Robotics and System Dynamics. "With telesensor programming, also known as learning-by-showing, the robot is taken through all the planned procedures by computer graphics. All the relevant data are stored and sent into space, and the precision work is ultimately left to the robot."

The reason is that all the control processes cover only the approximate robot positions, while the robot carries out precision path planning via its local sensor feedback system. The DLR's multi-sensor system, which is built into the robot's arm, is composed of laser sensors in the "hand" and "fingers" that measure the distance from an object,

and a minute pair of cameras that provide the robot with a three-dimensional image of its surroundings.

Franco-Russian Altair Mission Described

*93WS0399A Paris AFP SCIENCES in French
1 Apr 93 pp 7-11*

[Article entitled: "A Week's Training in France for the Cosmonauts of the Fourth Franco-Russian Space Flight"]

[Text] Paris—The Toulouse Space Center hosted the six cosmonauts of the Franco-Russian Altair mission, who came to complete their training for the fourth joint flight scheduled aboard the Mir next 1-22 January, from 29 March to 4 April.

The five men—four Russians and the Frenchman Jean-Pierre Haignere—and Claudie Andre-Deshays, who will be the first French female cosmonaut to travel in space in 1996, will familiarize themselves with the apparatus of the 13 experiments devised in France and scheduled to be conducted during the three-week mission.

Besides Jean-Pierre Haignere, the regular crew includes the Russian Vasiliy Tsibliyev, captain, who will be making his first flight, and Alexander Serebrov, flight engineer, who has already traveled three times in space. The deputy crew consists of Viktor Afanassiev, captain, who spent 175 days aboard the Mir in 1990-91, Yuri Oussachov, flight engineer, and Claudie Andre-Deshays.

The two French nationals are responsible for the experiments planned for Altair and for the following mission, Cassiopee, in 1996. The National Center for Space Studies (CNES) will pay the Russian consortium Energiya 165.75 million French francs [Fr], Fr127.5 in cash and Fr38.25 in complementary services, for the two flights. They were negotiated in 1991-92, and are part of a set of four joint missions planned between now and the year 2000.

The sum, says French project head Lionel Suchet, covers the payload of the Altair mission (Fr17.85 million), which is already aboard; Fr15.3 million worth of equipment, notably computer hardware, purchased to enable Energiya to re-equip Mir and its successor Mir-2; and Fr5.1 million in CNES contract obligations. The cost of the following flights has not yet been decided and is under discussion, Jean-Loup Chretien, director of astronauts at the CNES, told the AFP.

The Altair mission "is consistent with the Michel Tognini flight of last year and the CNES's long-term program to prepare lengthy flights," explained Jean-Pierre Haignere. "Our training in the Hall of Stars is moving ahead under the best possible conditions; the turpitudes of Russian life right now are not interfering. We are lucky to have a well-defined goal and access to resources. Hall personnel are very motivated, very devoted."

At the present time, 25 cosmonauts, including two women, Mrs. Andre-Deshays and the Russian Elena Kondakova, are training at the Hall of Stars for flights scheduled over the next three years. Russia's third female cosmonaut is slated to make a six-month flight next year aboard Mir, indicated General Evgeniy Diatlov.

The assistant director of the Hall would like to see the Russian cosmonaut training center used not only by the French, but by the ESA and other countries. Moreover, the general added, Russia plans to use, concurrently with Baikonour in Kazakhstan, the four launchpads of the Plesetsk base for manned flights launched by the new Rousset rocket. In particular, launches there will involve orbits with 65-degree inclinations, like the Mir 2's. But there is one problem with using the Northern cosmodrome: It does not yet have all the necessary training and mission-monitoring equipment.

Finally, General Diatlov and the Russian cosmonauts indicated that the orbital complex, which is built around Mir and the Spectra and Priroda modules, would not be enlarged before the Altair mission. The station will, however, be outfitted with several new gyroscopes to save fuel.

Altair Mission Experiments

Permanent experiments begun during the Antares mission and continuing until the end of the Altair mission

"Nausicaa" Experiment

Project heads: Marc SIEGRIST, CNES Nguyen VANDAT, Atomic Energy Commission/IPSN [Nuclear Protection and Safety Institute]

Nausicaa aims to describe the biological effect of radiation inside the station, to assess the radiological risks during lengthy flights. What makes the experiment original is its use of a sensor that simulates a portion of the human epiderm. Data are transmitted to the ground regularly via telemetry.

"Exeq" Experiment

Project heads: Didier FALGUERE and Sophie DUZELIER, Toulouse Research Center (CERT)/National Office of Aerospace Studies & Research (ONERA), Toulouse

Evaluation of heavy ion flows and study of their effect on electronic components (microprocessors and SRAM and EEPROM memories).

The French cosmonaut on the Altair mission will bring back the "Exec" information.

ANTARES Experiments Adapted for ALTAIR

"Orthostatism" Experiment

Project Heads: Olivier MARSAL, CNES Professor Philippe ARBEILLE, Medical Biophysics Laboratory, Tours School of Medicine Professor Claude GHARIB, Environmental Physiology Lab, Lyon School of Medicine

Study of the effects of weightlessness on cardiac function, arteries, and veins.

Assessment of the consequences of these disturbances on cosmonauts' readaptation to terrestrial gravity (upright position = orthostatism).

Several days exposure to weightlessness causes vascular deadaptation that leads to hypotension, even syncope, when the cosmonaut changes his position (sitting or standing) once back on earth. To combat and reduce the problem, cosmonauts use LBNP (Lower Body Negative Pressure) in flight, which simulates terrestrial gravity in the arteries and veins of the legs and gradually reeducates the cosmonaut.

Hemodynamic investigations are rounded out by the study of the hormone mechanisms involved in human adaptation to weightlessness (blood and urinary dosage). To reduce the number blood samples taken, a dosage system for hormones in the saliva is used.

"Illusions" Experiment

Project Heads: Guy LEGRAND, CNES Jean-Pierre ROLL, Human Neurobiology Laboratory, Marseille School of Saint-Jerome.

This experiment will study the human nerve mechanisms that are responsible for the adaptation of sensory-motor functions and body representation under microgravity.

Vibrations are applied to the tendons of the nape, legs, and arms to excite neuromuscular spindles.

Instruments are used to analyze the effect of vibrations, to study:

- postural motor responses (spontaneous movement of the subject)

- body movement sensations (postural illusions)

- apparent movements of light targets (visual illusions)

"Viminal" Experiment

Project Heads: Yoani MATSAKIS, MEDES Professor Alain BERTHOZ, Paris Neurosensory Physiology Laboratory

This experiment looks at how weightlessness affects the perception of body orientation in space.

An example: If a cosmonaut sees another cosmonaut in a position opposite to his, he can suddenly get the sensation that his own head is pointing downward. The sensation is sometimes disagreeable and can help trigger space sickness.

In other cases, the cosmonaut no longer recognizes a visual scene that, on the ground, would have been

familiar to him. One strategy is to mentally rotate the visual scene to a more typical orientation.

In so doing, he will more accurately reconstruct his orientation inside the station.

"Biodose" Experiment

Project Heads: Marc SIEGRIST, CNES, Laure SABATIER, Atomic Energy Commission (Fontenay-aux-Roses), Jean CADET, Atomic Energy Commission (Grenoble)

Fibroblasts (bioproducts) are placed aboard and then analyzed upon their return, to evaluate possible damage to genetic material from cosmic radiation.

"Immunology" Experiment

Project Head: Didier SCHMITT, Toulouse School of Medicine

Study of the adaptation of the immune system during space flight.

"Alice" Experiment

Project Heads: Jean-Marc LAHERRERE, CNES, Dr. Daniel BEYSSENS, Atomic Energy Commission (Saclay)

Study of different fluids—CO₂ (carbon gas) and SF₆ (sulfur hexafluoride)—during phase change (for instance, when CO₂ changes from liquid to gas, then from gas to liquid). The study will be performed under pressure, temperature, and concentration (critical point) conditions under which the fluids' physical constants (thermal diffusion, compressibility, etc.) behave in ways peculiar to them.

The consequences of these phenomena are difficult to observe on the ground, where the fluid is crushed under its own weight.

"Microaccelerometer" Experiment

Project Head: Yves DANCET, CNES

This experiment has three objectives:

- First, to characterize the dynamic parameters of an "Adele" type arm for the deployment of large space structures (solar panels, for instance);
- Second, to establish a vibration map of the Mir station;
- Third, to record video and technical information for use in other experiments ("Alice" and "Illusions").

Two data-collection electronic units, combined with microaccelerometer sensors and cameras, will be used.

New Experiments

"Synergies" Experiment

Project Heads: Jean MASSION, Motion Neurobiology Laboratory (Marseille) Thierry POZZO, Athletic Performance Research Laboratory (Dijon)

"Synergies" is a neuroscience experiment whose purpose is to study the "synergies" that exist when body muscles exert themselves during motion. The movements are quantified on the ground and under microgravity. The experiment uses some the equipment employed in the "Illusions" experiment.

"Tissue" Experiment

Project Heads: Professor Philippe ARBEILLE, Medical Biophysics Laboratory, Tours School of Medicine Professor KIRSH, University of Berlin

"Tissue" is an experiment involving the cardiovascular system that will be conducted with German equipment, HSD, that has been aboard the Mir station since the German-Russian flight of 1992. In correlation with the "Orthostatism" experiment using the Ultrasound and Diuresis, the study aims to investigate the displacement of liquid to the upper part of the body during space flight, by measuring the "compliance"* and thickness of tissues in the cosmonaut's skull and leg.

*"Compliance" is the variation of volume as a function of pressure.

"Teleassistance" Experiment

Project Head: Guy LABORDE, CNES

This operations experiment aims to study how the French cosmonaut uses the Ultrasound while guided in real time by the experiment's French scientist from the Toulouse Operations Center. The goal is to gauge the technical difficulties and scientific value of remote-controlled work, a practice that is expected to grow in the future.

DASA's Mehdorn on Airbus A321, Market for A319
93WS0402A Stuttgart FLUG REVUE in German Apr 93 p 13

[Article by Goetz Wange: "A321 Secures Important Jobs"]

[Text]

FLUG REVUE: The A321 is celebrating its roll-out at a time when money is short in the airline companies.

Mehdorn: The airlines need new aircraft. The old rattle traps—let me put it crudely—stink; they are noisy and occasionally even emit smoke. They have to be taken out of service. We are plunging into this market segment and are replacing the Boeing 727 with this aircraft. We have sold 153 aircraft; an additional 120 are firmly positioned. The market is buying this aircraft because it is even a bit cheaper than the wide bodies.

FLUG REVUE: Nevertheless, you still have had to introduce short time work in the German Aerospace Airbus plants.

Mehdorn: Naturally, but final assembly also provides jobs; we are not working short time on the A321. But that's not the point. We've got a worldwide problem. The airlines are not making enough money with their transport operations. An airline receives 30 percent less per ticket today than in 1985. Air fares are falling, while costs are increasing. If our customers don't earn money, they'll be hard pressed to buy aircraft.

FLUG REVUE: Do you see this crisis ending in the near future?

Mehdorn: The fact that we have introduced short time work shows that we are convinced that this is only a temporary crisis. Otherwise we would be laying people off. We believe that the market will pick up in late 1993, perhaps in 1994 as well. We delivered 157 aircraft in 1992. This year it will probably be 149. That number will probably drop further, perhaps to 140. The step we have taken with our employees is not so dramatic. Our competitors have been much tougher. Our goal is to come out of this crisis smiling. Meanwhile, we are trying to utilize the time to increase efficiency.

FLUG REVUE: Hamburg wants to become the narrow-body center for the Airbus. Is the A320 production rate low enough now to enter into discussions with Aerospa-tiale to move the final assembly of that model to Hamburg as well?

Mehdorn: That will come up at some point, but not now. We are of course making every effort to boost the production rate of the A321 to six aircraft a month. We will then add in the final assembly of the A319. I think we have to take some time so that we don't take on too much. At some point, the A320 will also be included in the final assembly line.

FLUG REVUE: When will the A319 actually be taken into the Airbus family?

Mehdorn: The market will have to decide that. We know that there is a demand for the A319, for example, Lufthansa. Lufthansa is flying 33 A320s and has also ordered 20 A321s. They will soon be operating with 50 Airbus-class aircraft. Of course an A319 fits in well with the advantages of cross-crew communality, spare parts, and pilot training. The 737 can be dispensed with. Naturally, we are not just counting on Lufthansa. There is Swissair, SAS, and other airlines. There are presently six customers for the A319. But we don't have to market before 1995, we still have time. I believe that we will still find another two or three customers this year. Then the program, having the industrial green light, will be adopted with delivery contracts.

Ariane V Passes Initial Tests

93WS0402B Stuttgart *FLUG REVUE* in German
Apr 93 p 27

[Article by V. Leuchsner: "Ariane-5 Solid Fuel Booster Passes First Test"]

[Text] The first test run of an Ariane 5 P230 booster was conducted in Kourou in February. With a thrust of about 600 tons, it is more powerful than the largest version of the Ariane 4 (AR44L). Seven additional tests are planned before the first launch of the Ariane 5 in October 1995.

The first evaluation of measurement data obtained during the B1 test at the Kourou Space Center in French Guiana indicates that the first test performance went off smoothly. One of the new P230 solid fuel boosters was tested at full thrust and full burn time for the first time. The thrust distribution confirmed the theoretical calculations. Maximum thrust was about 590 tons. Both the pressure and temperature values were also as expected. A subsequent visual check showed that the engine had passed the test with good grades. This test inaugurated the "hot phase" of testing components of the Ariane 5. The new European carrier rocket has been designed, among other things, to put two heavy satellites (5.9 tons) in a transfer orbit for subsequent repositioning in geostationary orbits. With costs per kilogram in orbit that are 40 percent less than those of Ariane 4, the new booster throws down the gauntlet to the Russian and the Americans.

The B-1 trials also represented the first test of the solid-propellant test stand (BEAP [Test Bench for Powder Accelerators]). This 60-m-high concrete erection is the only test stand in the world in which solid-fuel booster rockets can be tested in the vertical position, which is to say, in flight configuration. The ditch constructed to divert the exhaust gas stream is about 60-m deep, 35-m wide, and 200-m long.

The tests were controlled from a control center situated 600 m away. From two minutes before ignition, the test program proceeds automatically and, in any case, cannot be stopped after ignition. During the test, the booster lifts about 5 cm up from the platform and is held only by the thrust measurement facility and two safety rings. In all, 623 measurement points deliver a flood of about 400,000 measurements per second. In addition, there are the pictures from 16 moving picture and four video cameras. It takes about three months before the final evaluation of the test can be made.

In flight configuration, the booster is 30-m tall and has a diameter of somewhat over three meters. The booster weighs 272 tons, of which 237 tons represents the solid fuel (propergol) contained in three segments. Burn time is 130 seconds; maximum thrust is 600 tons. During the launch phase, two P230 boosters deliver 92 percent of the thrust of the 730-t Ariane 5. A reinforced 30-mm-thick structure is used in the so-called B1 test. Flight hardware includes the mere 8-mm-thick housing for the

solid fuel. This safety measure was considered necessary in the event overpressures develop.

The solid-fuel engine is the most powerful ever to be built by European companies. Technical management was exercised by the French National Center of Space Studies (CNES). MAN Neue Technologie in Augsburg produced the housings for the three booster segments. BPD Difesa e Spazio in Collefero, Italy, installed the heat shield, delivered by SEP, and filled the uppermost, smallest segment with 22.5 tons of solid fuel (propergol). The middle and lower segments were filled with about 107 tons of propergol in the Guyana Propergol Plant (UPG) in Kourou, which was especially built for this purpose. With a production of about 4,000 tons a year, this plant, operated by the Regulux Company, a joint BPD and SNPE enterprise, has the largest solid fuel production capacity in the world. SEP supplied the nozzle. The final assembly of the booster is carried out in Kourou by Europulsion, a consortium consisting of BPD and SEP.

Concern for the protection of the environment during the tests was expressed in lively discussions. Most problems could be resolved after thorough talks with various organizations devoted to the protection of the environment, including WWF. Requirements were stringent. For example, the tests were only permitted to take place under very specific weather conditions, which would guarantee the rapid dispersal of the exhaust gas cloud. Although in close proximity to the BEAP special restrictions had to be taken into account, measurement stations were set up throughout the entire test and even remote areas. Neutral specialists monitored the region's flora and fauna.

Responsible ESA and CNES authorities were very much satisfied with the tests in connection with environmental concerns. The exhaust gas cloud dispersed within a half hour without acid rain developing. The noise was less than anticipated.

Seven more experiments will follow the B1 test in order to optimize all booster systems. The first launch of the Ariane 5 is scheduled for October 1995. Flight 501 will put a cluster of four scientific satellites in orbit.

AUTOMOTIVE INDUSTRY

Germany: Laser Developed To Aid Fuel Injection

93WS0342B Frankfurt/Main FRANKFURTER
ZEITUNG/BLICK DURCH DIE WIRTSCHAFT
in German 1 Mar 93 p 10

[Article by J.B.: "Fuel Injection With Laser; Lower Consumption and Less Strain on Environment"]

[Text] Frankfurt—In gas engines fuel injection can also be affected by laser pulses. This is the result of research conducted by the Juelich Research Center (POB 1913, 5170 Juelich) in cooperation with private companies and

with aid from the Ministry for Research. Laser-induced injection results in less strain on the environment due to exhaust gases and lower consumption.

As reported by Dr. Roland Herzog and Dr. Wolfgang Krasser of the research center, the limits for maximal pollutant emissions and fuel consumption by motor vehicles have been repeatedly lowered. On the other hand, automobile registration fees are rising, engines are getting to be more and more powerful, and the time spent in traffic jams ever longer. Because of this the need for better systems for supplying engines with fuel is increasing.

The goal of the best improvements is to more precisely measure the amount of fuel apportioned to the gas engine. Most vehicles with gas engines in Europe still have a carburetor system. But carburetors are more and more being replaced by electronically controlled fuel injection systems. The accuracy of the dosage of injection amounts is currently at about 5 percent and the smallest possible amount is about 3 milligrams.

Laser-induced injection now offers us an alternative. A prototype of such an injection system has been developed in Juelich. The decisive component is a rotary vane that is linked with the cylinder by a spring-loaded needle valve. During the flushing action the fuel gets into the slide channel, which is subsequently vaporized by a pulse from the adjoining laser. The rise in pressure during vaporization opens the valve and the fuel is injected into the cylinder.

The scientists used a carbon dioxide laser with a wavelength of between 9 and 11 micrometers and an output of 6 watts as a laser. Injection amounts of less than a milligram were obtained. This is only a third of the amount produced by injection pumps. When large amounts of injected fuel were used during operation under full load, they barely fell short of the maximally admissible injection time because of the relatively low laser power.

With a more powerful laser, injection can clearly be completed within this time limit. On the other hand, the power output was so high that it was barely under the destruction threshold of the light entry window set into the rotary vane. Another adjustment of the power output and the employment of more compact, lighter lasers are also prerequisites for the large-scale operation of these systems. Under consideration as possible candidates for this are the semiconductor lasers, which are today mainly being developed for the optical transmission of signals in optical cables. As further reported, laser-induced injection is superior to the injection systems in common use today because with it very small amounts of fuel can be injected during idling and because of the precise and swift adjustment of the amount of fuel delivered. The mechanically operated rotary vane could also be abandoned. The simplified system consists of a pipe flooded with fuel with a laser entry window and an injection valve opposite it.

Thomson-CSF Joins Auto Safety Project*93WS0386D Paris AFP SCIENCES in French
18 Mar 93 p 51*

[Article: "Thomson-CSF Joins SARA Project"]

[Text] Paris—Thomson-CSF is going to provide 100 million French francs [Fr] of the financing for the Automobile Safety Advanced Research Simulator (SARA), a project launched in 1990 by INRETS (National Institute for Research on Transport and Transport Safety), PSA Peugeot Citroen, and Renault, the project instigators announced on 15 March.

It will be an interactive simulator, with the operator at the wheel navigating a virtual road network of synthetic computer-generated images. The very advanced performance characteristics of SARA, which is scheduled to go into service in 1997, will make it "the most comprehensive automobile simulator in the world."

SARA is expected to spur national and European research on highway safety: vehicle design and highway infrastructure, basic research on driver behavior, assisted driving, emergency situations, etc.

The preliminary development work on SARA was completed late last year. At that time, INRETS and the two automobile companies, the lead contractors, created the SARA GIE (economic interest group) to handle technical design and actual operations.

They received financial support from the Ministry of Research and Space Affairs, the Ministry of Industry and External Trade, and the Ministry of Equipment, Housing, Transport and Oceanic Affairs. The Ile-de-France [Paris area] region, the Association of French Superhighway Companies, and the Agency for Environment and Energy Conservation have also signed on to help finance the project.

West European Car Firms Plan Development Process Acceleration**PSA Supplier Integration Process***93WS0395A Paris INDUSTRIES ET TECHNIQUES
in French 5 Mar 93 pp 52-55*

[Article by Thierry Mahe: "A Visit to the Suppliers of the New Citroen Xantia: Equipment Manufacturers Increase Their Added Value"—first paragraph is INDUSTRIES ET TECHNIQUES introduction]

[Text] PSA [Peugeot] has a dual objective: to reduce design lead times and to improve productivity. This challenge extends to its suppliers, who have been promoted to partners. Taking part in design and engineering at an early stage, enables them to get more added value and better control their costs.

Highlights

- The number of Peugeot primary suppliers was cut from 2,219 in 1985 to 924 in 1992.
- The new Citroen Xantia marks the transition between yesterday's subcontracting and tomorrow's "partnership."
- Equipment manufacturing "partners" are associated to a new vehicle project two to three years earlier than usual.

Peugeot has a clear-cut industrial strategy. The development of a vehicle carrying the lion or the chevron insignias must no longer exceed four years by 1994 and three years by 1999. Simultaneously, Sogedac [General Purchasing Company], the group's purchasing department, aims to increase the competitiveness of automotive equipment manufacturers by 15 percent in three years. Add to this equally drastic procedures with respect to quality and logistics (just-in-time). When it reaches its objective, Peugeot will have fully caught up with its Japanese competitors; the fight for the European market will be even. Clearly stated problems will find clear answers. To reconcile these imperatives, Peugeot, like the other manufacturers, will delegate an increasing part of its new model development to its equipment manufacturers. First, because a Citroen general engineer will never perform as well as the specialist of a given equipment manufacturer, who derived his expertise from multiple projects. Second, because if these suppliers are to appreciably improve their productivity, they need high value-added projects. Therefore, although this is not always clearly stated, we are going toward a redistribution of the roles; the car manufacturer will define the major technical lines of a vehicle, leaving the details to its suppliers.

This industrial new deal cannot fail to have repercussions at car manufacturers, to the extent that it implies—of necessity!—an internal loss of expertise. But its most immediate consequence will be the spectacular decrease in the number of automotive suppliers, at least those who receive orders directly from Sogedac, i.e. the primary suppliers. In Europe, their ranks shrank from 2,219 in 1985 to 924 by November, 1992 (including 681 in France), and they keep getting thinner. The others will become mere subcontractors of primary suppliers... or disappear.

End of speech. It is the mutations in the field that we have attempted to grasp, using the launching of the Citroen Xantia as an example. In many respects, this model marks the transition between two eras. Most suppliers mentioned in this article played only a very modest part at the design and engineering stage. Some, however, saw their prerogatives extended, and the projects they are currently carrying out, for Citroen or for other car manufacturers, confirm this trend. All strive to increase their "autonomy," either by making large investments in computer-aided design systems, or by introducing more competitive processes or materials,

or by increasing their design and engineering department staffs, or even by creating research departments. Here is what they said and what they plan to do.

Hutchinson, Chatellerault Plant (86 [Vienne])

Radiator Grille Front: New Injection Process

The Hutchinson bodywork department provided the Xantia grille, the trim placed in front of the car radiator. To make this part, which is very much exposed to shocks and gritting, the company used a novel process: reaction injection molding [RIM] of glass-fiber reinforced polyurea [sic]. The process consists in mixing two liquids (a polyamine and an isocyanate) which react in the mold to form polyurea. Simon Choumer, head of the bodywork department, explained the advantages of the process: "A very short manufacturing time, excellent resistance to heat, a perfect surface condition, and a very high resistance to shocks and surface alterations... We also add the fastening bar during molding, which simplifies assembly. The RIM process had already been used for fenders, bumpers, underbodies... but never yet for such an intricate part!" Does this increase the cost? It does not seem to: "Although the starting materials are expensive, we end up being more productive than with a traditional injection molding process."

Hutchinson has invested 60 million French francs [Fr] in its new Chatellerault plant which—at least initially—is dedicated to the Xantia. This plant (250 jobs, 50 of which are due to the Xantia) started in December, 1992, and will reach its design production rate already by July 1993: over 1,000 parts per day, in 19 colors. Obviously, the plant will work in tight production flow: parts ordered in the morning will be delivered to Rennes in the afternoon. Among other innovations, we should mention a degreasing process that uses water, and above all a state-of-the-art paint shop, where dust (down to 5-micron particle size) is banned. New plant, new process... Hutchinson's training efforts are commensurate to the risks incurred. Simon Choumer pointed out: "The head of production started his training one year before the plant startup. We started training team supervisors six months ahead of time, technicians three months, and operators one month..."

ECIA, Crevin Plant (35 [Ile-et-Villaine])

Dashboards, Exhaust Systems, Seats: Dashboard Assembly Ready To Be Installed

The fifth largest French equipment manufacturer, Ecia is a Peugeot subsidiary. As can be expected, the Crevin plant (near Rennes), which started production in 1989 and is managed by Arnold Tramaille, is a major supplier of the Citroen Rennes-La-Janaïs plant. The first division, with a staff of 100, provides dashboards (Allibert is another supplier) and exhaust systems for the AX, BX, XM and Xantia models. The other division, which started production in May, 1991, and has a staff of 165, supplies the XM and Xantia seats. For Ecia, the introduction of the Xantia resulted in 60 new jobs. "A

population of young plastics molders that had to become operational within a very short time," Arnold Tramaille pointed out. Making dashboards is a particularly difficult operation. On a high-end car like the Xantia, the dashboard consists of an injected plastic structure encased in foam and covered with a "skin" to which a special molding process (flush molding) confers the feel and look of leather. A manifest sign of change is that the dashboard includes an increasing number of integrated components: glove compartment, vent flap shutters, etc. It is a complex part that must be absolutely free from any defect in its appearance or its polish... An Ecia executive pointed out the problems encountered. "The part must fit perfectly on a sheetmetal structure whose tolerances can be as high as several millimeters. The solution? The designer's knowhow, that's all!" This dashboard is something of a designer's nightmare. Never perfect, always perfectible. It is one of the parts most frequently subjected to what is called euphemistically "restyling"; in other words, redesigning plus retooling of a new mold one or two years after the start of series production. A dashboard requires four years of work and at least two or three mold tests. An amusing detail: the mold costs Fr5 million (to design and to make). Except for knowhow, there is not much to go by. And the plant manager concluded somewhat ruefully: "With every model of every manufacturer, you have to start from scratch."

Montupet, Chatellerault (86) Plant

Aluminum Wheels: Computer-Aided Foundry

The Montupet Wheel Division made the Xantia aluminum alloy wheels. The silicon-base alloy is used in high-end vehicles: it provides freedom of form and a high-quality surface condition. The plant manager, Michel Chretien, told us right away: "A wheel is a styling component and a safety part." Hence the huge investments made in both respects. Styling is the responsibility of Citroen, which provides the equipment manufacturer with the wheel geometric definition—a new one each time. Then, it is up to Montupet to design the best-suited foundry process and surface treatment; that will take one year. Mr. Chretien explained: "We have developed a family of computer programs jointly with Pechiney, both to simulate the wheel mechanical strength and to optimize the foundry process and machine the mold." Such a numeric-control computer-aided design and manufacturing line is far from common in the foundry industry. "We managed to do away with prototype development. We no longer 'loop back' in a trial-and-error cycle. Thus we save time and gain in quality and productivity." The Simulor program is a finite-element analysis code that displays the alloy fatigue, under impact and in normal conditions. This study may lead to profile changes. "Computations are very complex, as they take into account the intrinsic characteristics of the material: its crystal structure, heat treatments, etc." And that is not the end. Montupet is working on an expert system that will optimize the alloy thickness in order to make lighter wheels with a more open profile. The program's essential contribution to the ancestral foundry trade lies in that it

can simulate casting: it took three full years to develop the computing code used. "We can tell which mold feeding system will reduce turbulence in the molten alloy and guarantee optimum solidification. We know precisely how crystallization will propagate in the alloy, which part of the mold should be reheated, which part cooled, and what the injection pressures and rates should be..." And he added, with some pride: "Foundry has at last become a reproducible and controlled process."

What can the wheel-making trade expect? More freedom. Car manufacturers' "in-house" designers may have the last say when it comes to styling, but that does not mean that ideas cannot be submitted to them... "We are compiling style libraries with the help of Italian, German, and French designers." This "catalog" approach goes hand in hand with ever shorter design lead times.

For instance, the manufacturer is studying with Dassault the feasibility of lost-wax molds obtained by stereolithography. "Aluminum wheels appeal to 35 percent of the American clientele, compared with 12 percent in Europe, and 8 percent in France: there is a market to conquer. To do this, we must further reduce our lead times and diversify our lines." Montupet is also considering supplying manufacturers with balanced wheel assemblies. In the case of Citroen, however, this is Michelin's privilege!

Sofedit, Vendome Plant (41 [Loir-et-Cher])

Dash Panel Assembly... From Delivering a Part to Designing an Assembly

The Sofedit group, specialized in blanking, stamping, and cataphoresis, was formed four years ago; it furthered its growth through the acquisition of small and medium-size businesses in the mechanical sector, until it reached sales of Fr1 billion with a personnel of 1,000. It is to Sofedit that we owe the Xantia dash panel assembly, which separates the engine compartment from the passenger compartment. Just a piece of sheetmetal, of course, but a very complex one since it acts as an interface between the controls (steering, pedal support) and the engine (steering column, braking system), providing a passage for wire harnesses as well as strong noise insulation... A premiere for Citroen and Sofedit: this is the first time that the car manufacturer entrusts the fitting out of this part to someone else. In other words, the dash panel is supplied as an assembly, with its insulating foam, rubber flanges, cable grommets, and a few more small accessories. Sofedit started working on the project at an early stage, in June 1990. Somewhat later, it consolidated its advantage with the U60 (the future Peugeot-Fiat minivan). Georges Sciberras of Sofedit pointed out: "This time, we added the pedal support assembly and the steering column support." This is a major step: from delivering a part (a piece of sheetmetal) to designing an assembly (the driver-engine interface). Also, the company is fully in charge of the pedal support test bench. As a result of this approach,

Sofedit has equipped itself with a design and engineering department divided into project teams. How far can it go? "Much farther! We could integrate the entire braking system..." This is as far as integration can go. It will not be easy to turn major brake-system manufacturers such as Bendix or Lucas into mere subcontractors!

Eurostyle, Saint-Clement Plant (89 [Yonne])

Trim: Buyer's Investment in "Unprogrammed R&D"

The specialty of this subsidiary of the German group Moller Werke is automotive "interior design." We are not talking about walnut paneling, but about all the interior trim, with the exception of the seats, doors, and dashboard. Interior trim includes door pillars, wheel housings, the center pillar, and various other trim. Eurostyle employs 500 people and achieves sales close to Fr400 million. The Xantia parts are produced at Saint-Clement, near Sens. Henry Witeska, a Eurostyle board member, pointed out: "In our trade, the clearest trend points to designing the parts that we produce." Manufacturers love terms like "industrial partner," "expert supplier," etc. They reflect reality. It is with Renault that Eurostyle went farthest in co-designing a vehicle, and also with Matra [Mechanics, Aviation, and Traction Company] for the Espace interior design. "We did not really take part in the Xantia design and engineering," Henry Witeska indicated. "On the other hand, we are closely associated to the development of the C15 replacement." That will also be the case for the future "605." "Plastics engineering is a trade with no unemployment, which requires more brains all the time." The Eurostyle design and engineering department now consists of 100 people, i.e. one-fifth of the company's personnel... The preponderant importance given to design and engineering turns into technological gains. For instance, Eurostyle industrialized an injection process called coaxial gas injection: with little material and simple tools, it yields rigid parts that will not pit when the plastic solidifies.

While manufacturers are prepared to give up part of the design and engineering work, styling remains their exclusive preserve. Is that still quite true? "Yes! But sometimes we make minor forays in designing our parts: loudspeaker or air-extraction grilles for Renault..."

Better still, like other suppliers, Eurostyle carries out in-house projects for which there is no immediate need. Sogedac calls it "unprogrammed design and engineering," and encourages it. For this technological watch, Eurostyle relies on its parent company's R&D department which employs at least 100 people in France, Germany, and Spain. "We have developed a dashboard project based on a relatively new process: low-pressure textile overmolding." This method simplifies the steps involved in making a dashboard (structure, foam, skin) since the covering is molded at the same time as the structure. It has a strong impact on the cost of dashboards for high-end vehicles.

Bundy, Crevin Plant (35)

Hydraulic Lines: 40-Meter Tubing Systems Delivered to the Assembly Line

Bundy France (600 people, Fr350 million), a subsidiary of the British TI Group, specializes in fluid transport systems for the automobile and refrigeration industries. Headquartered in Nazelles-Negrin (Tours), Bundy has developed the Xantia hydraulic systems: power brakes, hydraulic suspensions, cooling... a full 40 meters of tubing. Bundy manufactures this tubing, which consists of copper-encased steel strips, at the rate of 110,000 km per year. In Tours, the tubing is cut to length, provided with fittings, and shipped to area plants: Les Mureaux, Sochaux, Le Havre, i.e. to the doors of car manufacturers. A new area plant was opened in Crevin (Rennes) in December 1992; it will deliver bent tubing assemblies directly to the assembly line.

In this respect, suppliers are very slow to emancipate themselves... Citroen still jealously presides over the development of the hydroelectric systems that gave it so much prestige. The Hydractive-II system showcased on the Xantia tremendously increased the complexity of the hydraulic system: 125 tubing part numbers instead of 48, as for instance on the Renault Safrane. Christian Jean, manager of Bundy France, explained: "Citroen used to bend the tubing by hand, with lightweight tools. We can perform the same operation in series on special bending machines or numeric control machines." The Renault Clio was the first car whose entire fluid systems were thus subcontracted. That was also the case of the 405, the Safrane, the 106, the Twingo, the Xantia.

This is a tangible, if not very impressive, transition "from the part to the system." "First, we supplied straight tubing, then bent tubing, and now tube assemblies delivered directly to the assembly line and which fit perfectly between the ABS [antilock brake system] unit and the master cylinder."

As a corollary to this increasing complexity, work starts further upstream in design and engineering. "We often start working two and a half years before the vehicle is marketed. For instance, we are already working on the R19 replacement, which will be introduced only in 1995." This does not prevent untimely setbacks. "In June 1992, following modifications of the Xantia, 80 percent of the part numbers were changed." It takes about three months to design a part and program the bending machines... This transfer of activity to the subcontractors entails considerable investments: numeric control machines (Fr10-20 million), CAD [computer-aided design] stations, three-dimensional measuring systems, etc. This translates into productivity and quality gains: geometric optimization of the tubing shape, quicker assembly, and the elimination of any potential cause of wear or friction. For Bundy, the Xantia means revenues of about Fr20 million per year, plus about 30 new jobs in Rennes.

United Technologies Automotive (UTA), Guipry Courtbouton Plant (35)

Wiring Harnesses: Integral Design of a 500-Wire "Octopus"

At first sight, developing an electric distribution system is not one of the nobler automotive trades. Yet, in this case too, things are changing fast, moving toward integration and increased supplier's responsibility. Christian Lefebvre-Vary, general manager of UTA France, commented: "Three years ago, we would work on a project one year before series production startup. Today, we start working three or four years before, on the prototype." The U.S. firm collaborates with practically all European manufacturers. Once again, Renault paved the way for full subcontracting of the wiring. "We were given 100-percent responsibility to design the wiring of the Safrane. The same thing happened with the Xantia. The Xantia includes an "octopus" of about 500 cables connecting the dashboard to the engine block, plus another 10 ancillary harnesses. The cable routing study was carried out at Velizy (Peugeot technical directorate), on mockups, with a view to maximizing assembly ergonomics. Four UTA engineers took part in the study. The study is far from trivial, witness the size of the UTA design and engineering department at Garches: 35 people." Christian Lefebvre-Vary indicated: "We have simplified wiring diversity as much as we could to reflect the various options possible, which is a guarantee of reliability: the Xantia will use only 12 types of harnesses."

Like many equipment manufacturers, UTA is subjected to rapid-fire changes, which are particularly frequent upstream from the project. It must therefore constantly adjust to new vehicle systems and keep shifting the locations of cable grommets, tubing, and other parts that go through the dash panel! Christian Lefebvre-Vary is reserved as to the alleged emergence of "buses" (a single multiplexed cable replacing wiring harnesses, even for the power supply). "They have been announced for 10 years now, but I do not see any significant implementation. One U.S. manufacturer merely tested this solution on its doors..."

Fiat Automation Concept

*93WS0395B Paris INDUSTRIES ET TECHNIQUES
in French 5 Mar 93 pp 56-57*

[Article by Thierry Mahe: "The New PSA [Peugeot]/Fiat Plant in Valenciennes Will Start Production in 1994: Fewer Robots For Better Quality"—first paragraph is INDUSTRIES ET TECHNIQUES introduction]

[Text] New plant, new vehicle, novice personnel... A triple challenge that Peugeot and Fiat expect to meet by minimizing industrial risks. Make room for reliable solutions! Sevel-Nord [European Light-Vehicle Company] is not an industrial laboratory; rather, its objective is to achieve total quality from day one of production.

Highlights

- Only one-half of sheetmetal operations will be robotized, compared with 80 percent and more at other sites of the Peugeot group.
- Contrary to custom, preseries vehicles were assembled on the final production lines rather than on prototype lines.
- Sevel-Nord will employ 1,100 people by mid 1993, 2,400 by 1994, and 3,500 by 1995.

A new French car plant... This is something extremely rare and very exciting for the personnel of Peugeot-Citroen, the project owner. Actually, early in 1994, from the Sevel-Nord assembly lines will roll out the first vehicles designed jointly by Peugeot and Fiat. Nothing or nearly nothing is known about the "baby," except its acknowledged kinship with the Renault Espace and the Chrysler Voyager, in the tradition of high-end recreational vehicles—and a code name: U60. But the plant where this new model is being created is already famous, as it concentrates to a large extent the latest concepts of mass production. Sevel-Nord is first of all a formidable boost for the Nord-Pas-de-Calais region which can expect 3,500 new jobs by 1995, not counting the work force drained by equipment manufacturers when they come and set up business at the plant doors. Actually, Sevel-Nord is a terminal plant, dedicated exclusively to body assembly (body-in-white), painting, and vehicle assembly; 70 percent of the vehicle added value is subcontracted.

The first original characteristics of this plant is that it is "signed." Just as the future minivan was born under the leadership of a project manager (Jean-Francois Laprand), a single man—Jean-Guy Queromes—is in charge of the entire setup, from process studies to validation tests. Project manager at Peugeot's directorate of industrial processes and equipment (DMEI), former head of Peugeot's computer-aided design department, he is now fully in charge of process control. He explained: "Between Sevel-Nord and my project team, there exists a genuine client-supplier relationship." That is another way of expressing a total commitment toward the client plant and the promise that production lines will be quite ready as scheduled. Obvious as it may appear, this organization marks a complete break with "the old regime," where each trade (construction, sheetmetal, painting, assembly, etc.) had its own manager. Jean-Guy Queromes praises its merits: "First, more freedom to trade off; then, an overall view of the project; above all, a single person to talk to management when it is necessary to catch up with a delay or to increase a budget."

One most remarkable fact is that Sevel-Nord puts a brake on all-out robotization. It may even be a step backward, not toward the mechanization of man, but toward a reassertion of the value of manual work. One example: only one-half of the sheetmetal work will be robotized, compared with 80 percent or more at other

sites of the Peugeot group. For instance, the body-assembly shop where the frame and opening parts are assembled will include (not even—if we may say so) 68 Acma robots, although it will employ 1,000 people. Around the two body-assembly lines, many welding islands will use hand-welding, in particular those responsible for the more difficult operations, e.g. the welding of visible parts and finishing operations. As a result of this "industrial artisanat," some sheetmetal workers will devote over 1,000 hours to training. Not so long ago, flexibility meant that nearly everything had to be robotized; in 1993, on the contrary, it means that expert craftsmen are making a comeback.

Simplicity considered as a virtue... This change of industrial policy, which the automobile sector appeared about to trigger, finds here its perfect demonstration. Never before had this new production philosophy shaped management policy to such an extent. For instance, Jean-Louis Silvant, Peugeot's assistant general manager, recently stated: "Superfluous sophistication can only result in more problems to solve." Requiem for a superfluous robot.

Jean-Guy Queromes completed and justified this reasoning: "Starting with a new plant, a new vehicle, and new personnel, all at the same time... That's already quite something! You will understand that we did not want to take on every risk." No startling innovations in Valenciennes therefore... Its main architect is also quite frank about it. "We have used existing processes throughout, proven solutions." For instance, body handling on the frame line (body assembly) is a synthesis of the handling systems used at Sochaux, Mulhouse, and Poissy; the surface treatment line (paint shop) is an exact copy of the lines existing at Citroen, in Rennes and Vigo (Spain). And in the assembly shop, the handling system used on the body trim line is a replica of the handling system used at Sochaux. Make no mistake, though. This industrial policy does not reflect opposition to progress, far from it. It marks the consolidation of past experience. First, because all these processes embody considerable improvements. Then, because the automated systems were recast around a consistent equipment basis: Telemechanique and Siemens for programmable controllers; Renault Automation for robotics.

The advantages inherent in this approach are obvious. "We have of course reduced design and engineering costs! Better still, we are shielding ourselves from unpleasant surprises." If there is any unpleasant surprise, it will not be due to a failure to track down the most minute elements of industrial risk. At Sevel, assembly manufacturers must appear one by one before the inquisition tribunal whose presiding judge is Jean-Guy Queromes. The latter indicated: "We have forced every one of our suppliers to prove the endurance of his equipment. It's simple: each line must run on no load for at least 100 hours." For instance, all the equipment used to install opening parts have undergone this final test at CMR (Rennes Mechanical Structures). During January,

the line was then shipped and reinstalled at the Sevel-Nord body-assembly plant. This approach is not new in itself, but it had never been applied on such a large scale and as systematically.

It is during preseries that most problems—preferably all!—will appear. This probation stage, which started in February, 1993, at Sevel-Nord, was completely rethought by Peugeot, with a view to achieving zero defect. Traditionally, the planning department would industrialize a manufacturing process based on blueprints from the design and engineering department. During the entire preseries process, a team of experienced technicians would check the reliability of the production process on a pilot facility; they would report all defects observed, either in procedures (so the production process could be modified), or in design and engineering (so the part could be modified).

This has changed considerably! First, because at Sevel-Nord preseries are made on the final production lines, not on prototype lines as used to be the case. Then, because the Peugeot management wanted the workers who will have "to live with" these procedures day after day to have their say. How? By having them participate actively in the preseries. Better still, a handful of operators were involved much earlier in the design cycle; already at the prototype stage! Jean-Louis Silvant justified this approach thus: "We are eager to have the operator show the man from the design and engineering department how he would like to perform his daily task."

Jean-Guy Queromes added: "The operators' opinion is very valuable when, in assembly procedures, they show us which movements they think are difficult or inconvenient. We have eliminated certain risks by making sure that no assembly operation is performed 'blindly.'" Thus, the operator really sees what he is doing, even when working on vehicle parts that are not readily accessible.

Obviously, this supports the quality approach, since the preseries experimental stage thus reproduces actual production conditions as faithfully as possible. Jean-Guy Queromes makes sure that this passing of the baton between the testing and production stages is performed "smoothly, in common, and with an overlap." The very definition of simultaneous engineering.

This much vaunted overlapping of tasks nevertheless presupposes perfect synchronization between the rate at which changes are made in the vehicle (about 1,000 changes are required at this stage) and the progressive setting up of manufacturing lines. While, of course, meeting deadlines and the cost requirements imposed on the three preseries campaigns.

To appreciate fully this perilous balancing act, we should add that the Sevel minivan will be made in four versions—Peugeot, Citroen, Fiat, Lancia—each with a markedly different styling and an impressive number of option levels. This means that some vehicle parts or systems will have different part numbers, and that there

will be many alternatives in production procedures, which must be systematically tested during the final preseries campaign.

The first of these preseries started in February. By then, the outfitting of the paint shop had just been completed, and the body assembly shop was entering its final stage. Also, the study of the vehicle assembly shop had barely been completed... Simultaneously, the first startup tests were undertaken at the paint shop in December, 1992, a few weeks before the first body assembly tests.

Jean-Guy Queromes explained: "Since we do not have enough new vehicle prototype bodies, we use Citroen ZX bodies to simulate the behavior of the surface treatment and paint shop." A carousel of 300 Citroen ZX bodies continuously revolves in this tunnel. Why the ZX? "Because their weight, their surface area, and their fluid penetration coefficient are similar to those of the minivan." A similar stratagem will be used to validate the assembly line. As you can see, preseries stages progress at Sevel-Nord like the Far West train traveling while the railroad tracks are being laid!

[Box, p 56]

A Huge Training Site

Peugeot can no longer be suspected of paying more attention to its robots than to its workers. Witness the unprecedented training effort made by the company—and paid for by the government. The agreement signed by the state, the manufacturer and the Nord region provides that 75 percent of the individuals recruited will be residents of the Cambrai, Valenciennes, Douai, and Maubeuge arrondissements. Better still, 40 to 60 percent of the employees will be chosen among the unemployed. This will be no major problem: the Valenciennes area has an unemployment rate of 20-30 percent. Vocational school graduates will be trained (for at least 800 hours) by regional organizations, to become skilled workers in body assembly, painting, and vehicle assembly; this will be followed by a training period in a Peugeot center. The trainees will be followed under a sponsoring system. Young people without a vocational school certificate will get 850 hours of training to complete their general and vocational education. Hiring will take place after completion of one or the other of these training cycles. This is a large-scale program: Sevel-Nord will employ 1,100 people already by mid-1993, 2,400 by 1994, and 3,500 by 1995.

[Box, p 57]

When Fiat and Peugeot Join Forces

Sevel (European Light Vehicles Company) was created in 1978 by Peugeot, Peugeot-Citroen, and Fiat. The Lieu-Saint-Amand-Hordain industrial site (20 km from Valenciennes, near highway A2) complements the first two Italian plants of the Sevel group, the first one in Val di Sangro (near Pescara), the second in Pomigliano d'Arco (near Naples). These two sites produce van-type

commercial vehicles for Peugeot (J5), Citroen (C25) and Fiat (Ducato). Already in 1994, Sevel-Nord will produce minivan-type high-end vehicles at the rate of 500 vehicles per day (100,000 per year), for Peugeot, Citroen, Fiat, and Lancia. The plant was financed 50-50 by Peugeot and Fiat and represents an investment of Fr6.3 billion (buildings and equipment).

The Nord region was in competition with other sites, in France and in Italy, but it had three substantial assets: roads and an industrial infrastructure; a large area (built for several decades, the Sevel-Nord plant is expected to cover the 160 hectares of the site); and an "employment basin": a polite way to describe a region devastated by the compounded effects of the mining, steelmaking, and textile crises.

Sweden: Volvo's "Environmental Concept Car" Uses Hybrid Propulsion System

93WS0423A Duesseldorf VDI NACHRICHTEN
in German 19 Mar 93 p 27

[Article by Olaf von Fersen: "The "Mr. Clean" Concept Car: Combination Gas Turbine and Electric Motor Power Experimental Limousine"]

[Text] VDI-N, Goeteborg, 19 March 93—In the early 1980s hardly anybody was giving the gas turbine a chance as a means of automobile propulsion. Today, Volvo is capturing attention with its combination gas turbine-electric motor propulsion system. This experimental hybrid vehicle, called by its Swedish producer the "Environmental Concept Car (ECC)," is very convincing as an environment-friendly automobile. In the category of hybrid automobiles, it easily meets and exceeds the strict California vehicular pollution limits. For Volvo's responsible project director, the ECC is not a kind of futuristic showpiece, it is very close to realization. Lennart Svantesson is the research director and considered the "father" of the hybrid vehicle; Stefan Juthage is project manager. Svantesson is vice president of Volvo, where he is responsible for product planning and design.

Often, in the case of an experimental research automobile put on display, its relation to reality is very vague. The Volvo Company of Sweden, on the other hand, has developed a hybrid vehicle that is obviously superior to all previous "automobiles of the future" in meeting the requirements for an efficient passenger car. The ECC (Environmental Concept Car) hybrid automobile is an almost 4.5-m long, four-door limousine, weighing 1580 kg empty.

The ECC is equipped with an autarkic propulsion system, i.e., its range of action is not limited by its storage battery capacity. Its propulsion system consists of a small gas turbine, which shares the double shaft with a generator, and an electric motor with a two-gear automatic front-wheel drive.

The gas turbine and the generator run at an almost constant maximal speed of 90,000 min⁻¹. There is no mechanical connection to the wheel drive. That is effected strictly electrically. Drive is selected simply by pressing a button, namely, 1) electrical by means of current drawn from the batteries; 2) hybrid propulsion; or 3) by means of the gas turbine.

Purely electrical propulsion is used for city traffic, the gas turbine for the open road, and the combined battery-turbine operation for maximal acceleration and top speeds. When both systems are operating optimally, a propulsive power of 70 kW is at the driver's disposal. From a starting position, the vehicle can accelerate to 100 km/h in 13 seconds and reach a top speed of 175 km/h. Using battery propulsion a range of 85 km can be attained on 80 percent power consumption. Powered by the gas turbine, a Volvo can travel 670 km with a tank capacity of 35 l diesel fuel. The turbine may also be operated with other liquid or gaseous fuels.

With its gas turbine activated, the Volvo EEC easily meets the California ULEV (ultra low emission vehicle) norms for hybrid vehicles. This is a very modest statement indeed when the ECC results are compared with the presently authorized limits:

EEC Performance Compared with California Standards

Pollutant	California Norm	Volvo ECC
NO _x	0.25 g/km	0.11 g/km
CO	2.6 g/km	0.08 g/km
HC	0.16 g/km	0.006 g/km

The excellent turbine values are attributed to the fact that it operates at an almost constant speed. Unlike aircraft engines, which likewise operate at an almost stationary speed, previous experiments involving the mechanical gas turbine propulsion of automobiles failed because of two disadvantages: 1) the sluggish reaction to load changes; and 2) its poor economy when operating under partial load. Aside from these weak points, the gas turbine has much going for it, namely, its compact construction, light weight, its almost vibration-free operation, and the relatively few pollutants in its exhaust gas. Still another advantage is the multifuel capability of gas turbines, which, because of the small number of parts and absence of oscillating motions, are viewed as reliable and durable.

Each of two different research programs made a significant contribution to the development of the Volvo EEC. A subsidiary consortium consisting of United Turbine, Asea-Brown Boveri, and the Vattenfall Electrical Company, had much to do with the development of the gas turbine, while the technology of the high-speed generator had its origins in a research project conducted in the Royal Technical University in Stockholm. A single-stage radial compressor likewise goes along with the single-stage radial turbine. The exhaust gas heat is—for the most part—returned to the compressor air stream by means of a rotating heat-exchanger.

Volvo has had much experience in the development and production of gas turbines. Serious experiments were undertaken with vehicular turbines as early as 1980-1981. In this regard, Lennart Svantesson, ECC project director, emphasizes: "The ECC is not a window show-piece, but a serious research project aimed at producing an environment-friendly vehicle."

A generator that runs at 90,000 revolutions should be entered in the Guinness Book of Records. This high-speed generator delivers alternating current at a constant voltage, but at much too high frequency for it to be utilized directly in the traction motor. Consequently, it is first converted into direct current and then again converted into an alternating current suitable for the traction motor. A second conversion, which delivers direct current especially tailored to charge the storage batteries, occurs concurrently during the direct current phase.

The high-speed generator's control unit regulates the system voltage (direct current) and also translates the position of the acceleration pedal into the traction motor's required driving torque. The rated output of the traction motor is 70 kW; its continuous power is 56 kW. Conventional nickel-cadmium batteries, having a combined energy capacity of 16.8 kWh, serve as storage batteries. They may be charged up flexibly with voltages ranging from 170 to 380 V. A conventional 12-V lead battery is used as starter and service battery.

ECC Provides Absolutely Normal Ride

After identifying the trademark, whoever happens to spot the ECC in an everyday setting would most likely take it for a new Volvo model series. As soon as the ECC revs up its engine, however, its unusual sound suggests immediately that this vehicle very probably has something to do with the automobile of the future.

The ECC is a well-designed, spacious, and well-appointed four-door limousine. The design is modern, but not overly stylish; the interior is elegant but practical. It is very rare indeed that an automobile producer will entrust such a unique developmental vehicle (not even a second model exists) to a foreign guest to check out for himself. That act alone attests to the confidence Volvo has in its new car.

A rotary switch in the middle of the leatherized dashboard displays the usual positions for automatic drive (P-N-R-D-L). First, by simply pressing a button, the propulsion mode is selected: fully electric, hybrid, or gas turbine.

If it is not being operated in town, the turbine is activated. The switched-on generator serves as starter. It takes about 10 s for the tachometer to reach 40, i.e., 40,000 min⁻¹. At that point injection begins and the diesel fuel-air mixture is ignited in the combustion chamber. Acoustically, it sounds somewhat like a vacuum cleaner operating in another room behind a closed door.

If the battery is still weak when hybrid drive is selected, the turbine continues to operate. When the requisite

battery charge level is reached, the electronics system switches automatically to battery operation.

The gas turbine will again take over propulsion in the event the electrical power source becomes exhausted. Both power sources are combined when rapid accelerations or high speeds are needed. The vehicle rides absolutely normally and the passengers, providing they are not clever company specialists, are totally unaware of what the electronics systems under the flat, white engine hood are up to.

After this convincing driving experience, the question always arises: "When can we expect this car to go into mass production?" The Volvo technical people are waiting for the answer from the United States Advanced Battery Consortium (USABC). "The batteries currently used in the ECC are much too heavy (350 kg) and cost far too much (30,000 German marks [DM])," project director Lennart Svantesson confesses.

Aside from the batteries, Volvo's car of the future appears to be technically ready in every sense. The next step will be to make long-term tests of the engine. In the tests, the engine will be installed in a regular Volvo 850 in place of its five-cylinder engine. It will be operated extensively for a long time in regular traffic situations. Meanwhile, Volvo engineers hope that USABC will succeed in developing a usable traction battery.

Vehicle Turbines Consume Less Diesel Fuel

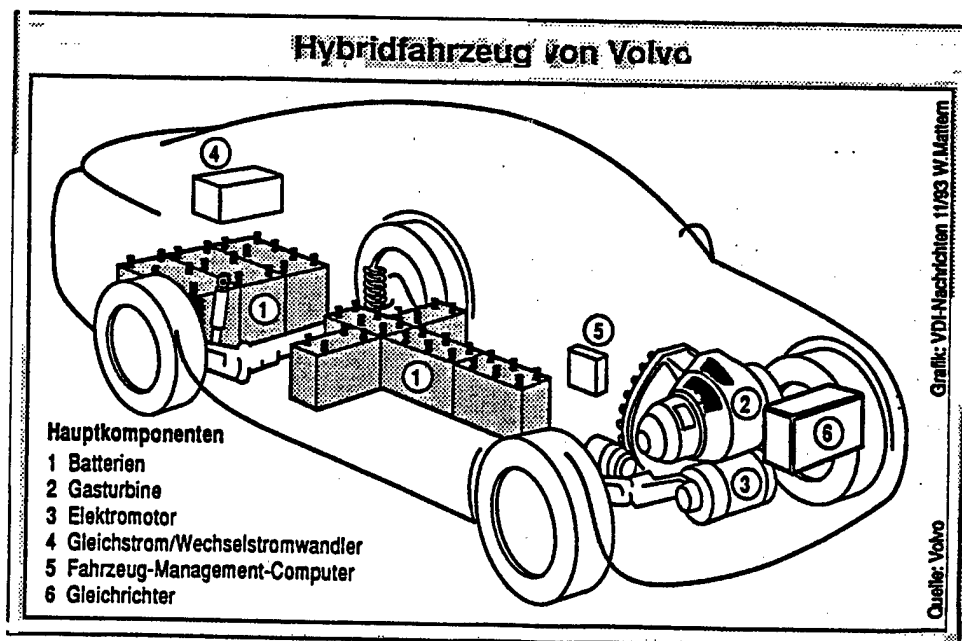
The following requirements are foremost in the specifications for Volvo's "car of the future:" four-door, medium-size automobile of the lightest possible weight, good aerodynamic characteristics, and extensive recycling capability.

The series model "850" is the basic undercarriage of the new hybrid vehicle. An aluminum body, weighing 220 kg, has been mounted on top. External components like the formable front end and the rear bumpers are made of plastic material.

Wheel base and tracks are 2700 mm and 1520 mm, external dimensions 4487 mm x 1804 mm x 1390 mm. The c_w value of 0.23 ($c_w = 0.46 \text{ m}^2$) indicates that the Volvo aerodynamicists have done a good job. The total weight of 1580 kg includes the 237-kg engine and the 350-kg batteries.

The size E205/60 RR 15 tires at a pressure of 4.5 bar, especially developed by Goodyear for the Swedish ECC, reduce rolling drag by about 50 percent as compared with other mass produced automobiles.

Besides good exhaust gas values, pleasing fuel consumption results were also achieved. Using gas turbine propulsion the environmental concept car consumes 6.0 l diesel fuel per 100 km in city traffic and only 5.2 l/100 km on the highway. Operating strictly on battery power, and drawing 50 percent power, the ECC can travel a distance of 140 km.



**ECC Power Plant Consists of Small Gas Turbine, Generator and Electric Motor for Front-Wheel Drive
Volvo's Hybrid Automobile**

Key: Main Components 1. batteries 2. gas turbine 3. electric motor 4. ac/dc converter 5. vehicle-management computer 6. rectifier

BIOTECHNOLOGY

Germany: New Algorithm To Control Chaotic Reactions in Chemistry

93WS0342A Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 2 Mar 93 p 8

[Article by O.E.L.: "New Algorithm Permits Control Over Chaotic Reactions; Chemists Hope To Find Faster Way To Develop Major Technological Processes"]

[Text] Frankfurt—It will be possible to control chaotically occurring chemical reactions through new mathematical methods. Through them it will in future be possible to use a number of processes and syntheses in chemical process engineering that up to now could only be used at great cost or not at all.

Under the term chaotic states are understood reactions whose occurrence cannot be classified among any of the regular processes known today and whose operating parameters oscillate back and forth in an uncontrolled manner between different sizes or intermediate combinations.

A typical example of a chaotically occurring chemical reaction is the Belusov-Zhabotinskiy reaction, which can be observed during the oxidation of citric acid by Cer ions in the presence of bromate. In this case we have an oscillating reaction process which can be identified by a rhythmically appearing and disappearing yellow coloration.

Control of chaotic states goes back to the research of physicists Edward Ott and Ceslo Grebogi together, with mathematician James A. Yorke of the American University of Maryland in College Park (Maryland), in 1990. Because of this, the new algorithm is also referred to as the Ott-Grebogi-Yorke algorithm, after its discoverers. They developed an algorithm that uses slight changes in the oscillation of a chaotically operating system to transform it into a stable, periodically reacting system. It acts as a feedback loop in which the deviations can be transformed into a nearly harmonically oscillating system.

In chemistry chaotically occurring reactions can be identified by the fact that unforeseeable concentrations of various kinds of intermediate stages or combinations are produced. If the intermediate combinations in the Belusov-Zhabotinskiy reaction are affected by means of a precisely controllable additional number of Cer and bromate combinations in the reaction vessel, they can be transformed into the desired end product.

At the present time the use of the new algorithm for chemical process engineering is not yet of any great practical importance, on the one hand, since there are only a few known chaotic reactions and, on the other, since they are not used because they are uncontrollable. But this situation can change if new synthetic reactions that may lower production costs are actively sought.

Process engineers now hope that they will be in a position, sooner than they have been up to now, to be

able to apply laboratory processes to pilot or even production plants in order to be able to more easily avoid the difficulties that crop up time after time when "upscaling" chemical plants.

The use of this algorithm has led to the achievement of significant results in other natural science or technology fields. Thus, they have succeeded in stabilizing the movements of the so-called magnetoelastic materials in a magnetic field that oscillates back and forth. Semiconductor diodes, whose resonant behavior rolls over into the realm of the chaotic, can also be stabilized like lasers that can be raised to a very high power output through this process.

In biological research they have succeeded in bringing tissue cells from the heart of a rabbit from a condition of irregular beating of the individual cells to the common rhythm, as with a regular heartbeat. New biomedical methods may possibly be derived from this to use heart pacemakers to make adjustments for irregular heartbeats.

The antichaos algorithm is only at the beginning of its varied possible applications in research as well as in technology. Along with research on dynamically operating processes and reactions, it is leading to new insights into how reactions behave in nearly all natural science systems, from biology and chemistry to physics and metrology and automatic control engineering.

Germany: High-Temperature Polysaccharide Degradation Enzyme Obtained

93WS0382B Paris *INDUSTRIES ET TECHNIQUES* in French 5 Mar 93 p 34

[Article by Michel Le Toullec: "The Enzyme That Can Stand High Temperatures"; first paragraph is *INDUSTRIES ET TECHNIQUES* lead]

[Text] Active up to 140°C, this enzyme, derived from a microorganism, could be used in the sugar, paper, and textile industries.

Thermophilic Archaea leads a hard life. This microorganism remains active under temperature conditions that would kill its congeners. Its metabolism (or, more precisely, its enzymes: biological macromolecules with catalytic functions) withstands temperatures of up to 140°C, while others generally lose their effectiveness above 60 to 70°C. On the basis of this finding, Garabed Antranikian, a professor at the Hamburg Technical University, has launched a vast research program. Today, 40 laboratories in 12 Länder are participating in the program, which is expected to last three years. The first laboratory experiments have succeeded in making fructose from starch. High-temperature enzymes have the advantage of withstanding the 100°C required for the new starch degradation process and of eliminating an intermediate phase in the conventional process. Traditionally, sugar is made by cooking starch to obtain an intermediate product, maltodextrin. This compound is then converted to maltose and glucose through a very

long process, since the enzyme used cannot withstand temperatures above 60°C. The next phase consists of going from glucose to fructose at 65°C. Using the high-temperature enzyme would combine the first two steps into a single phase. Glucose could be obtained directly at between 90 and 105°C and then converted to fructose at around 75°C.

In Professor Antranikian's view, this type of enzyme could also play a role in the paper industry, where it could be employed to bleach paper using a biological process. Currently, bleaching relies mainly on chlorinated products and oxygen. The biotechnical process, called xylanase, for which the intermediary is an enzyme, [as published] would be suitable for paper bleaching and would make it possible to avoid contaminating wastes. According to Garabed Antranikian, high-temperature enzymes could also be used in the leather industry and the dying of textiles. For now, the problem is to produce the enzyme in large enough quantities. The latest experiments have succeeded in locating the relevant DNA sequence in Archaea and transmitting it to a well-known bacteria, *Escherichia coli*. Large quantities of the enzyme can be extracted from cultures of this bacteria. Professor Antranikian's team is currently working on this extraction phase.

French Researchers Identify Genetic Marker for Autism

93WS0383A Paris *LE MONDE* in French 23 Mar 93 p 45

[Article by Jean-Yves Nau: "Reviving the Debate on the Origin of the Disease, a Genetic Marker for Autism Is Said to Have Been Identified"—first paragraph is *LE MONDE* introduction]

[Text] The National Health and Medical Research Institute (INSERM) just announced that a team of French doctors and scientists had succeeded in identifying a genetic marker for autism, a major psychiatric affliction that affects approximately one child in 2,000. The announcement of this discovery revives the controversy about the origin of autism.

Autism is one of the most enigmatic and most disturbing psychiatric afflictions. This extremely serious pathology was identified 50 years ago.

It is characterized (and defined) by a nearly total inability to communicate, which results in profound developmental problems. The child appears "walled in" in absolute solitude at a very early age, any attempted contact or exchange being almost irremediably doomed to failure.

Very schematically, there are two opposing schools of thought, which often virulently disagree on how to account for autism. According to some, the symptoms as a whole are the result of various (still unidentified) biological factors leading to a total isolation of the individual.

For others, on the contrary, autism results in all or in part in an analytical perspective [as published], this pathology being then perceived as a form of defense mechanism. These different approaches lead to different analyses and treatments.

The result announced by the INSERM is in line with a scientific and organicist approach.¹ Until now, genetic approaches could rely only on studies of families, especially twins, to determine whether or not a genetic marker could be shown to exist.

Therapeutic Openings

The new tools and concepts of molecular biology now make it possible to establish an association by comparing two groups of unrelated subjects. The French team thus formed two groups of 50 children each (16 girls and 34 boys, aged seven and a half on the average). The first group consisted of 50 autistic children, and the second group of healthy "control" children. The analysis considered the mode of operation of four genes physiologically involved in the synthesis or metabolism of neurotransmitter molecules. In fact, various studies have already shown that these molecules, which serve to transmit nerve impulses, present some anomalies in autistic children.

The study did not find any anomaly in three of the genes. On the other hand, a significant difference was found to exist in the mode of expression of the fourth gene. "This observation is particularly interesting since this gene plays a part in the development of the nervous system, in the regulation of growth, and in the differentiation of nerve cells," the authors of the study explained. The gene is located on chromosome 11, in an area where two genes (those for tyrosine hydroxylase and for a dopamine receptor) have already been identified as being potentially involved in certain psychiatric afflictions.

According to Professor Dominique Sauvage (Tours University Hospital Center), who is one of the authors of the study, such a result might offer new therapeutic and diagnostic weapons in the intermediate term. "This pleads in favor of autism being due to a developmental disorder," he explained. "Conceivably, in the intermediate term, this might provide new markers making an early diagnostic of the affliction possible."

Footnotes

1. This study will soon be published in *PSYCHIATRY RESEARCH*. The authors are researchers from the INSERM (Unit 316, Professors D. Sauvage and G. Lelord) and the CNRS [National Center for Scientific Research] (Professor J. Mallet, Gif-sur-Yvette).

French Agronomic Research Institute Produces 5 Calves From Single Clone

93WS0383B Paris LE MONDE in French 1 Apr 93 p 17

[Article by Catherine Vincent: "A Premiere in France: INRA [National Institute for Agronomic Research]

Researchers Have Obtained Five Calf Births From a Single Clone"—first paragraph is LE MONDE introduction]

[Text] For the first time in France, five male calves, issued from a single clone and therefore genetically identical, were born at the developmental biology unit of the National Institute for Agronomic Research (INRA). Announced Monday, 29 March, at the Academy of Sciences, this French research success completes another stage toward standardization of the livestock cloning technique. It could have considerable economic and agronomic consequences.

Genuine quintuplets, born between 29 [January] and 3 February of five different "surrogate" mothers... Something the INRA had never seen before. And for a good reason: the result of several years of research,¹ this feat required the collaboration of six French public and private teams, supported since 1991 by the Ministry of Research and Space under a "technological leap" contract.²

"Obtaining clones is still something exceptional," Mr. Pierre Douzou, member of the Academy of Sciences and former INRA president, pointed out, "and the protocols used are still kept secret." Since the first birth by cloning, that of a lamb obtained in 1986 by the British team of Dr. Willadsen (Cambridge), the technique has been experimented on ewes, cows, rabbit does, sows, and goats. Several American firms have developed the process for cattle; they are said to have obtained several thousands of gestations so far. But the success rate remains low and the technique extremely unwieldy.

To achieve this "embryonic cloning through nucleus transfer," the Jouy-en-Josas (Yvelines) researchers used a "donor" embryo removed at the 32-cell stage from the uterus of a Holstein cow. From this embryo, they separated 17 cells. Each cell was then introduced into a previously enucleated "receptor" oocyte which was then implanted into the uterus of "surrogate heifers."

Considerable Economic Stakes

Whereas the average development rate of in vitro clones is hardly lower than the rate obtained through in vitro fertilization (24 percent compared with 28 percent), the number of live births, on the other hand, remains very small compared with that obtained with reimplanted embryos. For instance, at the INRA (where other births are expected soon at the experimental Bressonvilliers farm, in Essonne), only one-fourth of the surrogate cows currently reach the fourth month of gestation. The most difficult stage to control is the in vitro maturation of "receptor" oocytes collected in slaughterhouses—the only way to make the cost of cloned embryos competitive.

Superovulation, oocyte maturation, nucleus transfer, receptor oocytes activation, cloned embryo development: obviously, more time will be required to achieve full control over the many stages of this technology

before success rates are high enough to consider an "industrial" stage. But the long-term objective, people at the INRA point out, is nevertheless "the production of large quantities of bovine embryos selected for their agronomic qualities, and at a price competitive with that of a frozen semen dose. Economically, a lot is at stake."

"Cloning should make it possible to integrate into selection schemes the less common breeds that are now excluded," Pierre Douzou also added. The other side of the coin is that, used indiscriminately on a large scale, cloning livestock may impoverish their genetic pools. This danger was emphasized by none other than Mr. Jean-Paul Renard, head of the Jouy-en-Josas developmental biology unit, who recently pointed out that "this technique will render more acute the difficult question of preserving sufficient polymorphism in any given animal population."

Footnotes

1. Study signed by Mrs. Nathalie Peynot and Messrs. Patrick Chesne, Yvon Heymann, and Jean-Paul Renard; to be published in *COMPTE-RENDUS DE L'ACADEMIE DES SCIENCES*.

2. Financed in equal amounts (Fr8 million each) by the Ministry of Research and by Rhone-Merieux, the national research program on livestock cloning brings together teams from the INRA, the CNRS [National Center for Scientific Research], the INSERM [National Health and Medical Research Institute], the Pasteur Institute, and Rhone-Merieux. A technology transfer agreement was also signed by the INRA and the National Union of Insemination and Breeding Cooperatives (UNCEIA).

Germany: Biofilters, Bioscrubbers for Chemical Processes

93WS0392A Frankfurt/Main FRANKFURTER
ZEITUNG/BLICK DURCH DIE WIRTSCHAFT
in German 11 Mar 93 p 8

[Article by "JB": "Biofilters Can Also Be Economical. Advantages With Low Concentrations and High Volume Flows"]

[Text] Frankfurt—Biofilters and bioscrubbers can be the more reasonable-cost alternative to conventional exhaust-air processing methods. Dr. Michael Saake of Aqua Consult Ingenieur GmbH [Consulting Engineer Limited Liability Company] (Mengendamm 16, 3000 Hannover 1) is coming to this conclusion. The biotechnology methods offer advantages particularly with relatively low concentrations of organic exhaust-air components and high volume flows, Saake believes.

With such methods the organic components of exhaust air, after absorption in the filter, are degraded by bacteria having special degradation properties. While mainly the food industry and municipal purification plants have thus far made use of biofilter methods, now

they would be used also increasingly for cleaning solvent-containing exhaust air in paint and lacquer manufacturing, in wood- and plastics-working plants and in automobile shops.

Biofilters are also being used for deodorizing strong-smelling streams of exhaust air. The range of organic compounds degraded in the filtering process is large. They include, for example, aromatic hydrocarbons like benzene and xylene, sulfur-containing compounds like hydrogen sulfide and thiocyanate, amines and nitriles from the group of nitrogen-containing compounds, and halogenated hydrocarbons.

Simple biofilters often consist only of several fill layers of peat or compost by way of a carrier material through which the exhaust air flows. More expensive are bioscrubbers, in which exhaust air components are first adsorbed, are enriched in the scrubber liquid and are first then degraded by bacteria. However, such processes also have drawbacks, including being limited to organic components of exhaust air that are easily, or to a medium degree, soluble in water and in which the bacteria adapt to specific conditions.

The capital outlays for biofilters and bioscrubbers are between 25 and 60 German marks [DM] per cubic meter of exhaust air per hour. The operating costs—at DM0.50 to DM2.50 per 1000 cubic meters of exhaust air—would also be comparatively reasonable. One would have to reckon on capital outlays of approximately DM80 and operating costs for catalytic oxidation or thermal combustion of between DM2 and DM10 per 1000 cubic meters of exhaust air for the thermal afterburning of equal volume flows.

According to the results of a study by Aachen University, the threat to the environment from the use of biofilters and bioscrubbers is small. Human health hazards from pathogenic germs from biofilters and bioscrubbers are not to be feared, it reads further.

UK: Ligands Developed for Protein Cleaning

93WS0393D Frankfurt/Main FRANKFURTER
ZEITUNG/BLICK DURCH DIE WIRTSCHAFT
in German 17 Mar 93 p 8

[Article by "bh.": "Ligands for Protein Cleaning. Cambridge University Improving Ligands for Affinity Chromatography"]

[Text] Frankfurt—Many biotechnologists see in the use of custom-made ligands for affinity chromatography a decisive prerequisite for cost reduction in the production of recombinant proteins. The first successes in the production of so-called biomimetic ligands, those that imitate the natural bonding behavior of proteins, have already been achieved for the cleaning of various enzymes. The merits of biomimetic dye-based ligands lie not only in the cost. They are easy to synthesize and they are very stable, reusable and biologically inert.

An entire series of proteins like albumin, hydrolases, lyases, nucleases and other enzymes are presently being cleaned by means of affinity chromatography with immobilized Cibacron Blue F3GA, the dye part of dextran blue.

This kind of affinity chromatography is sufficient for the production of commercial enzymes. However, for numerous recombinant proteins that are to be used as medicines, the question arose of how the dye ligands can be improved in order for the expensive macromolecules to be able to be obtained with the highest purity and a good yield at the same time.

By means of computer-aided analyses of the bond relationships between the dye ligand and the bonding protein, researchers at the Institute for Biotechnology of Britain's Cambridge University have produced "custom-made" ligands with which the macromolecule to be cleaned forms an especially strong bond.

The fact that the cleanest crystals for X-ray structure analysis and a wealth of bond data are necessary in order to custom-synthesize protein ligands, however, for the present must be making harder the development of "designer" attachment points.

It has also not yet been clarified how the occasional separation of ligands from the matrix and the contamination of the product by this with ligand molecules can be prevented. In spite of these open questions, many biotechnologists see in affinity chromatography with custom-made ligands a promising method for cleaning high-grade biomolecules.

Netherlands: Biotechnology Firm Develops High-Efficiency Immunoassay

*BR0405151793 Rijswijk BIONIEUWS in Dutch
10 Apr 93 p 1*

[Article by Wim Zeijlemaker: "New Generation of Assays Based on Conventional Textbook"]

[Excerpts] The Leiden-based company Holland Biotechnology (HBt) has developed a new immunological test system. "A breakthrough," according to director Pieter Koning. "The system's sensitiveness is at least 20 times that of similar systems which are already on the market."

HBt has been looking for a simple test system on the basis of (monoclonal) antibodies since 1985. There are two approaches to doing this: "An immunoassay usually consists of two components: the antibody and the labeling system. Antibodies are hardly unique, because a patent on an antibody can already be bypassed by producing an antibody which is effective against another epitope in the same antigen. We therefore chose the other way, the labelling system," said Koning.

The Leiden researchers began with the "sol particle immunoassay (SPIA)." [passage omitted] Searching

through the literature, they came across the idea of carbon and silica sols. Finally, the decision was made to use carbon.

Financial Possibilities

The new system has attracted great interest, according to Koning. "HBt is holding in-depth license negotiations with a diagnostics company operating worldwide, which will most probably adopt the carbon-sol SPIA for its pregnancy tests." The world market for these tests is worth some \$350 million. HBt intends to use the carbon-sol SPIA to develop tests for cytokinins, for instance, as well as for tumor markers and bacterial and viral antigens. HBt is also continuing work on silica as the carrier for the SPIA. This would allow a yet wider scale of applications, because the silica particles can be labeled with colored or fluorescent compounds. Koning also anticipates many possible applications in DNA probes. "We can now harvest the results," he said, "because we have protected our know-how well enough with patents. We are holding discussions with other companies which want to take out licenses for the technology. We are too small to be able to do it all ourselves."

Little Breathing Room

During its eight-year existence, Holland Biotechnology has often stood on the edge of financial disaster. According to Koning, the climate for developing an idea into a marketable product is not good in the Netherlands. "The existing subsidy regulations, such as the Technical Development Credit (TOK) and the PBTS [Program for Industrial Technology Promotion] are absolutely insufficient. Development work does not count in the Netherlands; neither for scientists nor for financiers. In the United States, there would be absolutely no problem in attracting capital investment with this know-how and the position of the patent."

French Genome Project Officially Launched

*BR2104145393 Paris LA RECHERCHE in French
Apr 93 p 370*

[Unattributed article: "Small Genomes in the Shadow of the Human Genome"]

[Text] After two years of preparation, the French "Genome" project was launched officially in February following the announcement of the establishment of the "Genome Research and Study Group" [GREG] in the JOURNAL OFFICIEL. GREG was set up as a public interest group tasked with coordinating and financing the research project. GREG will coordinate human genome projects as well as those involving sample organisms. First announced in October 1990 by [then] French Minister of Research Hubert Curien, the setting-up of the project has been surprisingly lengthy and apparently fraught with dispute. At the heart of the issue lies the human genome itself, which, via the Research Center for Human Polymorphism [CEPH] and Genethon [company], already is receiving both public and private

funding. These investments are considered excessive by those favoring preliminary studies on small sample genomes, and insufficient, according to D. Cohen, CEPH director. More specifically, the organizational problems of GREG were caused in part by power struggles between various organizations over the running of the project. J. Hanoune, a biologist with INSERM [National Institute for Health and Medical Research], whom Hubert Curien tasked with the establishment of GREG, has been criticized for all the errors and delays. He resigned from the project in August, 1992, and was replaced by Piotr Slonimski, former director of the CNRS's [National Center for Scientific Research] Molecular Genetics Center in Gif-sur-Yvette. Matters have since accelerated, culminating in the setting-up of the GREG board of directors in March 1993.

The 1992 call for bids produced more than 150 research project proposals which were received and examined by a scientific committee led by P. Slonimski. Approximately 80 projects were retained and received 100 million French francs [Fr] in 1992, of which 20 were immediately allocated to the CEPH. In addition, according to Jacques Laporte, in charge of genome research for the Space and Research Ministry (MRE), "10 project proposals, mainly concerning sample genomes, arrived late but will be financed from the 1993 budget." This year's budget should amount to Fr84 million, not counting the Fr28 million allocated to the CEPH.

A number of researchers are wondering why their projects were refused as no explanations were given. Others suspect that the "delay" in small genome projects was caused by administrative red tape....

The GREG has six years to prove its worth (i.e., the official life span of a public-interest group). If the organization does not achieve its goals, researchers will have to turn to EC Commission programs for support, and thus likely incur delays in the race for sequencing small genomes.

The future of the human genome project in France essentially depends on the future of the CEPH and of Genethon. However, the project definitely is on the right track given the high number of spectacular scientific results published over the last few months.

COMPUTERS

Bristol Firm Develops New Transputer Microprocessor

93WS0270a London THE DAILY TELEGRAPH
in English 22 Mar 93 p 30

[Article by Leon Clifford (writes for ELECTRONICS WEEKLY): "All Agog for the New Transputer"]

[Text] World-beating computer technology developed in Britain will be unveiled this week by Inmos, the Bristol-based microchip firm. Inmos, founded by the last Labour government and now owned by French-Italian

chip maker SGS-Thomson Microelectronics, will launch a new version of its transputer microprocessor—called the T9000—on Friday.

The T9000 is the first major chip to come out of Inmos since it was bought by SGS-Thomson in 1989.

"This is the next-generation transputer," said Inmos managing director Michael Wright. "It is 10 times more powerful than current devices and it is the most complex, most high-performance device SGS-Thomson has ever made."

The transputer is particularly good at doing the kind of tricky calculations most other microprocessors, such as those in personal computers, find difficult—graphics, voice processing and character recognition—according to designer David May.

Transputers have also been used to make supercomputers that are much cheaper than the machines made famous by American computer firm Cray. This is because hundreds of transputers can be bolted together cheaply and easily to make extremely powerful "parallel processing" computers.

Machines such as these are used in universities, in defence laboratories and in aerospace firms, including British Aerospace.

Germany's Parsytec is one of a number of companies developing parallel processing supercomputers around the forthcoming T9000 transputer. It will show a working system built from a single T9000 on Friday.

Richard Horton, Parsytec's British managing director, said that because the T9000 is more than a year late, his company has had to be patient. "We had no choice but to wait. It is the only chip capable of such integration."

Bristol-based supercomputer maker Meiko found that it could not wait for the T9000 and turned to rival technology offered by Fujitsu, the Japanese computer giant.

Another start-up specialising in transputer-based supercomputers, London-based Parsys, coped with the delay by going after new markets with existing designs—markets such as banking, where raw processing power is less important. Dr. David Watson, managing director, said: "We have supercomputer designs on the drawing board ready and waiting for the T9000."

Inmos puts the delay down to the sheer complexity of designing a single chip with more than three million working elements—which makes designing the T9000 about as complicated as building a jumbo jet the size of a finger nail.

Despite all the apparent activity, only about a fifth of transputers end up in supercomputers. Most go into more mundane systems such as clever robots and telecom equipment.

Last year, Inmos sold some 285,000 transputers for a total of more than £20 million. The largest single use for the transputer so far is in a portable satellite navigation box for lorries and ships built by Japan's Panasonic.

"The transputer is certainly one of the leading microprocessor architectures," said chip industry analyst Mike Glennon, of Dataquest. "Transputers do not sell in personal computer volumes, but they do very well."

Which raises the question of why a technology developed in Britain, with the help of British taxpayers' money, should end up being successfully exploited by a foreign company.

The simple answer, says Mr. Glennon, is money. Up-to-the-minute manufacturing facilities were required, and he thought it highly unlikely that the T9000 would have been developed without the involvement of SGS-Thomson.

Michael Wright, of Inmos, pointed out that SGS-Thomson will eventually make T9000 chips at its new factory at Crolles in France, which cost several hundred million pounds to build. "Such a facility can be justified only by companies such as SGS-Thomson that make a large number of products." Inmos could never have afforded such an investment on its own; nor would the city have approved of Thorn pumping in the necessary money when it bought Inmos from the government in 1984.

Today, Inmos is almost totally incorporated into SGS-Thomson, employing around 300 people compared with 1,100 at the time of the acquisition. Its factory at Newport has been sold to a consortium backed by a Hong Kong electronics manufacturer, and the transputer is being marketed worldwide by SGS-Thomson.

"Inmos still has a name, it still has a sales force and the transputer itself has a place in the industry," Mr. Glennon said. "The transputer has been around a long time. I would say it's a stayer."

Germany: Research in Virtual Reality Applications

93WS0302A Frankfurt/Main FRANKFURTER
ALLGEMEINE in German 3 Mar 93 p N2

[Article by Klaus Dieter Linsmeier: "Shopping in Cyberspace"]

[Text]

On the Commercial and Scientific Utilization of Virtual Reality

One person foresees easier operation of the computer; another, a tool for visualizing scientific data. "Cyberspace," a programmed virtual reality, has developed in recent years to a preferred area of computer research. The standard equipment includes a high-performance graphics computer, data helmet and data glove. Two tiny monitors in the helmet produce a three-dimensional imaginary world before the eyes of the user and isolate him, at least visually, from his actual environment. The

glove is equipped with sensors. These sensors detect hand and finger motion and transmit such motion into the world of the computer. Using the image of his hand, the user controls his stay in this world. He can simply wander around or grasp, move and place objects again.

For the first time in Germany, virtual reality was the topic of a scientific conference. Two Stuttgart Fraunhofer Institutes, the Institute for Production Engineering and Automation (IPA) and the Institute for Labor Economics and Organization (IAO) organized the conference. These institutes offer developments for economic planning or scientific simulation and are looking for appropriate project partners. The technology, it was reported, is so mature that it can be improved during application. The development chances presented by virtual reality should not be left to the United States or Japan.

Until now, virtual reality only had a convincing effect if the quantity of data to be managed was sufficiently small, such as for architectural designs. The liquid crystal monitors built into the data helmet have a resolution like the screens of conventional personal computers. Besides, there is still a lack of image definition. There is still a lot to do in hardware and software until these applications become widespread.

However, science and industry see several possible applications. Commercial enterprises, for example, imagine using cyberspace in a mail-order company of the future. In a three-dimensional scene, the customer views an item of clothing and can see it under different lighting conditions. This could prevent a later surprise.

One of the first users is a furniture manufacturer. He contracted with the Fraunhofer Institute for Labor Economics and Organization for the development of a furnishing program. In this way, a virtual room can be equipped with furniture from the catalog. The colors of the items of furniture and their positions can be changed. To facilitate using the system, the engineers came up with a belt that appears in cyberspace. Functions, with their own symbols such as searching, moving or rotating furniture, are placed on this belt and can be selected using the data hand.

In the Vital project, biologists will have the chance of performing their experiment apparently in a Columbus laboratory. In this way, the individual steps are to be converted into instructions for robots. A personal computer appears just as suitable for such simple instructions. Virtual reality will only be able to provide advantages when the sensory information of the robots is also visualized. The German Society for Aeronautics and Astronautics developed just such a control system, for example, for Rotex, the D2 experiment.

Loss of visual contact with the environment is often undesirable. Consequently, for a simulator that is to reproduce the driving behavior of a truck, the landscape is not represented using a data helmet but rather with three projection screens. The angle of view is 170 degrees. Two computers generate the monitor images of the rear-view mirror. A

hydraulic system simulates the swaying motions of the cab during braking and acceleration. The simulation is very close to reality. The simulator was originally developed by a Munich armament manufacturer. The Munich transportation services are also interested in it. Using the simulator, training of subway drivers could move into the simulated environment.

The simulation and imaging of scientific or engineering data is perhaps the most important area of application for virtual reality. Whether it involves the flow behavior of an air-conditioning system, the lighting in a planned office building, or the shades of contrast of images from computer tomographs—a visual analysis of high quality is possible by the three-dimensional representation and wandering around inside the data. However, the system is too slow for many applications and the resolution is too low. The inadequate technology can be unpleasant for the wanderer in the virtual world. If the time between the movement of the head and the calculation of the new image is too great, our visual system contradicts the internal recording of the motion. This results in headaches and nausea.

To prevent this, 15 to 30 complete images are necessary per second. The scientists of the Fraunhofer Institute have achieved improvements by preparing cyberspace beforehand using a Transputer. Parallel processors select those objects of a scene that can be seen by the observer and transfer these data to the graphics computer.

A system that needs neither the data helmet nor the data glove was recently introduced by Siemens. The virtual reality appears on a screen. The gestures of the human hand are recorded by an electronic color camera. The system differentiates between areas of different skin color and can make do without sensors because of this capability.

The technology has continued rapid development in the meanwhile. The Fraunhofer Institute for Graphics Data Processing in Darmstadt is even working on linking acoustic and tactile simulations. As the first projects are ready for application, research institutes and business enterprises founded a working group at the end of last year. This group is to allow the members to determine jointly the direction for development.

FRG: Substitutes for Fluorocarbons Viewed

93WS0302C Duesseldorf *HANDELSBLATT* in German
3 Mar 93 p 27

[Article by Elvira Moeller: "Technical Alternatives for Ozone-Damaging CFCs"]

[Text]

Polyurethane Insulation/Keeping the Air Clean Requires Know-How

Without a doubt, the ozone layer is being damaged by chlorofluorocarbons (CFCs) which also intensify the greenhouse effect. The CFC prohibition became law on 1 August 1991 in the Federal Republic as a consequence of

this knowledge. This law requires that the user find a substitute either immediately, or at the latest after the transition period considered for their products has expired.

The Federal Republic consumes about 100,000 metric tons of CFCs annually. Of these, about 25 percent are used as foaming agents in polyurethane foams and, of this amount, one-third are used in rigid expanded polyurethane. These materials serve as insulation foams in domestic refrigerators and refrigerating bodies on trucks or containers. They are also used as thermal insulation material in building construction. In these materials, CFCs do not only function as foaming agents. In the pores of the foam, they serve as an insulating gas and lend the material the desired mechanical properties.

As a result, the criteria for substitutes for CFCs are not only a considerably lower potential for destroying ozone, but a coefficient of thermal conductivity that is as low as possible.

Substitutes and Tasks

In addition, the Technical Instructions for Preserving Air Quality (TA Luft) currently prescribe for all systems producing rigid plastic a maximum emission value of 150 mg/m³ for all foaming agents as of 1 April 1991. Thus, this also applies to the organic substitute products under discussion. Production systems processing more than 200 kg/h of raw materials require a permit in accordance with the fourth Federal Air Pollution Control Regulation (BImSchV). Even more stringent legal requirements are to be expected in the future, in particular for halogenated hydrocarbons.

The substitutes can be classified into four groups:

1. Halogen chlorofluorocarbons (H-CFCs). These products are commercially available under the names R 22, R 142b, R 123, and R 141b. They are technically mature, their thermal insulation values correspond, with slight trade-offs, to those of R 11, the most frequently used CFC. Production can be converted to the new foaming agent without major difficulties. The potential for destroying ozone is considerably less as compared to R 11. The greenhouse potential is relatively high. The maximum workplace concentration (MAK) for R 123 is expected to be set at 10 ppm. A prohibition of this product group can be expected if the ozone degradation continues to accelerate so that long-term planning is only possible with difficulty. If you make use of these substitute products, you must know that the TA Luft applies to them in any case.

2. Fluorocarbon (H-FC or FC). Based on the potential for destroying the ozone of compounds containing chlorine, industry has concentrated on products containing only fluorine besides carbon and hydrogen. Their development is not yet completed but even now the thermal insulation of the foams is almost as good and conversion

to production has virtually no problems. The compounds have a high greenhouse potential. Prohibition here, too, is expected starting in 1995 so that long-term plans are difficult.

Hydrogen fluoride and—just as is the case for H-CFCs—perhalogenated carbonyl compounds are created when decomposed in the atmosphere. The effects of these compounds on the environment have not yet been satisfactorily clarified. Good results with regard to the thermal insulation are obtained with fully fluoridated products, for example, C_5F_{12} . However, as such materials remain in the atmosphere for centuries, conversion is very questionable from an ecological standpoint.

3. Combustible hydrocarbons (e.g., pentane). Very few manufacturers in the Federal Republic have decided to convert to pentane. The main advantage, namely the lack of chlorine or fluorine, is contrasted with a few disadvantages. The thermal insulating values are poorer, the behavior over time of the thermal insulation is not yet sufficiently known. Conversion of production requires designing the system and air purification system using explosion protection because of the combustibility of pentane. These measures, if applicable, make the product too expensive and it can only compete with difficulty with polystyrene in building construction.

4. Carbon dioxide. The best variant, in terms of the ecology, is chemical foaming of polyurethane foam using water. Carbon dioxide results from water and isocyanate. The thermal conductivity of carbon dioxide is low enough to produce material with good thermal insulation. Carbon dioxide does not require any air purification measures, has no potential for destroying the ozone and thus would be a permanent solution.

These advantages are countered by the fact that this gas diffuses out of the foam at layers open to diffusion and the ambient air does not penetrate into the pores at the same rate. This reduces the thermal insulation to values for foams using air as the cell gas. Negative pressure occurs in the empty pores. This negative pressure impairs the strength primarily in the edge layers. This can only be compensated by increasing the specific gravity which increases the price of the products. The poor insulation properties would result in increased energy consumption and thus increased emissions with the same insulating layer thicknesses. The method requires a more expensive conversion of production.

As a result, it must be expected over the middle term that either H-CFCs or pentane will be used as foaming agents. In both cases, the air purification design required to satisfy TA Luft is difficult. H-CFCs are not adsorbed by activated charcoal without additional measures. They separate HCl so that the entire recovery system must be made of corrosion-resistant material. With pentane as the foaming agent, the entire system must be designed for explosion protection.

During desorption, all foaming agents absorb water. To prevent a reaction with isocyanate, they must be dehydrated. Foaming-agent mixtures also make the recovery design difficult. Just these examples show that the construction of the air purification systems requires special knowledge for the production of polyurethane foams.

Germany: 20 Giga-flop CPU Developed

93WS0355A Frankfurt/Main FRANKFURTER
ZEITUNG/BLICK DURCH DIE WIRTSCHAFT
in German 25 Feb 93 p 8

[Article by P.W.: "Simulation With Giga-flop Computers; Europe Wants To Acquire Experience With High-Performance Computers"]

[Text] Aachen—Parsytec Computer, Inc., (Roermonder Str. 197, 5100 Aachen) has developed a processor system for the four newly-established centers (Athens, Amsterdam, Cologne, and Paderborn) for high-performance computing in Europe. A total of 1,024 processors operate inside the GCel parallel computer. They at present provide a data throughput capacity of 20 giga-floping-point operations (giga-flops) per second. The performance capability will probably be raised to the teraflop level by the next product generation.

The Aachen company is integrated into a European cooperation network that brings together 80 partners from the fields of industry and research and which handles everything from the basic VLSI [very large-scale integration] technology with RISC [Reduced Instruction Set] T9000/T085 processors made by SGS-Thomson to System Environment with Compiler Technology by Ace Amsterdam.

The advantages of supercomputing for products are applied in simulation in the construction industry and in the simulation of technical-industrial and economic processes. This includes fields of application like fluid mechanics, structural analysis, molecular design, and production processes. High-performance computing with these Parsytec computers is already being used in medical diagnosis systems and in driving as well as flight simulation. The GCel system can also be used for basic research, for example, in climatology, bioinformatics, and quantum mechanics.

The four computer centers for high-performance computing are in Athens, Amsterdam, Cologne, and Paderborn. They are working on the problems involved in how the efficiency of massively parallel computing can be applied to industrial uses. Furthermore, they plan to acquire experience in the use and operation of massively parallel computers in the European combine.

Parsytec installed one 1024-processor system each in Cologne and Paderborn. Amsterdam and Athens were each provided with a 512-processor system of basically the same type of construction. Meanwhile, according to Falk Dieter Kuebler, general manager of Parsytec, the results of the initial experiences are already available.

Thus, Parsytec says that its performance capability can be increased 10-fold in the coming year on the basis of the RISC T9000 processor, which with a 0.8-micrometer technology and 2.3 million transistors represents a worldwide standard for maximally integrated logic chips. Unlike conventional microprocessors, RISC processors operate with a reduced command. User programs prepared with it can thus be executed faster.

Fuzzy Logic Applications

Airport Technology

93WS0375A Berlin *INGENIEUR DIGEST* in German
Jan 93 pp 31-32

[Article: "A Little Bit Right Is Often Enough"; first paragraph is editor's lead]

[Text] Fuzzy logic as an engineering solution for the future for critical control tasks or expert systems is already showing its strengths in practice today. The theory of fuzzy sets has quickly gained a foothold precisely in those disciplines where it is very difficult or not possible to mathematically describe formulations of problems. There is hardly a manufacturer left today that offers process control systems without fuzzy logic components; fuzzy logic chips and FASICs are the standard for the technology. Heiko Knappe, director of development at Schroeder Airporttechnik in Oberschleissheim, describes the role fuzzy logic is playing in the development of automatic controllers.

Fuzzy logic is a new type of logic introduced in 1965 by Prof. Lotfi A. Zadeh at the University of California at Berkeley. It is much closer than binary logic to the human way of thinking since it allows not only the expressions "right" or "wrong," but also the levels in between them. Thus, each expression is assigned a real value which indicates the degree of the correctness. That is why it is also considered a multivalued logic in which binary logic represents a special case. The fuzzy logic rules are closer to the human way of thinking; they allow "a little bit right" too. Fuzzy logic control is therefore "rules with human logic." Moreover, the basic theory, which no longer needs a mathematical model, is clearly simpler and more easily grasped.

In Japan, the new theory was very quickly accepted and implemented in industrial and consumer products: to prevent blurring in video cameras, in subway controls, for braking at platforms, and for control of entire production units. In Europe and America, however, the new logic had to first be analyzed scientifically. Now the time has come to profitably introduce the theoretical experiences into products here too. Meanwhile experts estimate Japan's lead has grown to almost 10 years. People want to catch up now, but the tools and know-how are needed for that.

Fuzzy logic has quickly entered into expert and control systems. Expert systems can also certainly be found here and there already in the industry, but they are far from

being mature. The greatest problems are still caused today by the modeling of uncertainty in the data and in the knowledge base. Remedial measures can be taken here by using the fuzzy set theory which can process the "fuzzy" data and linguistic formulation. The same statement of the problem exists in designing control systems. In this case, a suitable change of the manipulated variables must be established for a given system state. An interpretation and evaluation of the state by using rules is conceivable for this, especially when imprecise, fuzzy measurement data or inconsistent system requirements must be processed.

Unlike linear methods of classical control engineering, which implement a controller synthesis on the basis of mathematical controller and system descriptions, a completely new form of information can enter into controlling by using fuzzy logic. Instead of mathematical models and differential equation systems, a return to verbally formulated if-then rules for control interpretation is made. Controller design and inauguration are thus considerably expedited. Since nonlinear controllers can be built by using fuzzy logic, free modeling of the state space is possible. In the case of nonlinear systems, that leads to better operation/disturbance action and to higher robustness.

In the concept of a fuzzy logic controller, a series of parameters must be set. Since the parameter selection is heuristic, regulation can be automated by using adaptive fuzzy logic controls. In controller design, generating the rule base when there are many input and output values is very laborious since these quantities have an effect on each other. The use of fuzzy logic is often not practical to control technical processes for which there is already a mathematical model, but no rule strategy. But the design is not exactly simple either for all other application cases. A number of prior experiences are required to set up suitable rules and associated functions in correlation with the system to be controlled. On the other hand, an advantage of fuzzy logic control design is that all statements can be expressed with language and no mathematical model is required. Adjustment occurs then through modifications of the rules and functions. Fuzzy logic control is therefore best suited especially for nonlinear control with which most real processes run.

Naturally, fuzzy logic control is no panacea for all problems in control engineering; it is rather a complement to traditional techniques. That will remain so for a long time too. The future lies in the combination of traditional and fuzzy controllers, in hybrid methods.

An example of fuzzy logic control is the control of mixing ratios and the spray amount of an aircraft de-icer: Aircraft are de-iced before takeoff with a mixture of hot water and de-icer which is applied under pressure to the wings and tail. A fuzzy logic controller which shows good transient and fine control behavior through its nonlinearity allows avoiding complicated controller switching. Also, on and off logic which must be separate in linear PI controllers could now be built into the rule base. In

addition, simultaneous implementation of flow and pressure control is now possible.

The advantages of fuzzy logic controllers in general are an extremely fast development time, programming that is less susceptible to error, better operation and disturbance action through nonlinear control, enhanced robustness, simultaneous implementation of controllers for various input values or system states, no need for system modeling, use of imprecise sensors and the possibility of controlling nonlinear systems or those for which it is not possible to describe to build a model.

Photo Captions

1. p. 31: Fuzzy control in aircraft deicing: controller switching is avoided, on and off logic is integrated into the rule base, flow and pressure control are implementable simultaneously. Photo by Eisenwerk Friedrich Schroeder. [not reproduced]

2. p. 31: Fuzzy logic: It is especially helpful when imprecise, fuzzy measurement data or inconsistent system requirements must be processed. Photo by IBM. [not reproduced]

University of Leipzig

93WS0375B Berlin *INGENIEUR DIGEST* in German
Jan 93 pp 32-33

[Article: "SEL Research Prize; Fascination with Fuzzy Logic: Leipzig Researcher on the Trend;" first paragraph is editor's lead]

[Text] For the 13th time now, SEL has honored a scientist for applications oriented basic research in the field of communication of economic and technical systems. This year, the recipient was for the first time from eastern Germany: Prof. Dr. Siegfried Gottwald from the Department of Philosophy, University of Leipzig. Dr. Juergen Grubitzsch spoke with him at his Leipzig office.

If the information from the design departments of Japanese color copier manufacturers is correct, fuzzy logic is also a directly imminent blow against the most convenient way of multiplying your money: The color copiers of the next generation, you see, recognize the most common bank notes and refuse reproduction when a copy of a bank note is expected from them. Then just a black and white reproduction is printed. That is technically possible through an electronic control mechanism based on fuzzy logic. A few features of the corresponding pattern, for example the portrait of the architect Balthasar Neumann in conjunction with the number 50 and Helmut Schlesinger's signature are enough to refuse a color copy. As the Tokyo firm Omron reports, the fuzzy logic chip should be able to recognize 100,000 bank notes of 23 different currencies per second.

"But that alone is still not 'fuzzy logic,'" Siegfried Gottwald, who studied mathematics, explains and tries a closer characteristic: Technical processes are traditionally described as precisely as possible in mathematical

formulas and equations. That makes the exact precalculation of their processes possible. But that requires a highly detailed model which requires a lot of scientific resources. Then feeding the model with data often requires many measuring points and computer equipment with high capacity for processing the data. In comparison to that are the mostly verbally formulated concepts of operating instructions from everyday life which are more or less sharply defined. Thus, to keep a water boiler at a constant temperature, the given goals of "hot" or "lukewarm" are enough. Or to balance different drops in temperature through a flow of hot water or cooling, the energy supply levels "high" or "medium" are sufficient.

"Fuzzy logic allows processing by computer using imprecise data to that which has been done with traditional mathematical logic," Gottwald explains. Set theory and multivalued logic contributed to the basic ideas for that. Instead of the absolutely right or wrong, of the either-or, the fuzzy logic judges with approximate values. All levels between the two extremes are assigned as affiliated factors of fuzzy sets. In the process, the usual scale ranges from 0 to 1. Each value in between is represented by a precise number which allows quite normal computation. For simplification, that can be interpreted as an applicable percentage of a possibility. A water temperature of 60°C, which would approximately be verbally described as hot, would e.g. be assigned the property hot with the value 0.7. That means that the claim that this water is hot is at the 70 percent applicable level.

"The philosophy of technical systems based on that opens up fascinating prospects," Gottwald says enthusiastically. Many practical cases of process control might therefore be able to be quite reliably controlled with relatively undetailed models, approximate values and few, imprecisely formulated rules. It is advantageous everywhere where the abundance of data flowing in is not easily comprehensible. Designs of rough models are then simpler and less expensive. Procedures can be handled by smaller computers and in less time; in many cases, real-time operation is possible. However, the problem of making a computer technology operating with the hard opposites 0 or 1 process fuzzy data through suitable algorithms had to be solved.

Two decades ago, shortly after the world-renowned article "Fuzzy Sets Logic" by Zadeh was published, Gottwald began taking an interest in fuzzy logic from the mathematical side. Theoretical problems about the basic principles of the application formed his publications. In 1989, together with Hans Bandemer of Freiberg, he published the first German-language "Introduction to Methods of Fuzzy Logic," which is now in its fourth edition.

Gottwald recalls that there were application oriented works even back in DDR times: glass and electrode manufacturing in industry, projects at colleges and universities, developments of expert systems for medical diagnostics and therapy. He sees Japan's decisive lead

"in an entire stratum of young engineers who know what fuzzy logic is." In the spring semester at the Darmstadt TH [Institute of Technology], however, he made a dent by teaching the first coherent course on fuzzy logic. "And along with the technology, we should also see the economy—calculation of market prospects, solvencies, credit worthiness." Prof. Gottwald wants to pave the way for that too in his book *Mathematical Aspects of Fuzzy Logic* which is to be published in the spring of 1993.

Photo Captions

1. p. 32: SIEGFRIED GOTTWALD: "All levels between the two extremes are assigned as affiliated factors of fuzzy sets." [not reproduced]
2. p. 33: SIEGFRIED GOTTWALD: "Many practical cases of process control can be solved with relatively coarse models, approximate values and simply formulated rules." [not reproduced]

Chemnitz Consulting Center

93WS0375C Berlin *INGENIEUR DIGEST* in German
Jan 93 p 34

[Article: "Academics Support Industrial Projects"]

[Text] Fuzzy logic has been a research subject in Chemnitz for more than 15 years. A small research group around Prof. Steffen Bocklisch wants to pass on its knowledge and has established a "Consulting Center for Fuzzy Logic Technology" in Chemnitz. Services offered are:

- applications consulting and training, preparation of expert reports for fuzzy logic technologies and related methods
- execution of research and development projects in collaboration with the Chemnitz TU [Technical University]
- licensing and support of fuzzy logic software tools.

The scientists see the main focus of their work in project execution. A fuzzy logic model for a given task and the required software is developed together with the customer.

Available for that is the FUCS (Fuzzy Classification System) software package with which classification systems for diagnosis, monitoring and control tasks can be developed and tested. For the special development of fuzzy logic classifiers on site, the scientists have created the on-line systems micro-FUCS and process-FUCS which allow on-line operation at the process through a PC. Then there the information can be directly recorded, features formed and classifiers be developed. After the "learning phase," the system is usable immediately as a diagnosis or monitoring device. For "fuzzy logic control," there is the FUL (Fuzzy Logic) software tool with which knowledge can be interactively implemented and elaborated into fuzzy logic rules.

For further information, contact: Dr.-Ing. Joern Burmeister, Consulting Center for Technology, Seydelstrasse 32, O-1080 Berlin, Telephone 030/2293927.

Photo Caption

1. p. 34: Strategy for the design of classification models using fuzzy logic: Measurement and observation values are obtained from a process and supplied to a development system which then formulates the affiliation functions. [not reproduced]

Automated Production

93WS0375D Berlin *INGENIEUR DIGEST* in German
Jan 93 p 34

[Article: "Process Automation: Control Systems Using Fuzzy Logic"]

[Text] In the TELEPERM M process control system from Siemens, alternative control methods with fuzzy logic control can now be integrated into the process automation. In process automation, using fuzzy logic makes sense anywhere where the process is very difficult to describe mathematically or can be automated only a very large amount of resources. That applies especially in controlling extremely nonlinear processes.

Developed specially for the AS 230 and the AS 235 automation systems were fuzzy logic modules which translate imprecise expressions such as "small" or "cold" into affiliation functions and, based on the rules about the process knowledge, compute the fuzzy logic controller output values from the input values. A special project planning tool is available for the structuring of the fuzzy logic controller.

Better Control and Higher Quality

This fuzzy logic project planning tool supplements the engineering work station for the structuring. As soon as the fuzzy logic controller is developed and integrated into the automation structure, the control system can be switched to control with fuzzy logic control. For the most part, however, the fuzzy logic controller is appropriately used in parallel with the conventional P, PI or PID controllers. The controller is optimized by observation of control results and subsequent modification of the affiliation functions or the control action.

Compared to conventional control technology, the advantage of fuzzy logic control is improved control quality and therefore higher product quality and higher productivity of production. Maintenance personnel look after the operation of the fuzzy logic function module centrally with the OS 520 or OS 265-3 operating and observation system just like a conventional standard function module.

Analytical Controller Cleans Waste Gases

Together with scientists in Zittau, the development engineers of ABB Kraftwerksleittechnik [Power Station

Control Systems] in Mannheim developed a new type of control method which uses the advantages of fuzzy logic controllers but avoids its disadvantages such as fluttering control valves or set points not maintained exactly. The innovation is called the "knowledge based analytical controller" (WAR). With it, the various manipulated variables can be determined through an analytical method instead of through a fuzzy set. The results are continuous, analytical functions which unambiguously assign an output value to each process state.

The knowledge based analytical controller has already successfully passed its pilot test in the flue gas denitrification plant at a south German power station where it depended especially on optimized spraying of ammonia into the waste gas flow under continuously changing operating conditions. Severe fluctuations in the NO_x concentrations, which were not directly measurable, previously led, during the load cycle or when the catalyst was used up, often to harmful NH_3 surpluses which with sulfur oxide formed poisonous ammonium sulfate. Using the analytical controller caused a drop in ammonia consumption by 50 percent. According to estimates by the operators, a ton of ammonia can be saved every day now.

The knowledge based analytical controller has already been submitted for a patent. The development team now wants to develop the controller further for other applications too. For instance, a fuzzy logic controller for control of burning in a fluidized bed boiler. The goal of all the developments is to develop fuzzy logic components which only have to be switched on after they are put into operation. That is how the control concepts for safe and reliable power station operation can be implemented.

EC Launches Massively Parallel Computer Project *93WS0386B Paris AFP SCIENCES in French* *18 Mar 93 p 14*

[Article: "CERN Supercomputer Initiative"]

[Text] Geneva—Under the aegis of the European Community's computer research program ("Esprit"), and with financial support from the Community, CERN [European Particle Physics Laboratory] has just launched a project in the field of massively parallel computing.

This will be the first time CERN serves as principal coordinator of a project that will cost several million ECU, a fact which shows the strengthening of ties between CERN and the Community.

The other partners in the project, officially launched after a meeting of their representatives on 8-9 March in Geneva, are the European Center for Research and Advanced Training in Scientific Computing (CERFACS), the major French, German, and British meteorological and climatological research centers, and Europe's three biggest supercomputer builders, Meiko, Parsys, and Telsat.

The project is a direct outgrowth of the "Report of the Consultative Committee on High-Performance Data Processing and Systems," prepared under the supervision of Professor Carlo Rubbia, director of CERN, and published by the Commission of the European Community.

Massively parallel processing is a new approach to supercomputer technology in which many (from 32 to a 1,000) processors employing the same technology as individual workstations are linked together to provide speed and power equal or superior to that of traditional big supercomputers.

The project is intended to help the European science community become accustomed to—and acquire expertise in—high-performance computing and should help build user confidence in European capabilities in massively parallel computing, a new domain that could acquire strategic importance.

The project calls for installation of two expandable massively parallel machines—one at the CERFACS computing center, the other at its CERN counterpart. Integrated into the data processing systems of these two institutes, they should support complex applications in the fields of physics and large-scale climatological and meteorological simulation programs. More than 50 scientists will work on the project over a three-year period. First results are expected in 1994.

France: Virtual Reality for Aerospace, Medical Applications

93WS0390A Paris MICRO-SYSTEMES in French
Mar 93 pp 134-137

[Article by Pierre Duncan: "Medialab: The French Top the Ratings"; first paragraph is MICRO-SYSTEMES lead]

[Text] Canal Plus's brand new subsidiary, Medialab, is interested in every aspect of computer graphics processing: real-time animation, special effects, and computer-generated images. It is also one of the few internationally recognized private companies to work in the field of virtual reality and to make it pay by landing development contracts.

Have you ever happened to watch a few frames of Mat Le Fantome [Mat the Ghost], the character who assiduously frequents Canal Plus's *Canaille Peluche* programs? Mat is one of the first creations to bring Medialab to the attention of initiates in the field of real-time graphical animation.

Medialab, a wholly French-owned company, is a research and production center for the new computer-generated image technologies. To achieve its goals efficiently, the young company has based its strategy on three main departments:

- The Short Program Department: Its programs consist chiefly of television credits.

- The Long Program Department: Its programs include series such as *Mat le Fantome*, *Chipie & Clyde*, which we will see in September, and others under development.
- The Industrial and Entertainment Program Department.

The Short Program Department mostly uses conventional 3-D computer programs to solve relatively simple problems. However, specific problems, such as certain cases of inserting real images into computer-generated ones, or vice versa, sometimes require the intervention of research and development teams. "In contrast, the other two departments call for impressively more imagination," says Nicolas Bouterin, manager for virtual reality development. All of Medialab's work goes back to the development of Goeff Levner's PORC (Puppet Orchestrated Real Time Computer) program, an oft-modified, oft-optimized, and increasingly powerful piece of software.

Imagina 93: Spotlight on Medicine

Imagina 93, which just closed two weeks ago, is one of the big international shows devoted to computer-generated imagery and virtual reality. Medialab used this forum to present the first results of its research in the medical field with an ambitious program. The program simulates surgical procedures in real time in order to help the operating surgeon avoid certain danger zones which he has previously flagged. The first part of the program recovers all of the patient's 2-D scanner images, as well as the 2-D images of the operating field, and reconstructs them in three dimensions. In order to avoid a technical dead-end, this phase of the work will be validated by a radiological congress to be held in June, 1993, in Chicago.

Later, Medialab will recover the 3-D images of any foreign bodies entering the operating field (scalpel, endoscope, knife, etc.). These objects will then be positioned in real time on the virtual copy of the operating field incorporating (naturally) the reconstruction of the patient's scanned zones.

In preparation for the operation, the surgeon will determine the danger zones and connect alarms on the virtual image of the operating field. The operation, however, will be a real operation on a real patient, but with additional information. If the surgeon is unsure, he will be able to look at the screen and see the position of his scalpel. If he gets too close to the zones he delimited beforehand, alarms will sound. The virtual copy will be intelligent and provide full real-time data feedback.

Medialab's research team is working with Dr. Christian Debry, ENT surgeon at the Hautepierre Hospital in Strasbourg and the project consultant. According to Nicolas Bouterin, it will be at least five years before an operation can be performed in this way. Certain ethical and technical problems will have to be overcome. This program will not make it possible to perform simulated practice operations, as envisaged by certain American

experimental virtual environment programs. Although it is relatively easy to reconstruct hard tissues like bones in 3-D, soft tissues are a much more delicate problem, despite the high demand in this field. Soft tissues move, and the computer will have to regenerate them constantly at very high speeds. This is still very difficult to do, even with powerful computers.

Virtual Museum Visits Via ISDN

In a totally different field, Medialab also presented its telepresence project at Imagina. The goal was to link two Silicon Graphics computers over the Numeris network. One machine was located in Monaco and the other was in Paris. Wearing a visualization helmet, each user was able to "visit" the IBM data base representing the Cluny Abbey in a virtual world, enter the grounds, and explore the interior. However, the most interesting feature was that, thanks to the ISDN [Integrated Services Digital Network] link, each user could also see and walk about the same virtual site with his remote correspondent, symbolized by a small figure. None of this requires intensive use of the Numeris network. Only the vectors are exchanged between the computers.

This experiment can be applied to other fields, such as medicine and games. Imagine, in the future, two remote surgeons navigating through a data base of 3-D scans and commenting on the analysis results. Or imagine a chessboard, in the form of a graphical data base, and two remote players connecting to it to start a game. Last year, a German researcher, Monica Fleischmann of the Art + Com company, presented her research on the implementation of virtual philosophical houses, to which anyone could connect and decorate his space to perfection via a telecommunications network.

Telepresence is one of the major focuses of tomorrow's research. It will be possible to consult graphical data bases such as virtual museums or maybe even virtual stores without leaving home. As to when we can anticipate such possibilities, that is another question!

Entering the World of Total Illusion

Suppose you want to be a painter, a sculptor, or a rock singer without any knowledge, without any equipment, and without going anywhere. You need only enter the imaginary world of Crik. The artist, Crik, supplied Medialab with sketches of two of the four universes in his work. These sketches were then used by Medialab's engineers and computer graphics specialists to design a virtual world. The first world is an artist's workshop, where it will be possible to paint or sculpt. The second is the universe of "rock and roll," in which you will have the sensation of being able to pick up a guitar and sing in a concert hall. Immersed in an imaginary world, the "apprentice artist" will be able to interact with the data base on the basis of the sets supplied by Crik. Although there is no sense of touch, the visual sensation of picking up a guitar and playing is completely realistic. These works were presented at Imagina and will also be one of

the main attractions of FIAC (International Festival of Contemporary Arts) in December 1993.

Simulation of Future Space Shuttles

Medialab's virtual reality application fields are eclectic. In July, the company will be delivering a simulation program to the European Space Agency (ESA) that will allow the Agency to visualize and ergonomically validate all the orbital stations or shuttles that will go into space. The goal of the exercise is to put the future user back into the production process. Astronauts will be able to visualize their environment before any production work starts on their future work space. Technicians will also be able to contribute to the development of shuttles by indicating whether or not certain details are conceivable or compatible with maintenance requirements. Each simulated element will be interactive and will have a life of its own. "We are supplying tools that will make it possible to put together design data bases to visualize shuttles or stations that will not be built for 10 or 20 years," Nicolas Bouterin says.

When the new season begins in September, Canal Plus will be broadcasting a new animated series called *Chipie & Clyde* with humanoid characters. This series is a world first for Medialab. Like *Mat le Fantome*, the characters were first created and modeled in 3-D by inputting their entire palette of expressions, then integrated into the real-time system developed by Medialab. *Chipie & Clyde* were animated by four traditional puppeteers (two per character) wearing sensor-packed gloves. One gloved puppeteer animates the face and the other, the body. The result is transferred directly to the screen, in the case of *Mat Le Fantome*, or to a 2-D or 3-D set for the new series, which has 26 episodes. Two to three weeks are needed to complete an entire six-minute episode of computer-generated images.

Chipie & Clyde

As for the story line, Clyde is some sort of creative, multidisciplinary wolf that has run out of ideas. Chipie is a little girl who sticks her nose in his business under the pretext of bringing him something to eat and makes him say a bad word, which sends them both into a parallel world. Clyde will use this to turn the situation to his own advantage.

The research work presented at these big international shows is very often five or 10 years from production. Few big names in the games industry will venture to set a release date for a product involving virtual reality. Nevertheless, a first demonstration attracted a crowd of visitors at Imagina 92. With an Amiga 3000 platform and a helmet, it was possible to enter a simplified-graphic labyrinth and "shoot" at assailants. However, Japanese firms such as Sega and Nintendo are hard at work. These Japanese companies have the advantage of large "war chests" of tens of millions of dollars. In addition, Sega has a subsidiary that develops arcade

games and accounts for 35 percent of the parent company's sales. Their only problem is that they are using technologies and principles that, although nearing the end of their life, are nevertheless an international success. In contrast, companies like Medialab design very high-quality images—but ones that are also very expensive and technically difficult to achieve. They require powerful computers.

However, Medialab may be participating in the opening of a Paris games arcade with 3-D images based on the year's hit movies (a merchandising device) or three-dimensional car races and air battles. For example, for Steven Spielberg's next film, *Jurassic Park*, which recounts the meeting of men and dinosaurs, the company is planning two interactive games that will be released at the same time as the movie. Thanks to Canal Plus and its international network of connections, Medialab is beginning to make contacts in the international (i.e., American) movie market for participating directly on parallel projects of this type. "If we can find buyers for the first projects under way now, the Entertainment Department is going to boom." Since the end of the year is a particularly good time to launch new game products, we can anticipate the first interactive pseudo-helmets with target-fixing sensors then. Looking at an object on the television screen will target it and initiate a form of interaction between the user, his joystick, and the image. The first tests are under way.

Medical Study on Human Behavior

For several months, there has been a rumor going around that, while video games do not make you stupid (so a number of sociologists and psychotherapists confirm), now they trigger epileptic seizures. Although it is still impossible to determine whether this is fact or fiction in view of the enormous success of game consoles, Medialab has launched its own study. The goal is to identify, with the help of doctoral candidates in medicine and psychology, future problems that may result from wearing a visualization helmet and tactile gloves all day long. Research will focus on such areas as immersion behavior and observation of habituation, changes in behavioral procedure, and destabilization pattern. The results of the study, which will take place over a six-month period, will be incorporated into Medialab's projects in order to avoid as many problems as possible.

Today, computer-generated images, animation, and virtual reality are opening the doors to new work methods in such important fields as medicine, research, and museums. However, the general public should already be prepared to come to grips with all these technologies, which will be rapidly reaching our children through game consoles. In the future, we will be able to visit museums or tourist attractions from our apartments, communicate by immersing ourselves in virtual worlds via telephone lines, consult data bases of medical images, or choose a house before it is ever built, to cite a few examples. Some of these applications have already existed for some time;

others are under development. The line between science fiction and reality is fading.

Germany: Special Circuit for Faster Computers

93WS0392C Frankfurt/Main FRANKFURTER
ZEITUNG/BLICK DURCH DIE WIRTSCHAFT
in German 12 Mar 93 p 8

[Article by "dpa": "Transferring Computer Graphics Faster. Telekom Having a Special Circuit Developed in Saarbrücken"]

[Text] Saarbrücken—As fast as text can be sent from one computer to another today, it has thus far been so slow in the case of graphics. A research project contracted out by the German Postal Service's Telekom [Telecommunications Service] to Saar University in Saarbrücken is now to bring about faster graphics transfer by the end of the year. Over 35 million characters of data have to be transferred in order to transmit a color graphics page of a periodical.

The computer experts in Saarbrücken under Professor Wolfgang Paul's leadership are to develop a circuit that makes it possible to use for the fast transfer of graphics from computer to computer the "switched broadband network" (VBN) developed by Telekom for so-called video conferencing. Thus far Telekom has been transferring information faster from Hamburg to Munich than this information can travel the short path from a personal computer's hard disk to the network port.

The computer scientists at Saarbrücken University designed a box consisting of four parallel-connected hard disks from which data are retrieved simultaneously. After their trip through the network the data in the receiver are sent again to four hard disks. Still a data transfer rate of six million characters has been achieved already in this way. But the switched broadband network's capabilities are still far from being fully utilized with this.

The prototypes of the newly developed circuit for transferring computer graphics are already functioning in the rooms of the university, and installation at the industry partners is to follow in April.

Germany: Improved Databases for More Efficient Information Handling

93WS0392D Frankfurt/Main FRANKFURTER
ZEITUNG/BLICK DURCH DIE WIRTSCHAFT
in German 15 Mar 93 p 10

[Article by Peter Buttner, doctor of engineering, staff member, Daimler-Benz AG [Inc.] (TEF, technical information); has been familiar with the capabilities of databases since his time as manager of Fachinformationszentrum Werkstoffe e.V. [Materials Technical Information Center Registered Association] in Berlin: "There Is an Abundance of Information on Materials—Proper Access

Decides. Practitioners Still Want a Great Many Improvements in Database Information. Key Technology of Materials (15)"]

[Text] Frankfurt—Studies by economic institutes have shown that one of the reasons for longer product development times for products having a high level of innovation can be attributed also to the poor utilization of available knowledge. Other suppliers have not infrequently already brought competing products onto the market in the meantime prior to the time one's own product is ready for the market. The right time for entry into the market is often missed because economic conditions and customer behavior with them have changed long ago.

Successful businessmen have known for a long time that the availability of engineering knowledge needed at the time is just as important a company resource as the availability of production capital and materials. Such information is an early warning sign of technical trends and technological revolutions for one who knows how to use the information. Whoever is properly informed—and not just about what he himself urgently needs at the very moment—will not be surprised so easily by new competitive products and technologies on the market.

How does one get hold of knowledge about materials? Results of research on materials are often presented at conferences, published in technical journals, periodicals and books, and made the basis of patent applications. Since the middle of the sixties, voluminous databases based on computers have been set up, holding a rich store of important information. For the most part they can be accessed directly by computers and can be called up through data networks.

With the systems' availability constantly improved since then, today practically anyone can reach the literature or fact databases right for him through the publicly accessible remote data transmission networks (Telekom's [German Postal Service Telecommunications Service's] Datex-P [packet-switched data network]). In addition, such databases are also available on compact discs (CD-ROMs) for a broad range of subjects.

However, it must also be emphasized that, in view of the many millions of articles and references, the information desired has to be searched for purposefully by means of special methods. Otherwise one just wastes time and even finds oneself empty-handed at the end of the search. Catalogue-like database guides, like those published by the computer centers (called hosts) that attend to and update the knowledge banks, provide important assistance with regard to subject matter.

The most well known international database guide, which reports on a wealth of hosts, is published by Cuadra (Cuadra/Gale, Gale Research Inc., Detroit-London, ISBN 0-8103-8426-4 / ISSN 0913-6840). In addition, Schulte-Hillen's database guide (Manual of Databases for Science, Technology, Patents and Scientific Consulting, Dr.

Schulte-Hillen, Hopenstedt-Verlag) provides a subject-indexed reference for German interests.

Hosts are more and more going over to leading the user to the desired article by means of menus of choices, for dealing with databases and their retrieval procedures is still often too complicated and frustrating for novices. Searching in patent databases in particular presumes considerable experience in dealing with them, because here as a rule it all depends on the completeness of the references.

In fact, gaining experience and practicing retrieval pay only when one wants to make at least 10 to 20 searches per week. In this case one should also place the quality of the information obtained in proper relationship to the time and money spent. Whoever does not attain this volume should commission a management consultant having database experience (an information broker), and can also find help at chambers of industry and commerce as well as technical information centers. This is more efficient and, for just occasional searches, ultimately more cost effective than would be possible for a specialist without great database experience who makes only sporadic searches.

In the entire world there is only a handful of computer centers that offer significant databases on questions of materials. Of these, approximately 100 are materials databases in the narrower sense, that can be subdivided according to materials groups and applications. In addition there are important databases for special properties like corrosion resistance, friction, wear, flow properties, surface technology and the like.

The search for information on materials can be supplemented via additional databases having other focuses like physics, chemistry, aerospace, medicine and process engineering.

In Germany access to national and important international databases on materials is concentrated mainly at three computer centers. They are the Technology Technical Information Center Registered Association in Frankfurt, the Accommodations and Building Information Center of the Fraunhofer Society in Stuttgart and STN International in Karlsruhe. The latter is a database interconnection via satellite between the Energy, Physics and Mathematics Technical Information Center in Karlsruhe, the American Chemical Abstracts in Ohio, and the Japanese Information Center for Science and Technology in Tokyo.

For the most part not only are literature data required in practice, but, what is more, a recommendation for solving a materials application technology problem, as well as the supplying of missing knowledge concerning identification numbers, for example. So-called fact databases help here, on various subjects like the properties of plastics and metals, thermodynamics, crystallography, spectrum charts, corrosion data and other data.

Databases today are very helpful for practical application. However, there is definitely still potential for improvement from the practical viewpoint. Databases spanning various materials and whose quality is guaranteed, with characteristics spanning various types of materials, are lacking. In this way, for example, a recommendation could be given on a specific type of material as regards the choice of material or substitution for it on the basis of an input specifications list. This would be advantageous precisely for the composite materials that are being used increasingly.

Efforts toward such systems are available. However, their spread is being curbed because of the negligible standardization of the comparable data of various manufacturers and because of the very high cost of the preparation by qualified experts of quality-rated tables of materials. However, there is a number of smaller systems for particular specifications and for certain types of materials that deal with the service properties of plastics or with the corrosion resistance of materials in water supply installation engineering, for example.

Most technical engineering databases still have shortcomings, including missing data on the accuracy or scatter of parameters and types of facts. Also, the stated values do not always come from comparable measuring methods. The data even in the same database are often based on different standards and measuring systems. In addition there are not infrequently inconsistencies and errors in terminology. The representation of properties is sometimes criticized as being not very clear (tables, graphs).

In past years an attempt has been made to use expert systems also in order to improve and facilitate the retrieval of data from databases. This of course failed, because at the present state-of-the-art only an expert, can ask the database system the right forward-moving questions.

Communication via so-called natural language input is also not replacing the necessary dialogue between the requester and search specialists at the data terminal. For it is often first here that the variety of facets of the materials problem at hand becomes clear and thereby makes it possible to ask questions more precisely. There are in databases "answers" to many never asked questions, but they often give only unsatisfactory answers to many likely questions.

However, one should, within the limits of justifiability in terms of time and money, leave nothing untried in order to be able to be helped in one's present materials problem. This can help to avoid even more expensive double work and shorten development times. He who does not let it come to a knowledge lead on the part of his competitors has prepared himself to the best of his ability for the competition.

UK: Polymer for Electroluminescent Displays

93WS0393A Frankfurt/Main FRANKFURTER
ZEITUNG/BLICK DURCH DIE WIRTSCHAFT
in German 16 Mar 93 p 8

[Article by "toz.": "Polymer for Electroluminescent Displays. Tiny Rod-Shaped PPV Structures/Electric Field Decomposes the Film"]

[Text] Frankfurt—Today displays are produced predominantly by using liquid crystals. The electroluminescence effect is used only to a small extent for forming images. Recently discovered organic polymers present a reasonable-cost alternative. They are as easy to draw as thin films and are good for producing contacts. The subject is polymerized phenylene vinyl, abbreviated PPV.

Here it is a question of an organic compound in which a side chain of two carbon atoms, each with a double-bond hydrogen atom, is attached to a phenylene group (a benzene ring with two single bonds). PPV has in the molecule alternating single and double bonds (conjugated double bonds) and because of this structure can easily transfer electrons along its longitudinal axis, or enable electron charge equalization.

PPV is relatively simple and inexpensive to produce even in purest form, as well as to polymerize and draw into films. Additional expense for purifying the raw materials is not required. The light to be emitted can be set over a relatively broad range of the visible region of the spectrum. PPV accordingly permits the construction of large flat displays at a cost that can be far lower than that of today's cathode ray tube displays.

British chemists and physicists at Cambridge University's Cavendish Laboratory, headed by Richard Friend, provided PPV films with electrodes on their upper and lower sides and were able to produce electroluminescence when an electric field was applied. According to their investigations, the emission of light is brought about when positive and negative charges are produced in the PPV molecule and then are cancelled when they meet.

An excited particle called an exciton forms in this way, that emits light when it returns to a lower energy level, its ground state. This phenomenon passes through the entire PPV film and accordingly illuminates the display field.

The scientists have modified the film's composition and thereby are able to intensify the luminous effect. This takes the creation of so-called energy gaps for the purpose of facilitating the formation of excitons and preventing their too fast loss. Finally, they managed to reform by means of polymer chemistry methods the thus modified PPV into tiny rod-shaped structures that resemble structures in the retina of animals.

The spectral absorption approximately matches that of the current-conducting polymer, polyacetylene, which at present numbers among the most serviceable organic compounds and possesses semiconductor properties.

However, the development work still has to be continued, because at present the very same electric fields that bring about electroluminescence also decompose the PPV. Today's films, then, do not have sufficient electric strength yet to make displays or computer screens from them, Cambridge University reports (Cambridge CB3 OHE, United Kingdom).

Germany: Improved Optoelectronic Measuring Units in Industry

93WS0393C Frankfurt/Main FRANKFURTER
ZEITUNG/BLICK DURCH DIE WIRTSCHAFT
in German 17 Mar 93 p 8

[Article by "sel.": "'Production' Will in the Future Be Far More Than a Sequence of Individual Processes. New Lean Production Programs From a Few Optimized Individual Processes. Integration Into the Product Manufacturing Process of Unutilized Abilities of Personnel"]

[Text] Aachen—Production measurement techniques and quality assurance are becoming more and more important because of the constantly increasing requirements for the reliability and precision of finished manufactured articles. The trend toward 100-percent testing integrated into production requires new automatable measurement methods for the measurement of size, shape and position parameters in the production cycle.

The development of new methods of measurement and measuring instruments is therefore the focus of the work at Professor Dr. Tilo Pfeifer's department at Rhine-Westphalian Technical College in Aachen. New optoelectronic components will play an important role in the future. Innovative software technologies are being investigated in order also to be able largely to automate the interpretation of acquired data. The goal here is to utilize the knowledge, available in the company, of quality relationships, and above all by suitable means to make this knowledge available for the operations being planned.

In the opinion of the scientists at the Laboratory for Machine Tools and Manufacturing Technology (WZL) and the Fraunhofer Institute for Manufacturing Technology (IPT), the key to success lies in the purposeful configuration into an integrated development system of intercoordinated elements of cooperation. By this means advantages of scale (spreading of risks) can be combined with the advantages of flexible structures focused on particular core capabilities.

If product development is being subjected to a radical change, then this applies to the same degree to the organization of the work and the working conditions in the area of design, for example. Present efforts are being directed at the integration of all computer-aided job steps in design and production. In this environment the job of the designer and work scheduler takes a central position.

Present-day organizational structures like simultaneous engineering or concurrent engineering are also placing

demands on the performance characteristics of the software used in the areas of design and production planning. The goal is to make available to engineers, production facility designers and work schedulers a set of tools that assist throughout every product development stage up to NC programming, beginning with preparation of the specification list.

These tools are not to be developed anew for a future design workstation, but are to be usable on the basis of available systems as components of equal rank, optionally, in parallel, on any design screen. Product data are to be interchangeable between the systems without loss of information in this heterogeneous software world.

That quality assurance is constantly gaining in importance also holds true for the area of product development. New preventive quality assurance methods are being used increasingly in recent years. Providing suitable data processing systems is an absolute prerequisite for these methods to be able to be generally adopted in industrial practice. They are to represent the expert knowledge acquired in interdisciplinary teams. However, conventional computer-aided systems still often display considerable shortcomings in the processing of expert knowledge and also in the support of teamwork.

Shortened product life cycles with growing complexity and number of models are characteristic of the present situation in product development. Therefore, the fastest possible transformation of technical innovations into market-ready products is necessary in order to ensure a competitive edge.

Besides strategic approaches to the shortening of product development times (simultaneous engineering), the use of design-assisting models and prototype parts is an important aid for the support of product design and process planning. With the introduction of CAD/CAM technology the capability presents itself of making models and prototype parts directly on the basis of design data. Consequently, this route is being taken for techniques that are known by the name "rapid prototyping."

The markets being supplied by producing companies are characterized by increasing dynamism as regards delivery times, prices, qualities, and product variance. The effort to fulfill market requirements is resulting in growing complexity in production, which is resulting in big economic problems, particularly in the current difficult market situation.

Under these constraints the systematic orientation of all company resources toward the product manufacturing process represents a major challenge. Man is moving into the focus of production design with this. Man is also being included in the particular production stages in order to integrate into the product manufacturing process the often unutilized potential of personnel.

In this connection, the concept of "production" will in the future have to encompass far more than a sequence of individual processes for the working of workpieces

true to dimensions and shape. It will increasingly stand for a system in which a few optimized individual processes can, by the utilization of synergy effects, be linked up to form new lean-production sequences.

The ability of machine tool manufacturers and users to compete will be determined substantially by the efficiency of the production facilities used and their NC control systems. However, European control system manufacturers threaten to miss the boat precisely in this key technology. The Japanese competition's strong competitive position is based first and foremost on cost advantages.

Japanese machine tools are for the most part standard machines that are produced in large quantities and in the end are equipped with Japanese control systems. In addition, Japanese control system manufacturers profit from short production [as written] development times, which enable the rapid assimilation of new design approaches.

Therefore the creation of open-ended control systems will be the focus of efforts in the next few years, where, besides control system manufacturers, machine tool manufacturers and users are also being summoned. The basic goals are to make available more flexible control functions adaptable over a wide range to the particular application by the machine manufacturer, as well as the intensified use of standardized components.

In this connection, one must distinguish between the external and internal open-endedness of a control system. External open-endedness is decisive for the use of NC machines and refers primarily to the stronger harmonization of NC programming, operator control and communication interfaces.

On the other hand, internal open-endedness is a means for control system and machine tool manufacturers to lower development costs, as well as for the flexible adaptability of a control system to various machining tasks.

The use of robots in the manufacturing technology environment is also in need of closer consideration. There is a priority in the area of new programming methods and the improvements in the overall economic efficiency of robotic systems that can be achieved by this. Mechanical (greater rigidity and precision) and control technology improvements are also expanding the fields of application of present-day robots.

The technical progress of machine tools is at present characterized by growing technical requirements and by the greatly weaker economic situation. Therefore, the development status that can be seen presently in every type of machine has its source in the endeavor to implement the technically feasible with a justifiable amount of expense.

The detached purely technical rating of a design belongs to the past. A medium- and long-term competitive edge can be achieved only by a comprehensive view of the

product. The combination of the machine properties of reliability, precision, speed and cleanliness will be considered above all here.

European Software Institute Created

93WS0399D Paris AFP SCIENCES in French
1 Apr 93 p 16

[Text] Paris—Fifteen European firms have just created the European Software Institute to improve their development techniques, the new establishment announced 30 March.

The institute, which will employ 50 people and be headquartered in Bilbao, brings together computer manufacturers (Bull, Olivetti, and Siemens-Nixdorf), computer service firms (Cap Gemini Sogeti, Sema Group, Finsiel, Logica, Eritel, and Lloyds Register), and software users (the Bilbao Bizkaia Kutxa bank, British Aerospace, Electricity Supply Board in Ireland, Iberdrola in Spain, Telecom Ireland, and the German Research Laboratory GMD).

DEFENSE R&D

France: Experimental Solid Booster Launched

93WS0385C Paris AFP SCIENCES in French
18 Mar 93 p 6

[Article: "France: Successful Test of 8-Ton Solid-Fuel Military Booster"]

[Text] Paris—SNPE [National Powder and Explosives Company] and SEP [European Propellant Company] announced on 16 March the successful ground testing of a demonstration booster employing advanced solid-fuel technology that could have future military applications.

This test, conducted on 3 March at Saint-Medard-en-Jalles near Bordeaux, was the first to utilize a "carbon-fiber resistance coil, an annular ignition device, and most importantly an 8-ton supply of high-energy dual-base compound propellant produced by integral molding," the communique said.

Staged by SNPE and SEP under a contract with the General Delegation for Armaments (DGA) and the Engine and Missile Assembly and Testing Center (CAEPE), the test was "entirely satisfactory," especially given that it was the first large-scale booster of this type to be built. Destined for military missiles, this type of mixture of high-energy solid propellants, called "nutralane," generates greater energy than the more traditional "butalane" utilized in France's M-4 strategic missile. It could be used with the M-5, but has not yet been formally incorporated into any military programs.

"The success of this test is a notable technical achievement, even if it is not yet integrated into a [weapons] program, because it confirms that the defense industry has mastered the technology of large-booster solid-fuel propulsion," the communique noted.

ENERGY, ENVIRONMENT

France: Statistics on French Environmental Industry

BR2904135693 Paris INDUSTRIES (4 PAGES
SUPPLEMENT) in French Mar 93 pp 1-4

[Article by Myriam Julia and Michele Falco: "Industry Invests in Environmental Markets"; based on a survey by the French Industrial Statistics Service (SESSI)]

[Text]

[Box] Environmental Industries and Markets Survey: A First

The "Environmental Industries and Markets Survey," conducted by the French Industrial Statistics Service (SESSI) in 1992 examined industrial sectors concerned primarily with environmental markets outside the agro-food industries. Seventy-eight sectors were selected: three out of nine energy sectors; 37 out of 97 semiprocessed products sectors; 29 out of 73 equipment and automobile manufacturing sectors; and 10 out of 84 general consumer product sectors.

Excluded from the survey were service ecoindustries such as recovery industries, incineration plants, research and engineering companies, etc., which include many specialized subsidiaries created by industrial groups. According to the studies conducted up to now, the weight of services ecoindustries is at least equivalent to that of purely industrial ecoindustries.

Despite its limited coverage, the present survey is the first of this amplitude carried out in France. The response rate was 70 percent in terms of companies and 74 percent in terms of sales, which is remarkable.

Nevertheless, the results must be treated with caution, since:

- The results are based on 5,400 companies with 20 or more employees which responded to the survey;

- Some companies may have incorrectly stated that they are not active on the environmental markets, due to poor internal information on this aspect of their activity;

- The estimation of sales was made on the basis of rounding off percentages. [end of box]

Among the industries involved in the 'green' market, one company in five has an active presence on the market in terms of supplying either environmentally friendly products or antipollution products. Open to international developments, ecoindustries also pay close attention to keeping their products up to date. A proper response to demand requires a correct anticipation of legislation. That is the principal obstacle to entering this new market.

"Green products," "waste processing," "pollution control," "ecological balance," charters and declarations of commitment to protect the ecosystem: Businesses are acquiring a new vocabulary. In addition to mere public

relations talk, environmental considerations are having a tangible impact on business strategy, generating new industrial products and services.

Ecoproducts and Ecoindustries—Two Growth Markets

[Box, p 2] From Ecoproducts to Ecoindustry

Ecoproducts are products which are less harmful to the environment during their use and disposal. This classification excludes recycled products and products with cleaner manufacturing processes.

Ecoindustries offer goods or services for:

- Cleaner production, particularly, through the use of substitute materials;
- Antinuisance processes.

Ecoindustries in France are regarded chiefly from the decontamination point of view. Thus, the survey takes no account of "clean technologies" (less polluting manufacturing processes) or recycling operations.

The survey relates to:

- The involvement of companies in these new markets (limited to the past five years for ecoproducts);
- The proportion of sales achieved through these activities;
- The obstacles to penetration of the environmental markets; and, for ecoindustries only;
- Market conquest strategies (R&D, exploitation of patents, expansion, etc.);
- The structure of the customer base;
- Specialization through an overlapping approach in terms of:

1. Sectors: waters and effluents, wastes, atmospheric emissions, noise, soils;

2. Types of activity: manufacture of substitute products; supply of equipment (with or without installation); operation, maintenance, and services, including collection; research, advice, engineering. [end of box]

The number of companies directly active on the "green" market is still rather limited. Twenty percent of all companies in environment-related industrial sectors offer products and services on this market (essentially, outside the consumer products sectors); 14 percent manufacture ecoproducts (products which are less harmful to the environment); 13 percent call themselves "ecoindustries" (cleaner manufacturing and waste processing); and 6 percent of all companies are active in both areas: ecoproducts and ecoindustry.

Still, the sales generated are significant. With an estimated sales figure of 200 billion French francs [Fr], ecoproducts represent almost one-fifth of aggregate sales in all sectors concerned. Excluding automobiles, Fr50

billion remains, i.e., 6 percent of aggregate sales for the remaining sectors. Ecoindustrial activities, for their part, account for 3 percent of sales, totaling Fr30 billion.

Ecoproducts account for one-third of the revenues of companies manufacturing such products (13 percent excluding automobile sector). Sales linked to environmental protection generate 16 percent of aggregate ecoindustrial sales.

"Green" activities rarely figure among a company's predominant activities: They represent less than 10 percent of overall sales by nearly half of all ecoindustries and by two-thirds of all ecoproduct manufacturers. This indicates that ecoproducts, above all, are only gradually entering the market.

Activity on the ecomarkets is more widespread among large enterprises than among small- and medium-sized enterprises [SMEs]. Large companies give priority to ecoproducts: One in four companies offers such products. One in five offers antipollution products and services. Large companies account for 90 percent of all ecoproduct sales and 56 percent of all ecoindustrial sales. Their share of aggregate sales in the sectors surveyed is 65 percent.

SMEs are also interested in ecoproducts, but to a lesser extent: 13 percent of all SMEs supply ecoproducts, while 12 percent sell ecoindustrial products. Ecoindustrial production processes are implemented by the relatively smaller companies (90 employees on average, compared to 120 for SMEs selling ecoproducts). The promotion of new product ranges requires a strong marketing base. It may be easier for a small company to bring its technical skills to bear on the market of antinuisance products. Ecoindustrial SMEs are smaller and dedicate a larger proportion of their sales to environmental wares: 23 percent on average compared to 18 percent for SMEs selling ecoproducts.

First Automobiles, Then Other Ecoproducts

With sales totaling almost Fr150 billion, "Ecocars" and "ecotrucks" account for nearly three-quarters of overall "green product" sales. Automobile manufacturers believe that their vehicles will henceforth generate less pollution and scrap, since they are largely recyclable and equipped with factory-installed antipollution devices. Manufacturers say they earn more than half their sales with ecoproducts.

Lagging far behind the automobile sector, the second-largest group of ecoproduct suppliers is found in the fuel, perfume, soap, detergent, and petrochemical sectors, where "green" sales total Fr3 to Fr9 billion. But these sectors are not necessarily the most committed. Producers of phytosanitary products, large household appliances, paints and varnish, and asbestos products, for example, are equally or even relatively more committed in terms of number of companies involved or ecosales/overall sales ratio.

At first glance, SMEs seem far behind the large companies in ecoproduct sales (18 percent of sales compared to

37 percent for large companies). However, excluding the automobile sector, SMEs are more active on the "green"

markets, with ecoproducts representing 18 percent of their sales, compared to 12 percent for large enterprises.

Ecoproducts: Automobiles Rank First

Principal sectors supplying ecoproducts classified according to their sales of ecoproducts	percentage of total number of companies	Total percentage of sales in the sector
Total	13.817.2	
including:		
Private automobiles and utility vehicles	19.4	55.8
Asbestos works	66.7	30.3
Soap and detergent products	71.4	25.4
Phytosanitary products	75.0	20.3
Domestic refrigerators, washing machines, dishwashers	30.0	18.1
Perfumes	39.4	14.1
Electronic tubes & semiconductors	13.0	13.9
Artificial carbon, activated earth, and chemical products for metallurgical and mechanical applications	58.7	13.4
Photographic and cinematographic products	57.1	11.8
Paints, varnishes, inks	65.5	10.6
Packaging in plastic materials	25.3	9.6
Refined petroleum products	67.7	8.3
Synthesized organic chemical products	30.0	4.5

Source: SESSI Survey: "Environmental Industries and Markets, 1991"

Ecoindustries: Water Tops the List

Sectors classified according to ecoindustrial sales	percentage of total number of companies	Total percentage of sales in the sector
Total	12.6	2.6
including:		
Water distribution	58.0	16.3
Synthesized organic chemical products	26.7	4.9
Ventilation, thermal and refrigeration equipment	30.9	10.7
Machinery for the food, chemical, and plastics industry	18.5	8.9
Paints, varnish, inks	23.9	8.2
Boilers	9.6	2.8
Automobile parts and equipment	8.5	2.1
Concrete products	15.1	7.7
Compounds, plates, films, tubing, pipes, and profiles	7.3	4.5
Pumps and compressors	41.1	8.8

Source: SESSI Survey: "Environmental Industries and Markets, 1991"

Ecoindustries: Equipment Supply and Installation

Basically, ecoindustries supply processing, measurement, and prevention equipment. They also offer know-how. Nowadays, nuisance elimination is becoming an industrial activity in its own right. Seven ecoindustrialists out of 10 supply equipment; 42 percent build "turn-key" equipment and install it; this is the most widespread activity. Ecoindustries also capitalize on their

experience by providing studies, advice, and engineering services (16 percent of all ecoindustries), or by making their installations available (15 percent). One-quarter of all ecoindustries reduce pollution in existing production processes or the resulting product by supplying substitute materials.

SMEs, once they have entered the decontamination markets, are more dedicated on the average than large

companies. Decontamination-related sales represent roughly one-quarter of aggregate total sales for all ecoindustrial SMEs, compared to 13 percent of sales for large ecoindustries.

Ecoindustries Open Up Internationally

On the French market, manufacturing industry and local authorities are the two biggest clients for ecoindustries, accounting for more than 30 percent of sales each. Large ecoindustries supply more to local authorities than to industrial companies. SMEs serve chiefly the manufacturing industry, while their activities in the agro-food sector by far exceed those of large companies.

Thirty percent of all ecoindustrial sales are made abroad. Earning Fr9 billion in exports is a remarkable performance on an emerging market. SMEs are just as committed to exporting these products as are the large ecoindustries; where exploring markets outside the EC is concerned, they are even ahead of the large companies. Companies are also developing parallel strategies for the conquest of foreign markets through direct intervention. Thirty percent of the large ecoindustries say that they have created a partnership or subsidiary abroad in this field. Forming partnerships in EC member states is the favorite approach, appealing to one-quarter of the large companies. This is also the most common method for SMEs, 20 percent of which have taken steps to develop activities abroad.

The environmental industry must unceasingly adapt its technological solutions. Offering products and services on an expanding market largely dominated by changing regulations requires sustained efforts of technology-watch and renovation. Nearly 60 percent of all ecoindustries say that they have launched new products, small companies being scarcely less active than large ones. More astonishing still, half of all ecoindustries say that they have conducted research and development programs, employing at least one engineer in the equivalent of full-time work: three-quarters of all large companies do so, and nearly half of SMEs.

Water, the Largest Ecoindustrial Market

Ecoindustrial supply is limited to a very small number of players. Sales exceed Fr1.5 billion in only four out of the 78 sectors surveyed: water distribution; synthetic organic chemistry; ventilation, thermal, and refrigeration equipment (filters, dust protection); and machinery for the food, chemical, and plastics industries (equipment for water processing and surface processing bath purification). These four sectors account for nearly 45 percent of aggregate ecoindustrial sales. With more than Fr5 billion in "green" sales, water companies are the leaders among the ecoindustries surveyed. "Green" sales represent 16 percent of the aggregate sales for the entire sector, one of the highest rates in the sectors studied.

We are happy to note that France has become an expert in water treatment. In any case, it is the major field of

activity for the ecoindustries surveyed here. Participation is not limited to companies in the water sector: More than 45 percent of all ecoindustries are active on the H₂O market. Sales achieved on this market, estimated at Fr11 billion, account for more than one-third of aggregate ecoindustrial sales.

Large companies represent only 10 percent of the number of players on the water market, but account for more than two-thirds of sales. Water distribution companies predominate without question, generating 45 percent of the "clean water" sales for large ecoindustries, and 25 percent of sales for SMEs. They earn a total of Fr4 billion in sales from water treatment, a figure equivalent to nearly 40 percent of total sales achieved on this market. Their principal activities consist of equipment operation and maintenance, collection, and associated services, but they also operate as engineers.

Lagging far behind are the concrete product manufacturers and plastic pipe and tubing industries, supplying sewers and reservoirs.

These ecoindustries are principally active in the treatment and purification of municipal waters. Local authorities are their chief clients, particularly for large ecoindustries (48 percent of French ecoindustrial sales, compared to 32 percent for the SMEs). Industrial demand is a long way behind (16 percent of aggregate French ecoindustrial sales). Own demand from water distribution companies accounts for less than 10 percent of sales.

Water Treatment, the Leading Ecoindustry (percentage of ecoindustrial sales)

Waters and effluents	36.5 percent
Atmospheric emissions	30.9 percent
Wastes	23 percent
Noise	3.6 percent
Soils	2.3
Others	3.7 percent

Source: SESSI Survey: "Environmental Industries and Markets, 1991"

Followed by Air and Waste

The second largest field of activity is that of atmospheric emissions, which accounts for 30 percent of ecoindustrial sales. The French air pollution control market is, however, reputed to be rather narrow. In addition to equipment suppliers, there are a number of "indirect" operators active on the market: petrochemists, paint and varnish manufacturers, and automobile manufacturers, for example. They enable other industrialists either to market less polluting products, or to use cleaner production methods using equipment which provides better protection against air pollution.

The waste processing market occupies a mere third place in terms of its share of ecoindustrial sales (23 percent). Nevertheless, there are slightly more companies than in

the emissions market, but their average sales are less, regardless of the size of the company.

The other areas—noise, soils, and miscellaneous—only account for a small share, with less than 5 percent each of aggregate ecoindustrial sales. Antinoise and soil treatment are secondary markets, in both senses of the term: due both to their minimal weight and because very often a presence on such a market is associated with greater activity in one of the three principal markets.

On the whole, decontamination companies are not very versatile. More than 60 percent of all companies surveyed were active in a single area. Specialization in one ecoactivity is more marked among SMEs. Sixty percent of all SMEs are only active in a single market, compared to 46 percent of large companies.

Entering the Environmental Market

Only a limited number of companies have the opportunity to offer products on the environmental market. Is this due to indifference or timidity? Actually, it is uncertainty. Industrialists hesitate to take risks on markets governed by rapidly moving legislation, even when they are already active there. Industrial demand for environmental protection is largely created by regulation. It is absolutely essential for suppliers to understand and anticipate these regulations, which by nature evolve very quickly. Lack of understanding concerning future regulations is said to be the major obstacle to access to environmental markets: one-third of all companies surveyed describe this as the most serious obstacle. Large companies are very sensitive to it, as are companies already active on the market. This uncertainty hits ecoproduct manufacturers more than companies specializing in decontamination.

The second major obstacle is the lack of information and the difficulty of evaluating the trends on these new markets. This obstacle handicaps SMEs in particular. Companies already active on these markets mention these factors less often than companies which have not yet entered the markets: By virtue of their activity itself they are continually provided with information "through the grapevine."

Germany: Gas From Waste Dump Fires Power Station

MI2204135193 Wuerzburg UMWELTMAGAZIN
in German No 3, Mar 93 pp 128-130

[Text] After a successful trial run, the new landfill gas-fired power station operated by Wesertal Electricity Works GmbH, Hamelin, came on stream in Detmold-Mosebeck in September 1992. Just short of 2 million m³ waste have already been dumped on 17.6 hectares at the Detmold Waste Disposal Syndicate's (ABV) Hellsiek landfill site. Waste will be disposed there for another 10 years.

The nuisances caused by odors in the surrounding area a few years ago stirred the Hellsiek dump's owner to action. From the outset, priority consideration was given to a modern, economic gas collection and utilization scheme.

Since landfill gas is nowadays used mainly for electricity generation, the Lippe regional and municipal power corporation, Wesertal Electricity Works GmbH, was the obvious partner for the ABV. Together they found a pioneering environment friendly solution and contracted to reduce the dump's methane emissions before they leave the site. One of the most modern landfill gas conversion plants was designed and built for Wesertal, as plant operator, at a cost of 4.5 million German marks (DM). Lambda, a Wuppertal company specializing in landfill gas engineering, was engaged as prime contractor to design and construct the plant.

The gas collection equipment had to be built into the existing dump and equipped with a complete gas pumping system. Forty gas wells (diameter 800 mm) were sunk into the dump to a maximum depth of 27 m and brought into operation. With over 4,000 m landfill gas piping, Hellsiek is now one of the biggest plants in Germany.

Another 10 Years' Capacity

Each gas well's extraction pipe feeds separately into a gas storage tank. The wells are fitted with valves giving individual control, so the gas volume can be adjusted well by well and gas collection optimized. In the first and second stages, most of the future closed circular pipeline (HDPE [high density polyethylene] DA 225 suction pipes) with five substations was built. The third part of the dump is still being filled and is scheduled to take household waste for the next 10 years.

During gas extraction, condensate forms in the pipes. This is removed from the system at specific low points (Tiefpunkten) in the circular pipeline and fed through pump shafts into the leachate system.

The flaring plant, which is used only occasionally, has its own landfill gas safety monitoring device. If the system develops a fault, an alarm is first given then, if necessary, the flaring plant is switched off.

Precise Landfill Gas Analysis

Both ends of the circular pipeline, one in the gas pumping station and the other in the compressor building, open into a condensate separator with a filter unit to remove any residual condensate and solid particles like dust. A gas meter installed there receives and continually measures the quantity of gas extracted. An automatic analysis unit measures the amounts of oxygen (O₂), methane (CH₄), and carbon analysis systems can be automatically adjusted using stored calibration gases to keep the measurement accuracy high and consistent.

There are two rotary piston compressors to pump the gas downstream of the metering installations. They both generate the vacuum required to draw the gas out of the dump efficiently and provide the 100 mbar gas pressure required for the block power station's gas engines.

The compressor output must be adjusted to each of the gas engines' requirements, which depend on the methane content of the gas supplied. It is regulated automatically to handle the quantity and composition of the gas supplied at the time. The second compressor switches on if required. The gas pumping station is designed to pump 1,500 m³ per hour.

The landfill gas is used to generate electric power in two separate gas engines. These block power stations, developed by the GAS company, Krefeld, each comprise a gas line, control system, engine, and generator. The gas engines are modern turbocharged six-cylinder engines with charge cooling, operating on the lean-mix engine principle. They comply with the exhaust limits laid down in the Air Pollution Regulations without additional purification. The motors are housed in acoustically insulated containers, each of which has a separate switchgear room. The plant meets the latest safety standards in every respect.

Power for 1,200 Households

Both gas engines operate at 1,500 revolutions a minute. The two generators are directly connected at this mains-synchronized speed, each supplying a 400-V electric potential at the mains frequency of 50 Hz. It is then transformed from 400 V to 10 kV so that the power generated can be fed into the Wesertal grid via a nearby medium-voltage line. Both the block power plants have a nominal output of 320 kW. Wesertal expects to obtain around 3.8 million kWh electrical power a year from operating the Hellsiek landfill gas-fired power plant, roughly equal to the needs of some 1,200 households.

The plant is designed for almost fully automatic operation. If need be, the computer control can also be programmed for various marginal conditions. The most up-to-date digital and analog technology (optical waveguides, coaxial cables, remote data transmission) is used to supply all the main information required. Wesertal transmits the main plant parameters to the distribution center in Hamelin for continuous monitoring. It will also adjust the major operating settings from there by remote control.

The Hellsiek plant is designed to shut down automatically and make itself safe in the event of breakdown or faulty operation.

The aim of the Hellsiek landfill gas-fired power station is not only to collect and dispose of most of the gas that is constantly produced in a waste dump by rotting processes, but to use it effectively and, if possible, completely, to generate power. The muffle (flaring) facility is designed for occasional use only. The use of landfill

gas-fired power stations to greatly reduce methane emissions is an active contribution to climate protection. In terms of adding to the greenhouse effect, one methane molecule is considered 32 times more harmful than a carbon dioxide molecule, even though the total amount of methane given off by the world's landfills is many times less than that of anthropogenic carbon dioxide emissions.

Limits and Potential

In the Federal Republic of Germany, landfill gas conversion plants are used primarily to generate electricity. At the end of 1990, there were 81 plants operating in the public power supply sector with a total output of 60 MW, feeding 187 million kWh into the grid, and 24 more plants are planned or under construction. Together they represent a capacity of just under 20 MW. The German Electricity Works Association (VDEW) estimates that a further 1.5 billion kWh or so a year could be generated in landfill gas-fired power stations by the year 2010, which compare favorably with the total of 389 billion kWh, including grid dissipation, consumed in the old laender in 1991. Landfill gas-fired power stations will thus be able to complement the public power supply stations to a significant extent.

Priority is seldom given to the use of heat from landfill gas-fired power stations. This is because district heating pipes from landfill gas-fired plants to the more remote residential areas are not economic and there are generally no customers for thermal energy in the immediate vicinity.

The Wesertal landfill gas-fired power station will use some of the thermal energy to heat the Detmold Waste Disposal Syndicate's buildings at the site.

Geothermal Energy Project Planned for France or Germany

93WS0329A Stuttgart *BILD DER WISSENSCHAFT*
in German Mar 93 pp 15-19

[Article by Klaus Jacob: "A Hot Place"]

[Text]

Competition For the First European Geothermal Energy Project

The ground in Europe is hot beneath your feet—so hot that it is worthwhile recovering energy commercially from this heat. The technology of this clever plan is gradually maturing. Soultz in Alsace and Bad Urach in Swabia are competing to be the site of the first European geothermal power station. The decision will be made soon.

Steaming, the drilling shaft comes out of the earth. A cable pull draws the kilometer-long pipe, rod by rod, onto the derrick. With sturdy gloves, two workers get down to business, loosening the threads with a large pair

of pliers. They feel the heat coming from only a few kilometers beneath their feet.

Bad Urach lies on the edge of the Swabian Jura. Here, the drill bit pushed down last November to a depth of 4444.4 meters. At that point, the thermometer stood at more than 170 degrees. This is hot enough for a clever project. Geology scientists dream of "mining" geothermal energy there, like coal from the Ruhr valley. The "Swabian coal" is hot, dry rock.

Wet rock has been supplying energy for a long time. In volcanically active regions, steam from the deep has been driving generators for decades. The electrical power installed worldwide has reached about 6000 megawatts in the meantime. This corresponds to five nuclear power station units of the type used at Biblis. In 1985, this power had not even reached 4000 megawatts. The greatest volcano power producer by far is the U.S., followed by the Philippines and Mexico. The Californian cities of San Francisco and Oakland even obtain the major portion of their energy from a geothermal steam field. In Tuscany, volcanic steam has been driving generators since 1912.

Water-bearing rock that is also volcanically heated is, of course, the geologic exception. Physicists from Los Alamos Scientific Laboratory had the idea as early as 1970 of exploiting dry rock, too. In this way, they would be able to recover energy anywhere on land. Only a few kilometers below the surface of the earth, sheer immeasurable supplies lie dormant.

The temperature increases on average by 3 degrees every 100 meters. This is the result of natural radioactive decay in the earth's crust and the flow of heat from the hot, deep core of the earth. If enough heat is taken from one cubic kilometer of rock to cool the rock by 100 degrees, a power station having an electrical power of 30 megawatts can be operated with this energy for 30 years. This is enough power to supply a small city.

The concept of the American physicists was relatively simple. They proposed blasting one or more cracks in the rock between two parallel drill holes. These cracks would serve as flow heaters. Cold water is introduced into one drill hole. The water is then heated while passing through the hot rock and is pumped from the second hole. The Hot, Dry Rock (HDR) method was born.

However, HDR technology has been stuck in its infancy until now. Politicians have only supported it halfheartedly and scientists underestimated the problems. The HDR pioneers had to cope with the worst setback 10 years ago with their pilot project in the U.S. state of New Mexico. The water pressed into the ground abruptly did an about-face. Instead of forcing its way through the rock, it shot back out the inlet as powerful fountains of steam.

The pipework in the bedrock collapsed. The explosion not only destroyed expensive equipment but also the hope for quick success. Germany and Japan had also

borne the costs of this first HDR attempt. They bowed out—and started work in their own countries. Even England and France started HDR projects.

A demonstration system should now provide the breakthrough in Europe. Bad Urach is competing with the little French city of Soultz-sous-Forêt, north of Strasbourg, to be the site. Both locations lie in the center of geothermal anomalies, areas with unusually warm bedrock. The temperature necessary for profitable power generation is about 170 degrees. This is found in Soultz at about 3500 meters down and in Urach at about 4500 meters. Normally, the drill must push down to a good 5 kilometers.

HDR tests have been running in Cornwall in England since 1977. This location is no longer being seriously discussed as the location for the project of the European Community, not lastly due to its thermal normality. While a hole that is four kilometers deep costs about 10 million German marks [DM], pushing down to a depth of six kilometers swallows approximately DM20 million.

Geologists cannot say for certain why the earth is warmer beneath Soultz and Urach than elsewhere. Soultz lies in the center of the Upper Rhine trench, the largest thermal anomaly of Central Europe. There, the natural eddy motion of the water particles probably heats the rock.

The Dry Method Gets Wet Feet in the Bedrock

Surface water on the edge of the Black Forest and the Vosges Mountains seeps along the rupture faults kilometers deep into the granite. It then rises, heated, in the center of the trench—the center of the anomaly again. The sediment cover, which is more than 1300 meters thick, acts as insulation.

A thermal sediment cover also captures the heat in the ground in Urach. Here, this cover is about 400 meters thick. Previously, it was general knowledge among geology scientists that a deep magma chamber was the cause for the great heat beneath the small Swabian city. However, test drilling last year exorcised the magma devil. Beneath the sediment, the temperature increases at a completely normal rate—and not at all to an extreme such as would be the case for a close magma chamber.

The rock is dry only in Urach. In Soultz, water circulates in the bedrock. However, there is too little water to operate a power station so that artificial actions in accordance with the HDR method would be necessary here, too.

The concepts of converting this technology to practice have changed in the last 20 years. While the inventors of the method still thought that the crystalline basement was always dry and free of fissures, numerous international research drillings such as the Continental Deep Drilling Program in the Upper Palatinate or the Russian

record well on the Kola peninsula have shown conclusively that water-bearing fissures run through the primary rock. The HDR method has gotten wet feet.

Projects in the U.S. and England have shown that the method functions in theory in spite of this. Thus, water can work its way through rock subjected to powerful pressure. However, there are unsolved problems still today. Because of the low thermal conductivity of the rock, it is necessary that the flow of water introduced in the bedrock fan out widely and rush through a number of fissures. Otherwise, only lukewarm water would flow out of the pumps even after weeks or months. "Hydraulic Fracturing" provides the necessary fissures. In this method, which has been tested millions of times in the petroleum branch, liquid, pressed into the bore hole under high pressure, fractures the rock. New cracks can thus be opened and existing ones expanded.

When recovering petroleum from layers of sediment, millimeter-sized spheres of sand or ceramic are always added as support to keep the cracks open permanently. In hard primary rock, experience has shown that this measure is not necessary because the mistreated fracture surfaces move with respect to one another and interlock. In this way, the surfaces stay permeable over the long term without extra measures.

For a geothermal energy power plant to operate economically and to provide energy for decades, experts have calculated a heat exchanging area of several square kilometers. The fissures must not be too wide so that water does not flow in a short-circuit from one drill hole to the other. However, the holes must also not be too narrow as otherwise an uneconomical amount of energy would be necessary to push the water through.

Besides, it could occur with a very high water pressure that additional cracks open in an uncontrolled fashion and water is lost. With a loss of 25 liters per 100 liters of water pressed into the hole, the project is no longer economical. If a project is to be economical, power plant operators also require a flow rate of at least 75 liters per second and a temperature of the water pumped up being at least 170 degrees.

Skeptics doubt whether these hurdles can ever be overcome. Foremost among these skeptics is the responsible department chief in the Federal Research Ministry, Dr. Gert Hauerstein. He is suspicious of the fact that, after 20 years of research and worldwide costs of more than \$250 million—half of which went down the New Mexico hole—a functioning pilot project has still not come to pass. Even Siemens, until now active as the managing concern of a German industrial group in HDR technology, has dropped out for the time being. This means that, on the part of the Germans, only small engineering offices are still involved.

Ultrasound Even Draws Well-Kept Secrets From the Hot Rock

Dieter Blanck is responsible for geothermy at the Siemens subsidiary KWU. He fights against using the term

"dropped out." The company, he says, is still interested in the technology. However, it sees itself responsible primarily for the portion above ground, the power plant, and not for the flow heaters below ground.

Even now, it is still a subject of debate whether the planned demonstration system is to produce power and heat at all. The French, at least, want to put all of the research money into geological work because power plant technology has been tested for a long time.

Prof. Fritz Rummel is the German expert for geothermal energy from the Ruhr University at Bochum. He counters the skeptics by saying that considerably more than \$250 million was necessary to provide nuclear energy.

Geologists were never given research money as generously as the builders of nuclear power plants. HDR projects came to a standstill again and again worldwide in past years due to a lack of funds. However, Rummel has not lost confidence. He believes in the many results already achieved, primarily the circulation attempts in the U.S., Japan, and England, and the comprehensive preliminary work in Germany and France.

Tests have been running in Urach since 1977 and in Soultz since 1986. The scientists are feeling their way step by step to ever increasing depths. In the past months, they have pushed the holes down to rock that is over 170 degrees where thermal mining is economical.

They got close to the bedrock using an ingenious set of instruments. Only when they know how the fissures run can they drop the second hole at the right point. This is the hole from which the heated water is to stream later. Based on the deformations determined from the hole and the drilling cores, the drilling experts determine the stresses present in the depths. The stress relationships tell them how the fissures expand.

In addition, probes, dropped down the hole, find the existing fissures. Ultrasonic signals provide images of the wall of the hole and measuring the electric resistance betrays moisture. Where water-bearing fissures cross the hole, the resistance drops measurably. Finally, cracks were opened in Soultz and Urach using high water pressure and water was pressed in to test whether water could make its way through the rock at all.

Measurements have shown that the bedrock is completely different at both sites. Because of the trench structure, relatively low lateral rock pressure exists at the Upper Rhine so that less force is needed to open cracks and press water through them. It is also possible here for natural water to enter the artificial circuit and increase the heat yield. Of course, in the expanded natural system of fissures in the Soultz granite, it is also possible for considerable quantities of water to be lost.

In Urach, on the other hand, the drilling must go about one kilometer deeper to reach the desired temperature. However, geologist Helmut Tenzer is not worried about

this. He is managing the Urach drilling. During the test drilling, the bits ate quickly into the Urach gneiss—up to three meters per second. In terms of infrastructure, Urach has an advantage over the French competition. Because of the commitment of the Urach utilities, there is a sufficient number of consumers of process and heat energy in the immediate vicinity of the hole. These include thermal baths, sanatoria, and a paper mill.

In addition, geothermal energy expert Rummel is boosting the German location. He says that the experience obtained in Urach can be used in almost every other area. On the other hand, results from the Rhine trench, which is a geological special case, can scarcely be applied to other regions. On account of the empty government purse, geology scientists are, of course, happy when the project proceeds at all—whatever the location.

The intended schedule looks like this: Based on a feasibility study which is to be concluded soon, the decision should be made still in this year whether and where a demonstration project is to be created. Within ten years, HDR technology should then make the move from basic research to application. Different numbers are in circulation regarding the necessary costs. These range from DM120 million up to DM500 million.

On paper, the dream of energy from the deep has already become reality. The infernal flow heater is to have an electric power of 2.5 megawatts and thermal power of 17 megawatts. Dr. Jorg Baumgartner is the German coordinator for the EC project. In his opinion, a kilowatt-hour "will probably cost less than 25 pfennigs." This is a price between the production costs for nuclear power (less than 10 pfennigs) and solar power (over two marks).

The fact that paper is more patient than hard rock was shown in November in Urach. The drilling shaft, which weighs tons, broke while being extracted and sailed thundering into the deep. Then, the trail broke. This meant a forced vacation a few weeks before the planned end of drilling.

Berlin Institute Studies Pyrites for Photovoltaics

93WS0384C Duesseldorf *HANDELSBLATT* in German
1 Apr 93 p 27

[Article by Berlin-based professional journalist Wolfgang Asche: "Photovoltaics: Hahn-Meitner Institute in Berlin Looking For Alternatives to Silicon; Amount of Light Produced Could Be Noticeably Improved With Pyrite Layers"]

[Text] *HANDELSBLATT*, Wednesday, 31 Mar 93—In their search for a substitute for silicon, the most commonly used electrooptical material for the transformation of light into electrical current, scientists in Berlin have hit upon the iron-sulphur compound, pyrites. But process engineering problems are still to be solved before it can serve as a substitute.

Silicon has very poor light absorption properties, Dr. Wolfgang Kautek, the head of the Federal Institute for Research and the Testing of Materials (BAM) laboratory for laser and chemical thin-layer technology in Berlin, complained. The material experts maintain that, to obtain a satisfactory optical density, a solar cell made of crystal silicon would have to be 100 times thicker than one made of material optimized for that purpose.

Scientists in the Department of Solar Energy Technology at the Hahn-Meitner Institute (HMI) in Berlin have now found a possible substitute for silicon in pyrites, the semiconductor, iron disulphide (FeS_2), which absorbs light extremely well.

Research by the team headed by Prof. Helmut Tributsch showed that a minimal thickness of as little as 20 nanometers (equal to a 20-millionth of a millimeter) would suffice for an FeS_2 solar cell. So pyrite solar cells could be produced at low cost with the same light yield and with much less material. Other alternatives to crystal silicon like copper indium selenide, for example, require a layer thickness of 300 nm, gallium arsenide 1.5 micrometers, or amorphous silicon about 2 μm .

The costly processes of growing crystals and sawing them up, as with crystal silicon, would be eliminated. Kautek's team, which collaborates closely with HMI has reported on a new method for producing FeS_2 : A small sheet of pure iron is heated in an oven with some sulphur. The vaporized sulphur precipitates on the iron in a nitrogen atmosphere. First, FeS is formed and then FeS_2 through diffusion processes ("chemoendotaxy").

Kautek dubs the process "artificial rusting." In it the oxygen is replaced by sulphur. HMI has already thrown the CVD (chemical vapor deposition) process for precipitation from the gas phase into the race to achieve optimal production. Thus it has let iron pentacarbonyl with sulphur, for example, react to FeS_2 .

However, pyrites are not viewed as a producer of the useful photocurrent since the electrons, which are lifted out of the valence band of the semiconductor and placed into the conductivity band by the light photons, have to be brought into suitable contact materials first. But this does not seem to pose a problem either: At HMI they succeeded, for example, in precipitating an extremely thin film of FeS_2 onto titanium dioxide, from which the charge carrier could then be removed.

Despite a high rate of absorption, the thin-layer semiconductors nonetheless do not have as high a degree of efficiency as that produced by crystal silicon. At a rating of only 20 percent, they are not yet convincing. With this the degree of efficiency does not depend on the absorption rate, but on how well the energy gap, the difference between the valence and conductivity bands of the solar energy, is adapted.

No two-figure degree of efficiency has yet been attained with pyrites, but they did barely reach the 15-percent mark with copper indium selenide. "For the use of these

thin-layer cells, what is decisive is when the break-even point is reached, at which expensive, crystal silicon cells with small surfaces and cheap, thin-layered cells with large surfaces made of pyrites, for example, represent an evenly-matched offering," is the way Kautek outlined the uncertain future of the first practically profitable application of the new electrooptical materials.

German Firm Launches "Green" Refrigerator

93WS0386C Paris AFP SCIENCES in French
18 Mar 93 p 39

[Article: "Germany: Commercial Production of First CFC-less Refrigerator"]

[Text] Scharfenstein—An eastern German enterprise began commercial production on 15 March of the first "environmental" refrigerator that does not use chlorofluorocarbons (CFC), substances that damage the ozone layer. DKK Scharfenstein is the first company to use a mixture of the natural gases propane, butane, and pentane for its refrigerator cooling system.

The company, which currently employs 600 people, has thus in one stroke dispensed with both CFC and FC (fluorocarbons), which major western German household electrical equipment groups recently have begun to use in their appliances. FC is less dangerous than CFC but contributes to the greenhouse effect. Mr. Eberhard Gunther, director of the company, said it plans to build about 150,000 "environmental" refrigerators at its assembly lines in Scharfenstein (Saxony) this year.

Germany: BASF, Bayer's Dioxin Destruction Methods Show Promise

93WS0396C Paris INDUSTRIES ET TECHNIQUES
in French 5 Mar 93 p 63

[Article by Michel Le Toullec: "Avoiding Pollution by Chlorine Chemicals and Waste Incineration: New Weapons Against Dioxin"—first paragraph is INDUSTRIES ET TECHNIQUES introduction]

[Text] Dioxins are the result of many manufacturing—pesticides, paper bleaching—and incineration processes. BASF [Baden Aniline and Soda Factory] and Bayer propose innovative solutions to get rid of them.

Highlights

- Of the 210 dioxins known, only 17 are considered toxic.
- Bayer has shown that some bacteria can deactivate dioxins.
- Production of pyralenes, used as electric insulators, has stopped: the quantities already produced must still be disposed of.

Just beneath the surface, in chlorine chemistry, we find dioxins. These molecules form during the synthesis of

certain chlorinated products and at the end of the chain, when these very compounds (or other chlorinated products) are destroyed by incineration. Actually, emissions are usually minimal, at any rate insufficient to affect man. But these molecules have the drawback of being very tough, and especially of accumulating in fats, in particular those in the food chain. To get rid of them, the German chemical companies BASF and Bayer propose new methods.

The problem is that when we talk about dioxins—a generic term that covers both dioxins and polychlorinated furans—the image of Seveso immediately comes to mind. Especially since the dioxin involved in the famous disaster was 2,3,7,8-TCDD dioxin [tetrachlorodibenzoparadioxin], considered as one of the most toxic products ever synthesized. Actually, of the 210 dioxins known (including the polychlorinated furans), 17 are considered toxic. These are produced by two main industrial activities, where they occur as mixtures.

First, we have the chemical reactions involved during the production of pesticides and chlorine gas, during paper-pulp bleaching, and during pyralene synthesis. For each of these possible cases, solutions have been proposed. Production of DDT was stopped. Paper-pulp chlorine bleaching, on the other hand, was optimized to eliminate as much as possible all chlorinated organic compounds. All the same, chlorine bleaching is one known source of 2,3,7,8-TCDD dioxin. There are other chlorine-free bleaching processes, in particular those using oxygen (in the form of ozone). In chlorine bleaching, the dioxins produced are generally diluted, but they still exist. And they pollute the environment into which they are dumped. Bayer has studied this form of contamination and shown that some bacteria will break down dioxins (these are the *brevibacteria*, which are also used to make cheese). These microorganisms are said to be able to completely deactivate dioxins: they feed on dioxins to get carbon. This method is said to be so promising that it could even destroy the most formidable of all dioxins, 2,3,7,8-TCDD.

Production of the pyralenes used as liquid electric insulators in transformers was also discontinued during the eighties. Pyralenes are expected to be completely phased out by the year 2000. This means that we must now find a way to dispose of them. The most efficient method would consist in heating them to 1200-1400 °C for a given time so as to decompose them into carbon dioxide, water, and hydrogen chloride. Atochem uses such a process at its Saint-Auban site.

The second main source of environmental contamination by pyralenes is municipal and medical waste incinerators. One of the materials most often blamed is PVC [polyvinyl chloride], which is widely used in packaging and medical equipment. PVC incineration is known to release hydrochloric gas, but it also generates minute amounts of dioxins. That is quite a lot for a single material. Actually, according to the TNO [Netherlands Central Organization for Applied Natural Scientific

Research] (the Dutch equivalent of the INERIS [National Institute of Industrial Environment and Risks]), the amount of dioxin released by PVC is insignificant compared with the amounts generated by the incineration of other waste. Currently, the rates of dioxin discharge after incineration accepted in Europe are of the order of 0.1 nanogram of TEQ (toxic equivalent) per cubic meter. This rate can be achieved by controlling the flame temperature, the turbulence, and the time of contact between waste and flame. Very rapid cooling in the critical 450-250 x C zone is another effective mean to prevent the formation of dioxins.

To recover the dioxins that will form anyhow, incinerators are now equipped with filters made of fine activated charcoal powder. The disposal of saturated filters then becomes a problem: they must be incinerated (!) or buried in the ground. To avoid this headache, the German chemical company BASF just introduced a catalyst consisting of titanium, vanadium, and tungsten oxides, which turns dioxins into carbon dioxide, water and hydrogen chloride. The chemical company is now installing this system permanently at its Ludwigshafen plant. Supreme recognition, its competitor Bayer just installed the device at one of its plants, near Cologne.

EC: ENERO Environment Alliance One-Year Activity, Plans Reported

93WS0396D Paris INDUSTRIES ET TECHNIQUES in French 5 Mar 93 p 65

[Article by Thierry Mahe: "A European Industrial-Environment Club: Europe Federates Its Industrial Environment Expertise"—first paragraph is INDUSTRIES ET TECHNIQUES introduction]

[Text] ENERO [European Network of Environmental Research Organizations], a European association of environmental laboratories is turning into a research club to serve both European organizations and industrial groups.

A European association for the environment was created in the spring of 1992 by eight institutes specialized in industrial problems. ENERO ambitions to be a reference structure serving political and industrial decision-makers, and to which the Community could have recourse to guide its decisions. Who are its members? They are laboratories entrusted with public service missions, equally competent when it comes to air, water, soil, and waste problems. In France, INERIS [National Institute for Industrial Environment and Risks] is an ENERO member. INERIS was the initiator of this organization, which also includes the Spanish Ciemat, the Irish Eolas, the German KfK, the Dutch TNO [Netherlands Central Organization for Applied Natural Scientific Research], the British Warren Spring Laboratory, and the Portuguese INETI [National Institute of Industrial Engineering and Technology]. These laboratories employ a total of 3,000 researchers. Christine Heuraux of INERIS indicated: "We wanted all ENERO

charter members to be involved in industrial problems, so real needs would become apparent. We have therefore excluded agencies like ADEME [Agency for the Environment and Energy Control], because their role was judged too political."

One year after its creation, ENERO has still not found its place. "We are still at a stage where researchers are getting acquainted, where projects are being set up." Two working groups, however, have already been formed. The first one, sponsored by TNO (Netherlands) has taken for its theme the life cycle of industrial products. The second one, headed by INERIS, will study pollution in an aquatic environment after an accident.

This project, scheduled to last three years and financed with ENERO's own funds, gives a precise idea of its working procedures. During a full quarter, a Ph.D. student, Veronique Petit, worked on a comprehensive bibliography of research and results concerning aquatic pollution: product toxicology, impact on animals and plants, analysis of existing regulations, etc. The work was done at the Danish laboratory Teknologisk. Today, Veronique Petit codifies a pollution analysis methodology designed to measure pollution. The work is done in Great-Britain, at the Warren Spring Laboratory. This will be followed by a phase of analysis and laboratory simulation, using the INERIS facilities at Verneuil-en-Halatte, Oise. The ultimate goal of all this work is to update the Seveso guidelines. Thus, the program relies on a network of knowledge and expertise in order to avoid duplicating prior research and to make the best possible use of each laboratory's specific characteristics.

Each organization pays dues of ECU15,000 per year, giving ENERO an annual operating budget of 840,000 French francs [Fr]. It is rather modest, compared with its proclaimed ambitions. In addition, it was just revised downward: Fr560,000 for 1993. Therefore, it is hoped that these basic dues will be supplemented by outside financing from manufacturers or industrial federations such as the European Chemical Industries Union. This policy has not materialized yet.

SITA Launches Four Waste-Treatment R&D Programs

93WS0397C Paris COMPOSITES ET NOUVEAUX MATERIAUX in French 12 Mar 93 pp 2-3

[Unattributed article: "Plastic Mix: Recycling Plastics Recovered from Household Waste"]

[Text] The fact that it is France's turn to chair EUREKA [European Research Coordinating Agency] undoubtedly strongly motivated SITA [International Society of Aeronautical Telecommunications] when it drew up its European research policy. Presenting four new programs under the EUREKA label, a few days ago, Philippe Brongniart, the SITA chief executive officer, reaffirmed his desire to continue the company's R&D efforts to preserve the environment. In 1992, SITA had already shown its determination to provide new impetus to this activity sector: 32

million French francs [Fr] were devoted to R&D, i.e. twice as much as in 1991. This generous trend will continue in 1993, with Fr42 million devoted to R&D. The Cered (Waste Storage Research Center) created jointly with Rhone-Poulenc is about to be completed and should be inaugurated around mid-1993.

Fr300 Million in Research Impetus

Four new SITA programs already cover several key sectors of the Lyons Water-Supply Company/Dumez waste-related activities. "Electre" covers future waste-collection vehicles; "Plastic Mix" deals with the recycling of plastics from household waste; "Incipro" will deal with clean incineration and vitrification; and "Sitinert" will tackle the problem of ultimate waste storage. These four projects represent investments of about Fr300 million. Two of them alone, "Incipro" and "Sitinert," will get close to Fr250 million; the smallest project is the one dealing with plastics recycling.

"Electre" and "Sitinert" are the two programs for which SITA will be program leader. As for "Plastic Mix," it will get its impetus from the Testa group, the French leader of plastics recycling (including mixed plastics). Finally, "Incipro" will be headed by Rhone-Poulenc, which started a veritable research cooperation and partnership with SITA already a few months ago (Cered, acquisition of Scori, etc.).

Plastic Mix

—Amount: Fr18 million

—Duration: three years

—Partners: Testa (leader)—the leading French recycler; Remaplan (Germany)—plastic mix chemistry know-how; SITA

—Program orientations: to use mixed plastics to develop manufacturing techniques yielding finished products for targeted markets (composting or collecting bins).

The project will avoid manufacturing granules of secondary raw materials that would compete with virgin materials.

1. Characterization of the sources (quality, quantity)
2. Study of the process proper: chemistry: chemistry of the mix (plastics intercompatibility; identification and use of additives and compatibility products); process proper.
3. Work on the design and characterization of the finished products.

In a way, Plastic Mix will accompany the Eco-Packing system by offering a complete process leading to a finished product. The pilot plant that was operated on the Testa site in Gardanne is now being installed in the Bayonne-Anglet-Biarritz district to produce composting and collecting bins. The newly created Ecobac company (a joint SITA-Testa subsidiary) will manage the output

which, according to Francis Testa, should amount to 20,000 bins (about 1,000 metric tons of products) when the plant is in full production, and 12,000 bins during this first year.

Netherlands: Shell Produces Fuel Derived From Natural Gas

BR2304090693 Rijswijk POLYTECHNISCH
WEEKBLAD in Dutch 26 Mar 93 p 3

[Unattributed article: "Gas 'Changed' Into Benzine Products"]

[Text] Amsterdam—The research originates in Amsterdam; the application is found in Malaysia. That is where Shell has set up test operations with the first factory in the world to produce benzene products such as gas oil, naphtha, kerosene, and diesel oil from natural gas. The concern intends to achieve an output of 12,000 barrels of oil products per hour in Bintulu.

The process was developed by the Royal Shell Laboratory in Amsterdam, known as the KSLA. In fact, it updates the German Fischer-Tropsch process, which dates from the 1920s. It was only after the first oil crisis in 1973 that Shell thought about producing oil products from natural gas. The concern has been running trials with the improved process in a small test factory on the KSLA site for nearly 15 years.

Shell wants to use the new technology in order to be less dependent upon crude oil supplies. Shell owns 60 percent of the factory in Bintulu (Borneo). The remaining 40 percent belongs to the Malaysian government.

Paraffin Chains Selective in Usable Fragments

The Shell Middle Distillate Synthesis Process (SMDSP) consists in principle of three stages. First, the natural gas is oxidized under the influence of steam until it becomes a synthesis gas, a mixture of carbon monoxide and hydrogen. From this synthesis gas, pure paraffin is produced. This synthesis, also called "Fischer-Tropsch reaction," takes place because of the action of a catalyst especially developed by Shell, which ensures that very long, simple paraffin chains are formed. In the last phase of the SMDSP process, the paraffin chains are selectively cut into usable fragments. This process, called hydroconversion, is completed with hydrogen and a catalyst. The end product of the Shell Middle Distillate Synthesis Process is a mixture of middle distillates, such as naphtha, kerosene, and diesel oil. The catalyst type determines in which proportion these products are produced. They can be separated as pure fractions via distillation.

According to Shell, the middle distillates are of high purity. They contain no sulfur dioxide or aromatics.

The so-called paraffin wax, the intermediate product, can be used, for example, for the production of coatings or domestic products such as soap and candles.

German Environment Minister Introduces Controversial Bill

MI2204132993 Munich SUEDEDEUTSCHE ZEITUNG in German 30 Mar 93 p 25

[Article by Thomas Froelich: "Waste Avoidance Takes Priority—Toepfer Presents Controversial Bill/Criticisms from Trade"—first paragraph is SUEDEDEUTSCHE ZEITUNG introduction]

[Text] In the future, industry will be responsible for the recycling and disposal of used products, if Federal Environment Minister Klaus Toepfer, CDU [Christian Democratic Union], gets his way. Waste avoidance and recycling secondary raw materials will take absolute priority over waste disposal. Nothing that can be recycled as a secondary raw material should be wasted. These are the aims of the Residue and Waste Management bill to be passed by the federal cabinet tomorrow (Wednesday).

As long ago as last August, Toepfer had submitted a working bill, which had come up against massive criticism from industry. Wholesale and export trade president Michael Fuchs had described the bill at that time as an "ecological enabling act." After months of negotiations and representations to the Federal Chancellor by the Chemical Industry Association (VCI), the Environment Ministry was assuming yesterday that cabinet will pass the bill tomorrow, after which industry will have a much greater inducement than before to "think in terms of waste."

This means that, according to the principles of a low-waste recycling-oriented economy, hence the Recycling Economy Act, priority is to be given to avoiding residues or recycling them as secondary raw materials, and only as a last resort incinerating them or otherwise disposing of them as waste. For the first time, moreover, the bill will embody in an act the privatization of public waste disposal, which has already been introduced with the Packaging Ordinance. In that instance, privatization had led to the creation of the Dual System.

New Regulatory System

The bill, of which SUEDEDEUTSCHE ZEITUNG has a copy, creates an entirely new regulatory system, does away completely with the previously accepted concept of waste, and includes secondary raw materials. Waste is taken to mean only those residues that cannot be recycled lawfully and harmlessly as secondary raw materials. Recyclable residues are secondary raw materials; "residue" will be the central concept in the future.

In Article 4, the bill states that residue recycling (reutilization of materials) takes priority over incineration (exploitation for energy purposes). This is only a target, however. The priority to be given to recycling is restricted again in article 4 (4): "Where there is no difference, in ecological terms, between recycling materials and recycling waste for energy purposes, the decision shall depend on economic considerations." Proof of

the type and whereabouts of residues that have been recycled or disposed of must be submitted every two years in special residue balance sheets. In order to prevent waste being exported, the bill stipulates that, in principle, it must be disposed of in Germany. Exceptions are possible if the movement of waste is part of a cross-border regional waste management plan run by EC states.

The product liability advocated by the bill includes the requirement that products be reusable many times, be low in residues, and have a long useful life, but the federal government reserves the right to introduce product bans, restrictions, and labeling provisions by issuing statutory orders. In article 21, the legislator threatens to ban or restrict the use of packaging in cases where, "if they were disposed of as waste, the release of harmful substances could not be prevented or only at a disproportionately high cost."

In spite of months of negotiations with industrial associations, the trade associations that make up the Council of German Trade still reject this bill. According to a policy statement, trade supports waste avoidance and reduction, but claims that the principle of product liability takes no account of the particular circumstances of trade.

Thinking in Terms of Waste

Trading concerns, it continues, cannot "think in terms of waste" as they do not have sufficient product knowledge. If private collection systems fail to materialize, trade fears that areas will have to be set aside for waste removal and sorting.

Germany: Efficient High Temperature Fuel Cells Modeled

93WS0398A Duesseldorf HANDELSBLATT in German 8 Apr 93 p 24

[Article by Lutz Bloos: "High Temperature Fuel Cells: 80 Percent Efficiency Achieved"]

[Text] HANDELSBLATT, 7 Apr 93—Professor Wolfgang Winkler of the Technical University in Hamburg is certain that high-temperature fuel cells (HTBZ) in the form of combined power stations can reach an efficiency of over 80 percent. For the time being, however, problems in process-engineering are impeding the application of this new technology. Large amounts of waste heat are lost in the power generation process. Winkler has developed a model showing how these losses can be efficiently utilized.

Because of greenhouse gas CO₂, the operators of power stations try to achieve the highest possible efficiency in conventionally fired plants. To date, the 55 percent efficiency level achieved in the Ambarli combined power

plant in Turkey was considered the maximum possible. The use of renewable power sources is still in its infancy and it will take at least 50 years before solar hydrogen as an energy carrier will be practical. Nevertheless, intensive research continues in that field so that tested technologies will be available at the decisive time.

Current Generated Directly

The integral component of all hydrogen scenarios is the use of fuel cells to generate electricity. Current is generated directly in fuel cells by means of "cold" combustion, eliminating the need for hot combustion, steam generation, turbines, and generators. The principle of the fuel cell has been known for decades. Separated by an electrolyte, hydrogen and oxygen are directed into the cell.

Atomic hydrogen, which gives off electrons and which enters in solution as H^+ , forms on the hydrogen electrode. OH ions form on the anode. When the two electrodes are joined together, current flows. Besides hydrogen, natural gas (CH_4) can also be used in the fuel cells. By means of oxygen the natural gas is converted into hydrogen and carbon dioxide, which, however, as an impurity cannot be permitted in the cell because it reduces efficiency.

Calculations Tested in a Model

Of particular interest in power generation are high-temperature fuel cells, which operate best at about $1,000^\circ C$. Unfortunately, the considerable corrosion problems that occur with their use have still not yet been controlled, resulting in the fact that the service life of such cells does not exceed about 1,000 hours. In order to win large-scale technical acceptance, the cells will have to have a service life of more than 10,000 hours. Another disadvantage is that the fuel and the air as the oxidant have to be preheated to about $850^\circ C$, otherwise, owing to the high temperatures, thermal stresses would destroy the cells.

In the future, high-temperature fuel cells promise to yield a very good power supply and for that reason are being further developed by industry through considerable investment levels. Yttrium-doped zircon oxide is used as the electrolyte. Unfortunately, in addition to the current produced, a large amount of hot air and waste gas at about $1,000^\circ C$ are also generated. What can be done to rectify the situation? It would be profligate simply to let this valuable energy burn off uselessly.

Professor Winkler has some thoughts on utilizing this heat. He has thermodynamically calculated how the waste heat of the hot cell can be further utilized to generate even more power in a combination power plant consisting of a gas turbine and a waste heat boiler with steam turbine installed downstream. Many of Winkler's students have earned their engineering degrees by solving this very complicated problem. Since the hot cells must also be cooled from the outside, Winkler first contrived a heat decoupler in the waste heat air stream,

which is used to preheat the fuel and the combustion air. The decoupled heat is—in this way—again directed to the cell. The calculations of the air, fuel, and heat flows have already been completed, and the optimal arrangement of the individual components could be arrived by means of thermodynamic calculations.

The first designs resulted in the following arrangement of the individual component aggregates. The combustion air is compressed in a compressor, brought up to 850° in a preheater, and directed to the cathode. The direct current generated in the cell is taken off and made suitable for the network by means of an inverter. The waste gas flow from the anode is directed by way of a fuel preheater to a mixer, likewise the exhaust air flow via the air preheater. Steam from the waste heat boiler is forced into the mixer at the same time.

The entire flow is heated in the hot high-temperature fuel cell container to about $1,000^\circ C$ and released in the gas turbine. The work done there is converted into electrical current in a generator. A waste heat boiler, from which both the process steam as well as the steam blown into the mixer originates, is installed downstream of the gas turbine. A flue gas capacitor is installed behind the waste heat boiler. According to Winkler's computations, the highest efficiency possible in this arrangement is reached at a temperature of $1050^\circ C$.

In a further refinement the exhaust gas flow to the gas turbine is directed once again into the hot high-temperature fuel cell and vigorously supercharged in an intermediate superheater. A second gas turbine is connected upstream to the waste heat boiler. In this way, a somewhat higher efficiency can be attained at a lower temperature ($1,000^\circ C$).

In order to test the operation and interaction of the components in practice, Winkler hopes in the near future to build an actual laboratory model of the fuel cell, which so far remains only a thermodynamically theoretical proposal. He estimates that the actual efficiency level will be about 5 percent lower than the model computations suggest.

Despite that, Winkler is convinced that by the year 2010 the total efficiency of fuel cell power plants, with gas turbine and waste heat utilization units installed downstream, will reach 80 percent. Fuel cell stacks are already commercially available for 800 German marks [DM] per installed kW. However, they will have to achieve a longer service life at the same cost before the operators of power plants will find them profitable. It is also conceivable that cells with the shorter service life would be found acceptable if their cost were to come down considerably. It is still impossible to forecast whether in 15 to 20 years sufficient hydrogen will be generated by solar or water power to operate large power plants. But even the use of natural gas alone promises a substantially more efficient utilization of the primary energy source with less CO_2 emission.

Sweden: Process to Convert Waste Paper into Alcohol Tested

93WS0404A Stockholm NY TEKNIK in Swedish
1 Apr 93 pp 16-17

[Article by Kerstin Osterberg: "Turning Trash Into Alcohol"—first three paragraphs are NY TEKNIK introduction]

[Text] Talk about recycling: soon we will have alcohol that is made from trash.

The first samples of trash ethanol are now being made in a warehouse in Skoghall.

And the garbage collection company in Stockholm wants to build the world's first trash alcohol factory.

The label of the big aquavit bottle says "Skogstjarnan Home Brew from Skoghall." Inside swirls a yellow liquid. It smells of alcohol, perhaps not the highest quality, but there is no doubt that the beverage has a high alcohol content.

Is it extracted from trash?

"No, that is Chinese aquavit," laughs Mats Pihl, producing a small graduated flask instead.

It contains a coal black liquid whose acrid fumes make my nose smart. It is glucose, a sugar solution that is the first step in producing alcohol, ethanol. Made from waste paper from Stockholm and hydrochloric acid.

Warehouse

Pihl is a research engineer at Eka Nobel in Skoghall and it is here, at a laboratory bench in a warehouse, that trash-based ethanol is being developed. In addition to Eka Nobel and Chematur the work is supported by Reforsk, Swedish Ethanol Development, the Chlorine Manufacturers' Research Fund, Nutek, the National Civil Preparedness Board and Skafab (Stockholm Sanitation Development, Inc.).

Old and Well-Tested

The method itself, strong acid hydrolysis, is old and well-tested. It was used as early as World War I in Germany, but wood was used then.

Obtaining alcohol from trash, however, is entirely new. But the technique also works on this novel raw material, as Pihl and his colleague from Chematur, Hakan Aspelin, have shown in years of joint experimentation.

Trapped in Filter

Today 80-90 percent glucose can be obtained from the paper/hydrochloric acid mixture, a very good result. In principle the hydrochloric acid in the process is completely reusable; however, a fraction does disappear during handling. Most of it is trapped in the filter but some also goes out with the waste water.

The rest of the ethanol process is no problem. Fermentation and distillation are carried out in accordance with the usual methods for producing alcohol.

Big expectations are now attached to trash alcohol. In Stockholm, where the market for ethanol as a motor fuel is expected to increase, the municipal garbage collection company, Skafab, wants to build an ethanol factory.

The initial plans involve a demonstration plant where 30,000 tons of paper will be turned into 10-15,000 tons of 95-percent ethanol. The paper will be sorted from around 100,000 tons of Stockholm trash at the old trash sorting facility near Lovsta northwest of Stockholm that was severely criticized at one time.

Sorting Adapted

However, the facility is still going strong, according to Nils Lundkvist, Skafab development engineer, who told us it has been used for various research experiments throughout the 1980s.

"We can adapt the sorting process to get exactly the kind of paper that is needed to produce ethanol," he assured us.

Lundkvist called the factory a multistage rocket. Besides the ethanol, which can be sold as motor fuel or industrial alcohol, the residual products will also be valuable. The lignin from the cellulose together with fiber residues will form a high-value fuel powder. The plastic that comes along with the sorted paper can be reused in asphalt or used as fuel. Methane gas can be extracted from the mash, the residue after the alcohol is distilled.

Competition for Material

The factory could be ready in the second half of the 1990s. A small problem lurks in the wings, however; if the paper and packaging industry focuses on expanding the recycling of its paper, in accordance with the new goals in the recycling bill, there will be competition for the raw material.

"On the other hand industry may be interested in participating too. Ethanol production might be seen as a good recycling method," said Lundkvist.

State Support

Another problem—as usual—is financial. It will cost 100-150 million kronor to build this alcohol factory. Lundkvist is hoping for state support, otherwise it will probably never be built, he said.

The manufacturing price is another stumbling block. Trash alcohol cannot be produced for the world market price (currently around 2.70 kronor per liter).

"It would be possible with a plant that is large enough. Around 100,000 tons of paper would be needed. That is the total amount of waste paper in this region," said Lundkvist.

"But now we are talking about a huge factory. Where and when it will be built I have no idea," he concluded.

[Box, p 16]

From Paper Napkins to Ethanol

Dirty household paper is just like any other wood-related raw material; it consists of cellulose which, with the right treatment, can be turned into pure alcohol.

The dirt and plastic that come with it (think what may be concealed in a few paper napkins, for example) is not a big problem. The plastic is strained and filtered out. The dirt disappears in the hydrochloric acid.

For the process is based on hydrochloric acid. The method is called strong acid hydrolysis and it uses the acid to break up the molecular chains of the cellulose to get at the sugar that will be fermented to produce ethanol.

The hydrolization occurs in two stages: First the paper is mixed with 40-percent hydrochloric acid, which is dissolved in the cellulose. This is done at room temperature, 25-30° C, under normal pressure in a big tank equipped with an agitator.

Now the cellulose molecules are exposed and receptive to direct attack by the hydrochloric acid. Plastic and lignin are strained and filtered from the liquid.

In the next stage the temperature is raised to 60° C. Part of the hydrochloric acid is turned into hydrogen chloride gas which is cupelled and returned to the first stage in the process. The cellulose molecules are broken down to a sugar solution, glucose.

But it is an acrid and dangerous solution, quite black and very corrosive. It still contains a lot of hydrochloric acid, four times more than glucose.

The hydrochloric acid must also be removed.

This is done by evaporation in two stages, first in a so-called drop film evaporator, then in a thin film evaporator. The hydrochloric acid vaporizes, condenses and is returned to the mixer. The sugar solution is left at the bottom of the evaporator.

The very viscous glucose syrup is diluted with water and heated to 100° C. The molecular chains are split into shorter pieces and the glucose becomes fermentable. The approximately 2 percent of the hydrochloric acid that remains is neutralized with lime.

Fermentation and distillation occur as they do in any alcohol factory. A modern method is to integrate fermentation and distillation.

France: CD Polycarbonate Recycling Procedure

93WS0405A Paris L'USINE NOUVELLE in French
1 Apr 93 p 24

[Article by Jean-Michel Meyer: "Recycling: Looking for a Miracle Product; How to Reprocess the Polycarbonate of Compact Discs [CD]"—first paragraph is L'USINE NOUVELLE introduction]

[Text] A French plastics manufacturer, Remoplast, claims to have a solution that would use a semi-mechanical process. It is still looking for partners to develop it.

European compact-disc manufacturers generate close to 100 metric tons of manufacturing scrap per month. That is for an annual production of 500 to 600 million CDs. In spite of their efforts, scrap rates hover around 10 percent on the average. Every defective disk represents 16 grams of polycarbonate, a polymer that sells for 36 French francs [Fr] per kilo.

"A gold mine," some thought. CD manufacturers, chemical companies, plastics processors, and industrial-waste reprocessors are engaged in a fierce struggle to discover the "miracle" process that will make it possible to recover the polycarbonate. The main problem is that compact discs are a composite product consisting of a polycarbonate support coated with aluminum, which in turn is protected by a varnish.

The Germans crush the scrap after soaking it in caustic soda to remove the varnish and metal. But the polycarbonate becomes brittle and loses its mechanical properties. It can no longer be injected. The Chinese, for their part, scrub the CDs with metallic brushes to turn them into costume jewelry!

Still, a French plastics manufacturer, Remoplast, claims to have found a solution that uses a semi-mechanical process. "A method that dissociates the various components without attacking or altering the polymer molecular chain," Francois-Marie Franci, manager of the PMI [small to mid-size industry] explained.

Molding Tests

The French Plastics Company, in Cotes-d'Armor, has performed molding tests. "This solution is the most interesting of all those we have studied," Dominique Taburet, technical manager, explained. The company makes the additives that will enable the polycarbonate to recover its mechanical properties. The aluminum and varnish are turned into a slurry and serve to color the parts. Within a few months, the French plastics company will use recycled polycarbonate for the injection-molding of one-third of the 50 million inserts it produces every year, i.e. the supports on which CDs rest in their boxes. According to Francois-Marie Franci, a plant with a capacity of 200 tons per month and costing Fr4 million would cream off all CD production scrap in Europe. But no one is interested in the process. "Reprocessors have a monopoly on production scrap, with the producers"

complicity." There is also a rumor in the industry, that these rejects are stocked until a suitable process makes it possible to resell the polycarbonate thus acquired at rock-bottom prices.

In this context, alliances are flimsy. In a first stage, Remoplast had the support of MPO, the leading French manufacturer, based in Mayenne. They could not agree to industrialize the process, so Remoplast turned to the Swiss company Helverep to have it patented. For its part, MPO drew closer to Atlan, a reprocessor based in La Suze-sur-Sarthe. "We shall start production within two months," Edgard Atlan explained. They will use a process derived from the process used to recycle the aluminum-coated covers of yogurt containers. The company will thus be able to use some of the 1,000-1,200 metric tons that it acknowledged it has in stock. Mixed with ABS [acrylonitrile-butadiene styrene], the regrained polycarbonate will be used to make video adapter connectors. Another reprocessor, LPR (Lorraine Plastics Recycling), near Nancy, is also developing that process. They acknowledged having a 5-10 metric ton inventory.

Meanwhile, Remoplast is broadening the field of application of its process to include all surface-treated materials. Negotiations with Digital and Solido are in progress, to remove the metal respectively from computer "carcasses" and ABS toys. Negotiations have also started with car manufacturers, to treat bumpers, hub caps, etc.

Speculation on CD rejects, however, may soon end. LPR has received a request for 50 tons of crushed polycarbonate, coated with aluminum and varnished, to be used as backfill! The long-expected separation process will thus have been quite short-lived.

France Plans Large-Scale Water-Treatment Plant *93WS0405B Paris L'USINE NOUVELLE in French* *1 Apr 93 p 35*

[Article by Pierre Laperrousaz: "Pollution: A Two-Million-Francis [Fr] Contract for OTV and Degremont; Soon, in Colombes, a Weather-Proof Water-Treatment Center"—first paragraph is L'USINE NOUVELLE introduction]

[Text] It would cope with flows quadrupled by rainstorms. And it will supply water of the same quality.

Soon, we hope, the fish in the Seine will no longer be killed by the rainstorms that occasionally hit the Paris area. Water-treatment plants, like the one in Colombes (Hauts-de-Seine), where construction will start before next summer, will absorb the sudden flow variations caused by torrential rains. In fact, the new plant was designed to cope with flows four times as high as its design capacity, while still providing water of acceptable quality.

As you will recall, during the summers of 1990 and 1992, violent rainstorms killed a lot of fish in the Seine. The

sudden outpour of rainwater that water-treatment plants were unable to process properly choked the river with an excess of organic matter. Since then, a decision was made to inject oxygen at certain points in order to provide "survival islands" for the fish. But this is just a stopgap measure.

The Colombes plant, which will be completed in four years, will treat 2.8 cubic meters per second [m^3/s] in dry weather (240,000 m^3 per day, or the sewage of 800,000 people), and 12 m^3/s during heavy rains (for eight hours). "We were the only ones capable of guaranteeing such operating flexibility, the managers of OTV and Degremont," the two prime contractors stated.

Following an invitation to bid that included foreign companies, the SIAAP (Interdepartmental Syndicate for the Cleaning Up of the Paris Area), which will own the plant, decided in favor of a joint project submitted by the respective subsidiaries of the two leading French water-treatment specialists, the General Water-Supply Company and the Lyons Water-Supply Company/Dumez. This is a huge Fr2-billion contract that none of the two companies could fulfill alone. In a normal year, their sales amount respectively to Fr3.1 billion for OTV and Fr3.6 billion for Degremont. "We could not accept sole responsibility for such a project without seriously interfering with our companies' normal business," one of the two partners explained.

High-Performance Biological Filters

The core of the new plant consists in a battery of 65 fixed-bed biological filters; they are called "biological" because the bacteria that will digest the pollutants are fixed on a porous support. This technology, which will increase the efficiency of biological water-treatment, is one in which OTV and Degremont seem to have a strong lead over their competitors. These filters are arranged in three successive stages to eliminate carbon pollution, oxidize the various forms of nitrogen (in particular ammoniated nitrogen) to form nitrates, and finally eliminate the nitrates.

In dry weather, the three stages work in series, and treatment achieves maximum efficiency. If there is a rainstorm, actuating a few valves is all it takes to make the three stages work in parallel. A larger flow is then treated. Elimination of carbon pollution remains quite as efficient, because all three filter stages can take care of it. But nitrogen elimination is not as thorough. Actually, the treatment stops at "nitrification," i.e. the elimination of ammoniated nitrogen, without eliminating nitrates. "It is the lesser of two evils, because it is better to discard nitrates into the environment than ammoniated compounds that will consume oxygen during their natural decomposition," Aline Broussaud, a design engineer at OTV, explained.

The advantage of this configuration is that it was not necessary to design the plant with excess biological treatment capacity. This however, did not apply to the blade settling tanks (Degremont) located upstream from

the biofilters and which separate the particles in suspension, nor to the downstream slurry incineration furnace (OTV). These are self-sufficient and do not use fuel.

Flexible and efficient, the plant will meet European standards. The Colombes water-treatment plant will also be unobtrusive. Because there was not enough room, and for considerations having to do with its integration into the site, the designers had to bury it partially and build it over several floors.

United Kingdom: Sewage Sludge Biocombustion Process Developed

BR0505085993 Rijswijk POLYTECHNISCH WEEKBLAD in Dutch 9 Apr 93 p 9

[Article by Wim van Wijk: "Expensive Incinerator Possibly Already Outdated; British Discovery of Biological Processing Too Late for Dordrecht Sludge Incineration"]

[Excerpts] Dordrecht—While the finishing touches are still being put to a modern incinerator for sewage sludge in Dordrecht, British Professor John Pirt is proclaiming that the sludge can be degraded biologically. Despite this, Director A.R. Bresters, owner of the cooperative body which is exploiting the new incinerator in Dordrecht, denies that the 150-million-Dutch-guilder investment in the sludge incinerator was premature. "Biological processing is interesting, but is still at a very early stage. The method is not yet suitable for large-scale sludge processing."

In Dordrecht, they are refusing to believe that John Pirt, a British professor of microbiology, has found a viable alternative to sludge incineration. Pirt recently published a report entitled "Total Biocombustion of Sewage Sludge by the Biocycle Process," in which he reported that 96 percent of sewage sludge can be biologically degraded at high temperatures. For years, his coresearchers at home and abroad have been searching such a method in vain.

Bresters said, "We will have to wait a few years before we know whether Pirt's method can be used in large installations." Because our country [the Netherlands] has a very large amount of sludge to dispose of, the most modern incineration methods are necessary, according to Bresters. DRSB has already ensured that its new installation, with a capacity of some 230,000 to 240,000 tons of sludge per year, conforms to the strict 1989 Incineration Directive. [passage omitted]

Celebration Disrupted

Prof. John Pirt, who has been associated with King's College in London for many years, believes that he has discovered an appropriate bacteria for the process in horse manure. His purification process consists of four stages, during which the bacteriological "combustion" occurs at a temperature which switches from 80° C to 37° C consecutively. Thus, the bacterial growth which appears during one phase is annihilated during the

following. Bacteria which are active at the high temperature must be completely inactive at the lower one. "Only in this way can one bacteria break down another one, which during the previous phase had been able to increase tremendously," according to Pirt.

It was just that problem that his colleagues had been unable to solve. Initially, Pirt was unable to do so either, even though he was employing a two-phase process using a high and a low temperature. He was left with a large amount of undegraded material. Then, however, he decided to reintroduce the residue into the process in a sort of recycling stage. In this improved approach, it appeared that the solid particles were deposited on the bottom and the clear water could be siphoned off. Pirt then brought the remains of the solid particles back into the cycle together with "fresh" sludge.

According to Pirt, the new process has many advantages. It is not necessary to dehydrate the sludge. The process also ensures that germs and parasites are killed during the first phase. Pirt has concluded from calculations made by a local engineering firm that his process will be 40 percent cheaper than incineration. An additional advantage, according to Pirt, is the concentration of minerals which remains on the floor of the reactor. "Almost all the minerals remain in the reactor and can be recovered."

Pirt is convinced that the biological processing of sewage sludge is economically viable for purification plants, which must be able to process the sewage for 100,000 people. Pirt has already convinced the North West Water Board [in the United Kingdom] of his idea. "I expect my first plant to be operational by 1995," said Pirt.

FACTORY AUTOMATION, ROBOTICS

Germany: Karlsruhe Nuclear Research Center Describes Industrial Units

High-Efficiency Flow Meter Developed

93WS0341A Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 26 Feb 93 p 8

[Article by R.E.: "Higher Efficiency Through Use of Degasser"]

[Text] Frankfurt—Liquid gas or liquid vapor flows frequently occur in pipes in connection with many technical applications. It is often advantageous to reduce the percentage of gas or vapor, the Karlsruhe Center for Nuclear Research, Inc., in Karlsruhe reports. For this purpose a more simply built degasser was developed with has a high degree of separation efficiency. The device has no moving parts and does not require any energy supply.

As the nuclear research center further explained, the degasser can be built into the pipes, results in no noticeable loss of pressure, and exhibits a substantially higher degree of gas-separation efficiency than do the known devices.

The nuclear research center sees drilling for oil as one of the possible applications. More often than not the oil that is extracted contains a considerable amount of natural gas, which increases the loss of pressure in the pipes, thereby lowering production capacity. Furthermore, when there are surges in the flow of oil, severe mechanical strains are placed on the pipes, which can lead to breakdowns. Particularly undesirable is a surge at the end of an oil pipe that runs from the oil source to the offshore or onshore installation.

During the vaporization of liquids too, the transmission of heat is much better with low concentrations of steam than with high ones. By installing a device that lowers the concentration of the steam, the required heat surface as well as the pump output can be reduced, thereby increasing the efficiency, the KfK (Technology Transfer Coordination Point, Karlsruhe Nuclear Research Center, Inc., POB 3640, Karlsruhe, telephone: 07247/825580) reports.

Continuous Heat Exchanger Developed

93WS0341B Frankfurt/Main FRANKFURTER
ZEITUNG/BLICK DURCH DIE WIRTSCHAFT
in German 1 Mar 93 p 10

[Article by R.E.: "Heat Exchanger Operates Continuously"]

[Text] Frankfurt—The heat exchangers and catalysts used in power plant operations have to be cleaned or replaced at intervals. But this high maintenance cost due to the unavoidable suspension of operations can be reduced by using a multisectional heat exchanger, the Karlsruhe Nuclear Research Center (KfK), Inc., (Technology Transfer Coordination Point, POB 3460, 7500 Karlsruhe) reports.

A large number of separately movable elements endowed with heat-storing as well as catalytic properties constantly circulate through this heat exchanger. To make the service life of the elements in the heat exchanger, and consequently the activities of the catalyst, continuous, the elements are used like balls that are designated, for example, by size. In this way it can be guaranteed that only those will be removed during the constant circulation of the elements whose catalytic effectiveness has already diminished.

The heat exchanger surfaces are cleaned outside of the plant. The procedures for maintaining catalytic activity also take place outside of the plant so that power plant operation does not have to be interrupted. As the nuclear research center reports, this technique permits a smaller specific structural volume along with continuous operation. The catalyst no longer has to be oversized depending on the service life and more flexible operation is made

possible by several adjustment parameters. The technique, for which KfK is looking for licensees or partners in collaboration, can also be used for the denitrification and reheating of flue gases after wet desulphurization.

France: Center for Rapid Prototyping Studies Created

93WS0382C Paris INDUSTRIES ET TECHNIQUES
in French 5 Mar 93 p 39

[Article by Mirel Scherer: "A Test Platform for Rapid Prototyping"; first paragraph is INDUSTRIES ET TECHNIQUES lead]

[Text] The European Prototyping Center, located on the premises of the Central School, has three goals: training, technical evaluations, and technology watch. It represents an investment of 8 million French francs [Fr].

The rapid prototyping technologies are a recent development. Their objective is to minimize the time spent in going from a part's CAM [computer-assisted manufacturing] generated virtual model to a very real physical model that will be used in the design, the feasibility study, or as a practical model for industrialization (electroerosion electrodes, mold patterns, etc.) A lot of money goes into all of these operations, and accelerating the various phases can produce considerable gains.

To help manufacturers achieve a better understanding of these new techniques, the Central School of Paris and the Agency for Computer-Integrated Manufacturing (Adepa) recently established the European Center for Rapid Prototyping, Assistance, Transfer, and Experimentation (CREATE). Located at the Central School in Chateaufort-Malabry, the Center will offer manufacturers interested in rapid prototyping three different services. First, they will be able to evaluate the available processes through feasibility studies. They will also be able to improve their knowledge through training programs and seminars organized by the Center. A technology watch and innovation initiative will allow them to validate processes, materials, and new applications or build new machines. Another objective will be establishing work methods suited to rapid prototyping. To provide all these services, the Center will have a full prototype production line, including three-dimensional laser digitalization (the Laser Design LD 500 machine has already been installed); CAD/CAM [computer-assisted manufacturing/computer-assisted design] modeling using Euclid-IS, Catia, Pro/Engineer, the Central School's Icem, Cadds 5X, Unigraphics, and Adepa's I/EMS; high-speed five-axis milling (a machine tool will be installed soon, pending the selection of a vendor among several competitors, including Jobs, Roders, Gambin, and Maho); rapid prototyping per se (the system, which may or may not be stereolithographic, will be chosen from machines made by 3D Systems, EOS, L3D, and Dornier, among others). Two engineers will be in charge of this center,

which will represent a total investment of Fr8 million. Manufacturers interested in one of the services offered will of course be expected to pay towards the operating costs generated by their application.

CREATE will collaborate with other French rapid prototyping centers: the computer-integrated manufacturing center in Le Mans (which has a Cubital machine) and the Engineering, Research, and Transfer Center for CAD/CAM and Rapid Prototyping established by the Nancy Higher School of Engineering Sciences and Technologies in Saint-Die-des-Vosges. It will also benefit from the know-how of Sogamm. Three years ago, this PSA [Peugeot S.A.] group prototyping company acquired a SLA 250 stereolithography machine, used jointly by Peugeot, Dassault Aviation, and Renault (See also our article in *INDUSTRIES ET TECHNIQUES* No 735, p 24).

France: Virtual Image Synthesis Industrial Applications Reviewed

93WS0396A Paris *INDUSTRIES ET TECHNIQUES*
in French 5 Mar 93 p 46

[Article by Yves Ciantar: "Seen at the Imagina Show: Computer-Generated Images To Serve the Industry"—first paragraph is *INDUSTRIES ET TECHNIQUES* introduction]

[Text] Renault is experimenting with them to reduce design lead-times. The Stuttgart Fraunhofer Institute uses them to program robots.

The display shows a landscape in Provence. In the foreground, a vehicle is driving on an unpaved road—the Racoon, Renault's concept car. In 1991, when the film was made, the vehicle, a red turtle mounted on all-terrain wheels, did not exist. Or at least not yet. It was a virtual vehicle, a computer-generated image tacked on to real scenery by computer magic. It is only in March, 1993, that visitors at the Geneva Automobile Show will be able to discover the model—a real one this time.

The film, which is also called Racoon, was not meant just to arouse admiration. "With this film, the Renault marketing department wanted to validate the use of computer-generated images to visualize a project that was still on the drawing board," Bruno Simon, in charge of computer-generated images at the car manufacturer's CAD/CAM [computer-aided design and manufacturing]-design department, commented. At the back of his mind, he had a well-defined objective: to reduce product development lead-times.

How? An automobile project always starts with designer drawings. Based on specifications that set the major technical choices, the designs are then submitted to the chief executive officer and his staff. This group decides to materialize a number of drawings in the form of mockups, first on a reduced scale, then in full scale. Full-scale mockups look exactly like the real vehicle, three to four years before it rolls out of the assembly line.

After viewing them, the group decides to start engineering the car. Considering that, on the average, about a dozen mockups have to be made and that each one costs 1 million French francs [Fr], it is easy to understand why computer-generated images are so important; especially when they manage to reproduce the appearance of a car driving in real scenery; and still more when these images are derived directly from computer-generated designer drawings.

"By using software programs similar to the one that enabled us to create the Racoon film, we can cut the number of actual mockups from 12 to 4. That also considerably reduces the pre-project time devoted to styling. In addition, since we can reuse the film of the same actual scenery for every computer-generated car, the cost of the film goes down every time we use it," Bruno Simon confided.

This technical potential explains why the application field of computer-generated images is expected to expand. "These marketing departments will use virtual images to test the public's reactions to the interior layout of their vehicles," the designer predicted.

Useful to marketing departments, computer-generated images are also useful to robot installers, as is shown by the studies of Fraunhofer Institute engineers, in Stuttgart, Germany. Sitting on a chair, an engineer puts on "stereovision" glasses (two mini video displays applied to both eyes will form a three-dimensional image in the brain), and a tactile glove (loaded with sensors, this glove transmits the hand position at any instant to the computer program). The Fraunhofer computer program projects on the mini video displays the image of a workshop with several robots. "In this world which it can see, but which is in fact a pure creation of the computer, the operator will seize objects that the actual robot will have to grasp," Jens Neugebauer, project leader at the Fraunhofer Institute, commented. The same software that manages the creation of computer-generated images records the operator's hand movements. From these, it derives commands to control the robot. Thus coded, the robot will take a real object located in the same position as in the virtual world, reproducing the operator's approach strategy.

This type of programming "by imitation," as it is called, is already used. In the automobile industry, for instance, painters guide a robot arm to impart to it the correct "gesture" to apply paint. But "virtual" programming offers additional benefits. "The first one," Jens Neugebauer assured, "is that robot programming no longer requires a downtime. The virtual robot can be programmed 'off-line,' even while the actual robot goes on working." Second benefit: it is possible to simulate collisions between the arms of two robots in the same workshop without causing any damage. All that is required is to add suitable data to the program to make it simulate the behavior of the second robot in the workshop.

Alas! In spite of its many merits, the Fraunhofer program is not yet used by any manufacturer. The hardware necessary requires too much power (two Silicon Graphics workstations connected to other UNIX workstations). Hence a total application cost of Fr2 million. However, the Fraunhofer Institute believes that these handicaps are temporary. As evidence, it just set up a demonstration center aimed at small and medium-size industries. "The technologies used to handle computer-generated images will be very important tomorrow in setting up and maintaining industrial workshops," Jens Neugebauer warned.

[Box, p 46]

Five Years of Synthetic Imaging at Renault

- 1988: Fixed computer-generated car; fixed actual scenery.
- 1989: Animated computer-generated car; fixed actual scenery.
- 1990: Animated computer-generated car; animated but simple computer-generated scenery.
- 1991: Animated computer-generated car; animated actual scenery.

France: Prosyst Association Develops Automation Simulation Software

93WS0396B Paris INDUSTRIES ET TECHNIQUES
in French 5 Mar 93 p 87

[Article by Thierry Mahe: "To See How Automated Equipment Works Even Before it Is Installed: A Virtual Plant on a PC"—first paragraph is INDUSTRIES ET TECHNIQUES introduction]

[Text] This simulation software follows an automatic process control system from the specification to the on-site diagnostic stage.

Highlights

- The Simac software extends simulation to the operative part of a process, i.e. to controls, sensors, and actuators.
- Based on the work specifications, the mechanical engineer describes the sequence of mechanical movements that must be performed, based on imposed cycle times. Then, the automation engineer takes over.

Prosyst, a company headquartered in Valenciennes (60 people, sales of 20 million French francs [Fr]) has devised a system to design and simulate industrial process control; it is called Simac. It consists of software running on a PC, plus a series of electronic boards. Frederic Grzesiac, who is in charge of developing Simac, explained: "There is already software that will simulate the command part of process control systems. The idea underlying our product is to extend simulation to the

operative part of the process, i.e. controls, sensors, and actuators. For us, output is more than just a variable that sets itself at 1; it is a bit that attacks an electronic board, which board controls an electrovalve connected to an actuator. The actuator moves at a certain speed in front of sensor cells, etc." Taking the operative part into account results in a much more detailed modeling of the process and, therefore, greater simulation "realism." The objective is twofold. First, Simac is designed to follow the development of a project from specification (work specifications provided by the client) to completion, or even actual operation (aid to diagnostic). Then, it makes it possible to federate the efforts of the various trades (specialists of mechanics, automation, hydraulics, electricity, etc.) around a common design and simulation base.

The mechanical engineer comes first. Based on the work specifications, he describes the sequence of mechanical movements that must be performed, the constraint being the cycle time imposed by the client. These sequences are the machining procedures. To do this, he can use two types of representation, a simplified "grafcet" [transition-stage control graph] (called the mechanics' grafcet), and the concept of axis. We should add that, at this stage, the engineer does not know how the process will be automated.

An axis supports a movement, to which physical parameters, an amplitude of variation, forward and backward velocities, passage and end-of-travel detections, etc., can be assigned. The concept of axis is very general. It covers tool paths as well as the level of liquid in a vat, etc. The automation engineer then completes the representation by defining in greater detail how sensors will work and what conditions will trigger each movement.

A first simulation is possible at this stage. It enables the mechanical engineer to check against timing charts that all operations proceed in proper sequence. Once this first stage has been validated, designing the process control systems proper can start. Obviously, it is the automation engineer's task to determine which part of the process will be controlled by a programmable controller, which other part will be "cabled" in a relay cabinet. For the electric diagrams, Prosyst engineers work in partnership with the XAO [computer-aided systems] company, publisher of a major electrical computer-aided design software, X-Elec. When the study of the equipment wiring is completed, these electric diagrams can then be injected into Simac, and their operation simulated in the same environment as the operative part of the process. It is even possible to create a physical interface between the programmable controllers and the software, through special boards (AID-SIM) designed by Prosyst.

The objective of Simac is to reflect as closely as possible the actual behavior of the system. Actually, the software is more than a design tool; it also serves as a basis to validate the project. Based on the simulations made, the parties involved can guarantee by contract that their studies adequately meet the work specifications.

At this project stage, it is also possible to define test specifications, i.e. to draw up a list of all the tests that will be performed on location, in step-by-step manual operation, in automatic operation, in failure modes, in cycle restart mode following a failure or downtime, etc. If Amdec (failure mode analysis) tables are available, the software can validate them; it can show what happens if a hydraulic line fails, if the contacts of a relay stick, if a sensor bounces, etc.

When it started (in 1986), Prosyst specialized in the development of automatic diagnostic boards, the Aidiag (aid to diagnostic) boards that operate in parallel with operational programmable controllers and detect all their failures in real time. The temptation was strong to loop the loop and add design to operation. That is what they did. It is now possible to configure these diagnostic boards automatically through the software.

Prosyst can boast of having equipped a number of industrial sites, especially in the automobile sector. For instance, the new Sevel-Nord (Valenciennes) plant jointly owned by Fiat and Peugeot, considerably benefitted from Simac (see our article page 56). All programmable controller equipment used in the paint shop were simulated in this environment, as well as some islands of the body-assembly and vehicle-assembly shops. For Peugeot, this simulation tool is part of its industrial strategy to reduce design lead-times.

German University Research Project to Develop High-Precision Laser

93WS0422A Duesseldorf VDI NACHRICHTEN
in German 19 Mar 93 p 23

[Article by "kip": "The Laser Works As a Precision Tool. Special Position Measurement System Enables Exact Machining Analyses"; first paragraph is an introduction]

[Text] Erlangen, 19 Mar 93 (VDI-N, kip)—Quality with the use of a laser in manufacturing depends on many machine and process parameters that mutually influence one another. In a research project at Friedrich Alexander University in Erlangen laser experts are investigating how these process variables can be harmonized with high precision. The manufacture of products with the highest precision is the researchers' stated ultimate aim.

Quite a few process parameters cannot be kept constant during laser-assisted cutting or welding because of machine or workpiece properties, for which reason it is necessary to adjust important parameters. Adverse conditions occur especially at the beginning and end of the machining process as well as at critical part contours (e.g., small machining radii). In the three-dimensional welding of sheet metal, for example, burn-throughs occur at small machining radii, which are primarily attributable to the fact that the response of the control machine is limited. That is why the laser energy acts too strongly concentrated at particular machining points.

The Erlangen research project's goal is to investigate these phenomena and to optimize the process by means of the corresponding results. Machining quality is to be improved, and with this the workpiece's service properties, especially at critical part contours. The uncontrolled phenomena are being recorded by measuring and are being compared with the local machining result. A diagnostic system is being developed for this purpose. A system that records the plasma luminescence that occurs in laser beam welding and the laser radiation reflected by the workpiece is already being tested. A system for the on-line measurement of laser energy is also available in addition.

The response to setpoint changes of the commercial three-dimensional laser beam machine tool available in the manufacturing technology department was studied closely in the first year of research. These investigations will form the important basis for later experiments in process control. So, the rough shape resulting from machining cannot be more precise than permitted by the machine tool's response to setpoint changes.

A system for recording the response to setpoint changes was developed for these investigations. The current position as well as the feedrate of the tool head vis-a-vis the workpiece can be determined at any point in time of the process by means of this system. This position measurement system will first enable correlation between the diagnostic data and the machining result. Numerical simulation will be performed in the further course of the investigations. The results gotten from the special experiments will then be applied to other materials and part geometries.

Germany: Application of Expert Systems in Design Engineering Discussed

93WS0422B Duesseldorf VDI NACHRICHTEN
in German 19 Mar 93 p 24

[Article by "rus" under the rubric "Production": "Application of Artificial Intelligence in Machine Building. Expert Systems Provide Room for Human Creativity in Design. Krupp-Hoesch Vice-President Gerhard Neipp: "Computers Can Still Not Design Innovatively. But They Offer Extensive Expert Knowledge for the Solution of Recurring Problems"; first paragraph is an introduction]

[Text] Essen, 19 Mar 93 (VDI-N, rus)—Expert systems, an outcome of artificial intelligence research, can take over routine work and even lead to a strategic competitive advantage. However, even new developments like neural networks have still not reached the innovation capabilities of a designer, emphasized Gerhard Neipp, vice-president in charge of technical development of the Krupp-Hoesch Group, on the occasion of his being named a professor at Essen University and Cluster College. In his opinion, there are "natural limits to artificial intelligence."

With the development of modern technology the attending ethical challenge is also changing: "The development of machines having complete human abilities and the talent of inventive creativity cannot be a goal worth striving for." Gerhard Neipp, deputy CEO of the Krupp-Hoesch Group, defends this thesis. "Rather we should in the future focus on deploying new technologies and knowledge-based systems for assisting human beings in every field in which expensive routine work is to be performed," is how Neipp defines the development direction.

His point of view is that computers in the future can take over not only routine tasks but also more demanding or more intellectual tasks, and, to be more precise, by the assimilation of research results in the fields of knowledge processing, speech and pattern recognition and robotics. This will increase man's free time for the creative and innovative.

It is precisely these capabilities that Neipp is banking on, who dealt, among other things, with artificial intelligence's (AI's) role in design in his address on the occasion of being named a professor. While the English term "intelligence" has the meaning more of "understanding" and also of "information," according to German usage by intelligence is to be understood primarily an inspired and creative event, the getting of ideas.

Besides, expert systems were what the first programs from AI research were more modestly called. The vice-president in charge of technical development for the Krupp-Hoesch Group gave examples of the application of such clever systems already tested: By means of a knowledge-based system for the custom design of blow molding machines Krupp has shortened from 40 hours to four hours the time it takes to give a quotation. Expensive consulting by design, production scheduling and manufacturing experts has for the most part been able to be dropped.

Their knowledge concerning rule-obeying relationships between data on machines, extruders, blow heads and tools and their respective prices is always available, ready to be called, in the expert system's knowledge base. Customers and suppliers have common advantages thanks to this course of action. The customer gets a quotation completely tailored to his requirements within one or two days. The quotation's high degree of detail should also result in the supplier's meeting planned costs and in short times from the receipt of an order to its dispatch.

Neipp gives, as a second example of knowledge-based systems already in use, the diagnosis of products: "In a different way from doctors, we machine builders can already today use knowledge-based systems for diagnosing the condition of our technical products and they can operate to a great extent automatically. A diagnostic system developed by Krupp-MaK is monitoring the condition of marine diesel engines," says Neipp, illustrating the benefit. Sensors at around 30 measuring

points constantly sense the engine's condition and the thermodynamic process. The data arrive via satellite at the manufacturing plant in Kiel. From there the expert system can make a fault diagnosis and recommend preventive measures.

The system offers more than a technical benefit for Krupp Vice-President Gerhard Neipp: "Contact between the engine builder and its customer does not suddenly stop. There is constant communication for the entire life of our product. An important strategic advantage."

The technical head of the Krupp-Hoesch Group (95,000 employees and 25 billion German marks [DM] in sales) sees additional opportunities for artificial intelligence and the subfield of expert systems in design tasks that frequently turn up that have a limited number of options. Expert systems could assist the work of designers, take routine and documentation work off their shoulders and optimize the flow of information from design to manufacturing to assembly and servicing. By his account, conventional software systems already today are handling a task largely automatically, from giving a quotation to estimating and optimization, to the preparation of manufacturing drawings and NC programs.

But Gerhard Neipp also sees limits to the present application possibilities for AI as well as of computer technology in general: "The complete designing of an innovative component." Unlike the designing of optional models, development designing is a creative process that results in a new hitherto unknown solution. "Information processing thus far cannot provide much help at this stage of getting ideas," is how Neipp sums it up.

His point of view: "It cannot be our goal to conduct ad absurdum the pursuit of making work more efficient and of taking some of the burden off man with the consequence of ultimately replacing ourselves or being ruled by intelligent computers." But this does not rule out the fact that the computer with time will help man in more and more areas of knowledge processing, and even can be superior. Neipp: "We do not have to worry if our knowledge is ultimately not limited by sharing with others, but rather added to and expanded by communication."

Gerhard Neipp is banking on man's creativity and innovativeness: "We should focus more strongly on defining functions and tasks that are to be handed over in the future to knowledge-based systems and machines."

France: Rapid Prototyping Center To Increase Competitiveness

*BR0505085293 Paris INDUSTRIES in French
Mar 93 p 11*

[Article by Alexandre Routier: "European Manufacturers Test Rapid Prototyping"]

[Text] More than 150 manufacturers were present last January at the launch of the European Center for Rapid

Prototyping, Assistance, Transfer, and Experimentation (CREATE), located on the premises of the Production Automation-Logistics Laboratory of the Central School of Paris [ECP]. This high level of attendance is indicative of industry's interest in this new technology: "Product design and development teams are continuously looking for new ways to simplify and speed up prototype development," explains Alain Bernard, project promoter and ECP lecturer. With these new technologies, prototype development times are no longer measured in months, but in days, or even hours.

Unfortunately, they are little known by engineers, and institutes capable of providing the necessary training can be counted on the fingers of one hand. Created at the initiative of the ECP and the National Agency for the Development of Factory Automation Applications in Industry (ADEPA), this center pursues several objectives: For example, it will allow manufacturers to evaluate available processes through feasibility studies. In addition, the center will organize training programs and seminars to update knowledge in this rapidly evolving area, and it will act as a watchdog for new technologies and innovative processes aimed at the implementation of new applications, processes, and materials and at the development of new machines.

All these activities will be guaranteed thanks to the complete rapid prototyping chain which is taken into operation at the Chatenay-Malabry laboratory. This chain (total investment estimated at 8 million French francs [Fr]) will include three-dimensional laser digitization (Laser Design's LD-500 machine is already installed in the Center); CAD/CAM [computer aided design/manufacturing] (the ECP's Euclid-IS, CATIA, Pro/Engineer, and ICM and ADEPA's CADDS 5X, UniGraphics, and I/EMS systems); high-speed five-axis milling (a machine-tool will be installed next; several suppliers are under evaluation: Jobs, Roders, Gambin, Maho...); and the rapid prototyping system (it still remains to choose between machines from 3D Systems, EOS [Electro-Optical Systems], L3D, Dornier...). Two engineers will pilot the center, but other specialists, both from ADEPA and ECP, may be called upon. Manufacturers interested in one of the Center's services will have to pay for the operational costs generated by their application.

The other French teams specialized in rapid prototyping (the production automation center of Mans and the CAD/CAM Engineering, Research, Transfer, and Rapid Prototyping Center of the Advanced Engineering Sciences and Technologies School in Nancy) will participate in the technological venture. Finally Sogamm, the PSA [Peugeot] group's prototyping company, will also contribute to the new center. Sogamm has a SLA-250 stereolithographic machine which it uses in collaboration with Dassault Aviation and Renault.

MICROELECTRONICS

German Researchers Develop Microswitch With One Nanometer Cluster

93WS0384D Duesseldorf *HANDELSBLATT in German* 1 Apr 93 p 27

[Article by A.D.N.: "Microswitch on Microships"]

[Text] Essen—Scientists Prof. Guenter Schmid and Dr. Guenter Schoen of the Polytechnic University of Essen have come one step farther on the way to the miniaturization of switches on microchips. With a process that they developed, they have succeeded in making the protective cover between the gold particles between which the individual electrons can be shunted back and forth even thinner. These so-called "clusters" measure only a nanometer (a millionth of a millimeter). Every pair consists of 2 x 55 gold atoms and has the properties of a semiconductor. Up to now, the chief obstacle has been the difficulty in insulating the clusters from their neighbors, but at the same time maintaining enough contact between neighboring metal nuclei for the electrons to be able to avail themselves of their switching functions.

Germany: Electrohydrodynamic Micropumps for Precise Proportioning

93WS0392B Frankfurt/Main *FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT* in German 12 Mar 93 p 8

[Article by Volker Busse, staff member, German Patent Office, Munich: "Micropumps Enabling Precise Proportioning of Very Small Quantities of Fluid. Integration With Microelectronics on a Chip. Trends in Patent Applications"]

[Text] Munich—The general trend in machine building is going more and more toward reduced size and the greater use of electronic components. There are limits to this reduction in size or miniaturization owing to the fact that these miniature components have to be supplied with a working fluid or a coolant, and pumps are needed for this.

Thus far these have not been able to keep up with the reduction in size in the field of electronic components, for example. But a comparable degree of miniaturization has been attained recently for pumps too through the use of fabrication processes familiar from semiconductor technology. Primarily two different types of these so-called micropumps are being used.

The EHD micropump works according to the electrohydrodynamic (EHD) principle. These pumps operate completely without moving parts. They consist of two tetragonal single-crystal silicon wafers that have a lattice structure with a prismatic base. The size of the lattice space, which is produced by the photoetching process, is between 0.1 x 0.1 mm and approximately 10 x 10 mm.

Typical sizes of the lattice openings defined by the prismatic holes are between $2 \times 2 \mu\text{m}$ and $1 \times 1 \text{ mm}$. The lattice's thickness is in the range of $1 \mu\text{m}$ to $200 \mu\text{m}$. The distance from one another of the two lattices serving as electrodes comes to around 10 to $60 \mu\text{m}$.

When a potential difference is applied to the two lattices, an electric field forms between them. At the same time, under the influence of the electrostatic space charge in polar fluids in contact with the electrodes, ions are produced having conductivity of between 10^{-8} and 10^{-10} S/cm and rush toward the electrodes as a function of their charge.

They drag the fluid molecules along because of the internal friction and bring about flow through the double lattice. The small distance between the lattices made possible by the type of fabrication is a great advantage here, because a pumping action commences already with an applied potential of 10 V with a distance between the lattices of $60 \mu\text{m}$.

Static pressures of up to 2.5 kilopascals and pumping rates of up to 14 milliliters per minute under a pressure of 420 pascals (with a distance between the lattices of $350 \mu\text{m}$ and a volume of 3 microliters) can be attained with a potential of 700 V in ethanol pumps. Moreover, it is possible to adjust the pressure and flow rate over a wide range to suit requirements by changing the size of the lattices, the distance between the lattices and the operating voltage.

The other common principle for micropumps consists in carving out from a likewise single-crystal silicon wafer by means of the photoetching process a pump chamber and an inlet and outlet valve, and in cementing this silicon wafer between two glass plates, or, if possible, to another similarly worked silicon wafer.

The pump chamber is closed off by means of a diaphragm-like wall in this case. This diaphragm is then actuated by means of piezoelectric actuators or is even thermally actuated. Another type of actuation would be a capacitive drive, if the pump chamber's walls are covered by metal plates.

There are also different variations as far as the sequence of glass and silicon wafers is concerned. The thickness of these glass or silicon wafers is in the range of 300 to 400 micrometers and their diameter is approximately 10 to 20 millimeters. Flow rates of a maximum of 20 milliliters per minute and a maximum pressure of 8 kilopascals are attained with this principle. The advantage of this principle lies in the fact that fluids can be delivered regardless of their electric conductivity.

The general trend is going in the direction of integrating in the same process on semiconductor wafers, in addition to pumps, also their electric drive. There is a big advantage in the fact that the fabrication process used for this has already been tested for a long time in semiconductor technology and can be employed problem-free in mass production too.

The range of application of these micropumps extends from medicine to chemistry to optics and robotics. Their major advantages lie in the precise proportioning, delivery and metering of very small quantities of fluid. New micromachines that cannot be implemented by orthodox methods are coming into being by the integration on a shared silicon wafer of micromechanical operating elements and their electronic computing and drive circuits.

Germany: Network for European Microsystem Research Founded

93WS0398B Duesseldorf *HANDELSBLATT in German*
8 Apr 93 p 24

["Research Has to be Better Coordinated"]

[Text] hsn. Duesseldorf—European research activities dealing with microsystems technology will be better coordinated in the future by means of a network designated by the acronym "NEXUS." The Fraunhofer Institute for Silicon Technology (ISiT) in Berlin will have total responsibility for the future success of the program. The closer working arrangement has been necessitated by the excessively scattered and isolated research activities in European laboratories. It is the belief of the initiators of NEXUS that the only way already available know-how can ever be quickly converted into marketable industrial products is through multidiscipline cooperation. The success of the program seems assured. As early as late 1992, 31 companies and 50 institutes from 14 European countries had already expressed their interest in this cooperative venture.

Advances With Light-Emitting Plastics Reported

M10405092893 Munich *SUEDEUTSCHE ZEITUNG*
in German 8-9 Apr 93 p 39

[Article by Ulrich Eberl: "Cold Light From Plastic: Light-Emitting Plastics Compete with Conventional Semiconductor Diodes"]

[Text] Certain plastics, such as iodine-enriched polyacetylene, conduct electricity very well: In other words, their resistance is low. They therefore behave like semiconductors. Three years ago, a research team led by Richard Friend at Cambridge University's Cavendish Laboratory discovered that the plastic known as polyparaphenylene vinylene [PPV] is closely related to semiconductors in its optical properties: If a low voltage is applied, it reacts like a light diode and emits light. Conversely, when PPV is exposed to light rays, the plastic produces electricity, like a solar cell.

At the European Physics Society conference held in Regensburg last week, Richard Friend reported on progress with light-emitting plastics. It has now been established that they owe their special optical and electrical properties to a chain of carbon atoms containing alternate single and double chemical bonds. As in a semiconductor, the electroluminescence can convert the

electrons' energy into light. This light differs from the spectrum of a filament bulb in that it lacks the infrared component and so is "cold."

A PPV light diode is structured on the sandwich principle: A chemical foundation layer of PPV is applied to glass precooked with a transparent but electrically conductive layer. A kind of rotational coating process spreads the material until it is only a fraction of 0.001 millimeter thick. Heat or ultraviolet light converts it into PPV, which is highly stable. Lastly, a metal electrode on the PPV layer creates the second electrical contact.

Friend has succeeded in constructing a light diode that converts 1 percent of the electrical energy into light. According to Friend, this efficiency is sufficient for PPV display elements, enabling them to compete with liquid crystal displays (LCDs), which do not emit light of their own, but have to be artificially illuminated.

Friend calculates that, "in theory, it is possible to convert 25 percent of the electrical energy into light rays," though light-emitting plastics are still a long way from this limit. Friend is confident, however, of achieving 10 percent in the foreseeable future, which would make the new materials efficient enough for use as light sources.

The British researchers are able to control the color of the light by modifying the chemistry and adapting the sequences of different plastics. Besides basic PPV's color of greenish yellow, they have already developed red and blue light diodes. Though the blue ones still have only a short life, the red and green ones can emit light for several weeks.

Unlike conventional light diodes, plastics can be manufactured in fairly large sheets: For example, Markus Schworer and his team at Bayreuth University have developed components measuring several square centimeters. Structures as small as 0.001 millimeter can be written into PPV foil using ultraviolet light. The foil still behaves like plastic: It retains its flexibility and can be peeled off the substrate and bent without damaging the structure. This makes light-emitting plastics attractive for optoelectronic components as well.

NUCLEAR R&D

Germany: Proton Research at Cosy Ring in Juelich
93WS0384B Duesseldorf *HANDELSBLATT* in German
1 Apr 93 p 27

[Article by N.L.: "Cosy: Particle Accelerator With Improved Technology; Cooling and Storage Rings Make Protons Get a Move On"]

[Text] Duesseldorf, *HANDELSBLATT*, Wednesday, 31 Mar 93—Recently, [scientists] for the first succeeded in storing a proton beam in the "Cosy" cooling and storage ring at the Research Center for Nuclear Physics in Juelich. The 3 billion protons of the beam circled the 180-meter-long oval of the ring for up to 50 seconds,

equivalent to 25 million revolutions. The installation will be officially opened on 1 April (no April fool).

Basic research on nuclear physics has been conducted at the Institute for Nuclear Physics for three decades. What elements are our materials composed of? What forces hold them together? These questions and others like them are the ones that are being investigated here and at many research institutes worldwide.

The structure of the atomic nucleus was determined during the past few decades with the then available particle accelerators. With them, to be sure, many questions could be answered, but at the same time new questions about the structures of the individual elements arose. How does one track down the secrets of the smallest elements, the so-called "quarks," and the carriers of the binding forces, the "gluons"? These new questions can only be investigated with a particle accelerator with higher energy and greater precision.

Higher Energy and Greater Precision

In July, 1988, the foundation stone for the construction of a cooling and storage ring was laid at the Research Center in Juelich. "Juelich Cosy"—this is what the installation is called—is expected to accelerate the proton beam from the cyclotron once again at higher energy and at the same time precisely focus it. The installation is shaped like a racetrack with a circumference of 184 meters. Many efficient magnets weighing tons keep the proton beam in its orbit and accelerate it to 96 percent of the speed of light. This is equivalent to an energy level of 2.5 billion electron-volts. So that the particles do not lose their energy through collisions with air or other particles, the beam tube is kept in a vacuum.

What is so special and unique about "Juelich Cosy" is the way the proton beam is "cooled." With two different methods, "electronic cooling" and "stochastic cooling," a well-ordered particle beam is produced which is roughly as fine as a pencil lead. During every revolution the beam is analyzed and guided in a flash—a half a million times a second.

Analyzed and Guided in a Flash

After building it for almost five years, the Juelich engineers and physicists guided a particle beam from the cyclotron into the "Cosy" ring for the first time in September 1992. From that moment to using the proton beam in the first experiments, a rocky road full of hard work still had to be put behind them in order to test the interplay of all the parts and components of the installation. A highly precise installation like this, which is state-of-the-art science and technology, is after all no conveyor belt that is turned on and then simply turns out the finished product—that is, a proton beam of a specific quality at the site of the experiment.

The first successes once they went into full operation appeared in astonishingly rapid order. The first time a

proton beam was injected into the "Cosy" ring was on 10 September; as soon as 17 September, they successfully threaded the proton beam once around the entire ring, but as yet without focusing it with the four-pole magnet that has the same effect on the proton beam that lenses have on a light beam. On 21 September, they were able to pick up a focused beam on a viewing screen after the first revolution.

After these initial successes, the laborious work of adjusting the ion optical system in such a way that several revolutions of the beam could be attained began. To accomplish this, it was necessary to use diagnostic instruments that record the beam, to be sure, but do not interfere with it. On 7 December 1992, four revolutions of the beam in succession were observed in the "Cosy" ring and 20 a few days after that. After a pause in operations and additional optimizations, they had gotten this far: Cosy operated as a true storage ring for the first time. On 12 January, the beam could be sustained in "Cosy" for up to several milliseconds, equivalent to a few thousand revolutions. During that time it repeatedly passed through the target and in the process lost some of its intensity. By using fast magnets that guide the stored beam past the target within milliseconds, a storage period of 50 seconds could finally be attained.

The successful launching of full "Cosy" operations, up until then, could only be managed because those working on the project were willing to work shifts, which made it possible to set up a two-shift operation.

Many scientists from the Research Center and the surrounding universities, which have been preparing the experiments for a long time, are waiting for the measuring operation to begin. Another application of the "Juelich Cosy" will probably be added in the course of time: the especially precise and effective radiation of tumors.

SPD's Catenhausen on ITER, Nuclear Fusion Research

93WS0403B Munich SUEDEDEUTSCHE ZEITUNG
in German 8-9 Apr 93 p 38

[Interview with SPD's Wolf-Michael Catenhausen, FRG research committee representative, by Martin Urban; place and date not given: "Less Research on Nuclear Fusion?"]

[Text]

[Urban] After 30 years the Social Democratic Party of Germany [SPD] wants to apply the emergency brakes to nuclear fusion research whose objective, a fusion reactor, has kept receding farther and farther. It appears to be your desire not to have the European fusion experiment, the international thermonuclear experimental reactor [ITER], that is supposed to test the physical and technical possibility of "taming the hydrogen bomb," built in Germany. Why not?

[Catenhausen] SPD politicians concerned with research are agreed that we have to establish new priorities as resources dwindle. Strategies for rational energy use and energy savings take priority over a technology that is able to make a noticeable contribution to energy savings at the earliest in 50 years' time, if at all. Any country that wants to house ITER will have to contribute DM1.8 billion to that project. Germany cannot afford that.

[Urban] So what is the likely cost of ITER?

[Catenhausen] Based on current estimates, we are forced to assume approximately DM23 billion (design, construction, operating costs). Presumably though, Europe, the U.S. and Japan jointly will raise those funds.

[Urban] How do you plan to implement your will as the opposition?

[Catenhausen] The erection of such a large experimental fusion facility will require passage of a separate nuclear fusion reactor law that the parliament will have to approve. That is likely to occur only with a broad political consensus.

[Urban] Is it really indisputable that the law on atomic energy is inadequate to authorize ITER?

[Catenhausen] That is what the experts say.

[Urban] Is the SPD generally opposed to the building of ITER? Does it not only not want to have the reactor in Germany, but not to have it at all?

[Catenhausen] In principle the SPD is not opposed to nuclear fusion research. It does, however, want a fresh determination of the pace at which development should proceed. The decision for the ITER project is being worked out in negotiations among Europe, Japan, U.S., and Russia. Where we are able to exert real influence is on the issue of whether Germany should apply to house it with special costs.

[Urban] But if the fusion reactor were to be built, for example, in France, Germany would still incur considerable costs. How much?

[Catenhausen] If it is housed in Europe, the FRG would have to contribute nearly DM250 million to construction costs.

[Urban] Would you see any purpose in that?

[Catenhausen] If such a decision is made on an international level, then German fusion research also naturally has to contribute to that major project. In that case, however, we would have to discuss the scope of it.

[Urban] Politicians concerned with research in the SPD parliamentary party adopted a document. In it they voice their opposition to increased resources for fusion research in upcoming years and call for a review of the current scope of German fusion research. What is that driving at?

[Catenhausen] We are questioning whether nuclear fusion in Germany should really be conducted at three foci.

[Urban] It is being done at Juelich, Karlsruhe and, above all, at Garching.

[Catenhausen] We are deliberating whether this should not be focused on two research facilities. We also have to review whether it makes any sense, in terms of research policy, in addition to the Tokamak development, on which ITER is based, to pursue any further an alternative line of fusion reactor, specifically the Stellerator.

[Urban] That is the line being explored in Garching.

[Catenhausen] As a major German project, in any case, the Garching line does not have a chance. Therefore the question is whether Europe can afford such an additional line of reactor, and even this, I think, must be decided very quickly.

[Urban] What are you advocating?

[Catenhausen] I am open about that. Europeans should accurately deliberate, above all in the event that Europe applies for ITER, whether there is still enough money at all for the Stellerator. The Stellerator is a highly interesting technological project but the question has to be asked: can it still be financed?

[Urban] If it is not to be funded, does that mean that the Max-Planck Institute in Garching will no longer have a future?

[Catenhausen] That question will have to be raised when the ITER decision is made. I assume that with the fourth EC basic program for research and the corresponding development of Euratom foci (for the European atomic community), the decision will be made next year as to whether Euratom sees any purpose in continuing to pursue the Stellerator. I do not believe that Europe can afford a dual track in fusion research.

EC: Budget Cuts for CERN Affect Large Hadron Collider

BR2104082293 Paris LA RECHERCHE in French
Apr 93 p 368

[Unattributed article: "Accelerator Project Slowing Down?"]

[Text] CERN [European Nuclear Research Center], the Geneva-based European particle physics laboratory, is often cited as being one of the most successful examples of European inter-state cooperation. The scientific achievements are proof of the quality of research carried out in this laboratory. However, to observe matter in infinitesimal detail, the energies used must be increased continually and this implies constantly growing costs for the installations. CERN is funded by member states on the basis of a share-out agreement established at its creation in the 1950s. This share-out is now being

questioned by a number of member states, including Germany, the largest contributor, which provides 22.5 percent of the annual budget worth some 950 million Swiss francs [SFr]. This contribution should have been raised to 25 percent, the ceiling rate provided for at the outset, after German reunification. Economic difficulties, however, have led Germany to request, at the last CERN board meeting at the end of 1992, for the ceiling rate to be readjusted downward to 22.5 percent. The United Kingdom and certain northern European countries supported this proposal, which was approved finally, until at least through 1996. As a result of this decision, the CERN's annual budget will be reduced by SFr25 million (2.5 percent) until 1996. New negotiations should then follow.

This kind of reduction would not have had dramatic effects on the functioning of CERN had the new European Large Hadron Collider (LHC) project not existed. CERN had in fact planned building this collider at a constant budget rate just like it did for other accelerators. This project is widely supported by European elementary particle physics specialists. They believe that this will allow them to demonstrate Higgs's boson, which has been predicted via the standard interaction unification model, and possibly some unexpected new phenomena. For the past two years, engineers at CERN have been developing new techniques to build this facility while physicists and engineers are designing the necessary detectors for this project.

Everyone is hoping that the final decision to build the LHC will be made before the end of 1993, thus permitting construction between 1994 and 1999. The LHC therefore would be operational before its American competitor, the super superconducting collider (SSC), for which construction has started in Texas.

How will Europe finance the LHC in the future (SFr3 billion)? The United Kingdom also wants to cut its contributions to CERN. Spain only pays one-third of its share because the Madrid government does not believe that the Spanish economy gets enough from its contribution. When asked, the Japanese said that they would not participate in funding the LHC any more than would the Americans. From now on, most of the CERN members are looking to France, whose annual contribution amounts to only 16 percent. The arguments being put forward are based on the fact that the current LEP [Large Electron-Positron Collider] and the future LHC are both located on French territory. Therefore, France is reaping economic advantages which other members do not benefit from.

New financing forms now are under consideration. France could build certain parts of the LHC at its own expense but without increasing its official participation in the CERN budget. This would guarantee the future of the project. This view is upheld by French physicists, who are seeking an additional grant of 27 million French francs [Fr] per year toward the production of the detector (SFr300 million to SFr500 million). This Fr27

million would be in addition to the annual operating budget of Fr23 million for particles physics in France.

Considerable sums of money are at stake and choices will have to be made because the LHC is not the only expensive project of interest to French and European physicists. France in particular is involved in several European projects: the renewal of the high-flux reactor at the Laue-Langevin Institute and the equipping of the synchrotron light source, both in Grenoble; a new particle accelerator for nuclear physics; and a French source of synchrotron light.

It would be surprising if all these major projects were financed, even under a constant French research budget, particularly because many other fields of research exist which, although less expensive, contribute equally interesting new findings and may be more beneficial in the short term for society. A reduction in their funding would be difficult to justify.

TELECOMMUNICATIONS

Scientists Argue Against EC's Adopting US HDTV System

93P60233 Paris *LE MONDE* in French
9-10 May 93 p 11

[Text] We are a group of European scientists and researchers involved in the development of television systems. The media have reported certain statements by Mr. Bangemann concerning a new policy of the European Community concerning television.

The first part of these statements, the abandonment of the D2-MAC/HD-MAC system, is a logical step in view of the rapid development of new television systems. Moreover, for some time we have been calling for this step for technological reasons. But we are concerned by the second part of these statements. Although it has not been clearly stated, it appears that the door is open to the adoption of the American system [of high definition television] for European television.

We are convinced that there is no reason to adopt this American system, for the following reasons:

1. Europe has the necessary know-how and technology to design and manufacture a new digital HDTV system which would be better adapted to the European context, and compatible with other forms of digital television such as satellite transmission, digital recording, and so on. The problem which we must solve is the coordination of the European effort.

2. The so-called "all digital" systems currently in the United States are closed systems. Once they have been adopted and installed, there will be no more chance to enrich them during their long lifespan of about 40 years. However, important innovations are arising more quickly than envisioned, such as multimedia systems,

ultrahigh definition, three dimensional screen (with the perception of depth), virtual reality, and interactivity, to name just a few.

The new European digital system must be able at least to integrate these extensions in the future. To underestimate the rate of innovation in the digital television sector could soon lead us to the same impasse as we have now with the MAC family of systems.

This text was signed by the following professors: Belanger (CNAM, Paris), Delogne (University of Louvain, Belgium), Granlund (University of Linkoping, Sweden), Lagendijk (University of Delft, Netherlands), Kunt (Federal Polytechnical School of Lausanne, Switzerland), Rocca (Polytechnical School of Milan, Italy), Serra (School of Mines, Paris, France), Torres (University of Catalonia, Barcelona, Spain), Pearson (University of Essex, Great Britain), and Musmann (University of Hannover, Germany).

EC Spokesman Urges Use of 16/9 TV Screen

93WS0386A Paris *AFP SCIENCES* in French
18 Mar 93 p 13

[Article: "Wide Screen More Important Than Standard for Launching HDTV, According to European Commission Expert"]

[Text] Brussels—A European Commission expert, Mr. Juan Majo, said on 12 March that putting TVs with the wide "16/9" screen on the market is more important for the future of high definition television [HDTV] than adoption of a single transmission standard.

What's needed, he said, is to start popularizing wide screens now, independently of efforts to agree on a unique transmission standard, even though D2-MAC is the only standard currently available for HDTV broadcasting. A simple, relatively inexpensive decoder will allow viewers to keep using big-screen analogue televisions with the digital broadcasting standards. To encourage the switch to these screens, program directors and broadcasters must be given incentives to acquire the necessary equipment, hence the need for an action plan.

"However, there must not be a multiplicity of standards in Europe. It is very difficult to go back to a uniform standard once they all exist, and we must tackle the digitization problem without delay," Mr. Majo said.

In reference to digital standards developed in the United States and Japan, the Commission expert said "the most reasonable approach would be to work collaboratively, without turning the standard into a market protection feature." D2-MAC was developed solely for satellite broadcasting, Mr. Majo noted. "Europe should have the same digital standard for both satellite and terrestrial broadcasting."

Belgium: Philips Markets Euro-ISDN Videophone*BR2604121393 Antwerp DE FINANCIEEL-
EKONOMISCHE TIJD in Dutch 6 Apr 93 p 13*

[Article signed FrG: "Philips Demonstrates Euro-ISDN With Videophone Connection Between Brussels and CeBIT Fair—Sopho Exchanges Ready for Connection to ISDN Network"]

[Excerpts] Brussels (TIJD)—In July, Belgium will see the start of Euro-ISDN, the European standardized version of the integrated services digital network (ISDN). Philips Business Communication Systems, which has been working on ISDN in five European countries for some years, is now ready to start Euro-ISDN as well. It demonstrated this last week by establishing a direct link between videophones connected to its Sopho telephone exchanges in Brussels and the CeBIT trade fair in Hannover, via the national ISDN networks of Germany, France, and Belgium.

The advantages of ISDN already are widely known: faster telephone communication, very low noise level, simultaneous transmission of voice, data, and still or moving video images, etc. No wonder that the national telecommunications companies in all major countries have worked hard on ISDN in recent years. Unfortunately, as is often the case in Europe, each country has applied its own standards, which do not always match those of its neighbors. The only exceptions are Germany and the Netherlands, which both use the 1TR6 standard, while Belgium has its Alinel project, France its VN2, and Great Britain its DASS2. All use standards that not only differ, but also are far removed from the Euro-ISDN standard, which should be implemented this year. Perhaps Belgium's Alinel differs the least from the European standard, because the project started far later than in other European countries (1988-1989) and therefore could learn from the others' mistakes.

Some time this year, most countries should have to start working with Euro-ISDN, or E-ISDN as it is commonly known. In Belgium the network's commercial opening is planned for July, assuming that the software problems between Alcatel and Belgacom have been solved by then. "In any event we are ready to step in without any problems," emphasizes Marc Bauchant, product director at Philips Business Communication Systems. "In the past few months we have successfully tested links between our Sopho telephone exchanges and the ISDN network in Belgium, the Netherlands, Germany, France, and Great Britain, so as to gain experience in this field. It seems to have been the right choice, because now all we need to do is make some software modifications and we can connect up to the E-ISDN network."

Philips also already has tested successfully functional connections between its exchanges and Belgacom. Now it is simply waiting for European approval, which can be issued only by a certified European laboratory. "And,

unfortunately, at present there is only one such laboratory in Europe, in Denmark," explains Bauchant. "Similar laboratories also are expected to be set up in Germany and the Netherlands, but for now we have to wait because all manufacturers have to obtain approval from the one laboratory."

Belcomlab, Belgacom's laboratory, still is not certified, but the manufacturers in Belgium nevertheless have applied for permission to connect by the summer. This would allow them to hook up to the network and allow them to provisionally start using the European ISDN network. That would not cause any problems, because the connection between E-ISDN and Alinel is absolutely smooth. "Philips's major strength in this field is that it has all the necessary technological know-how under one roof," says Bauchant, "whether in telecommunications, data, sound, or image transmission. What places us in a unique competitive position is this combination of specializations plus our close cooperation over the years with the various national telecommunications operators."

Videophone

To demonstrate its know-how in practice, last week Philips established an ISDN connection between its Brussels headquarters and its stand at the CeBIT exhibition in Hannover. This was no normal phone connection, but a videophone link, one of the best applications for illustrating ISDN's qualities. This link transmits both speech and still or moving images, and possibly data as well. In any case, Philips has passed the experimental stage with its videophones, for it already has produced a limited series of several hundred machines for the Netherlands and German telephone companies.

At CeBIT, the company showed its first commercial version, which attracted particular interest from visitors. [passage omitted]

International

The CeBIT connection was achieved in close cooperation with Deutsche Telekom, but, for practical reasons, the final route also went through the French network (without any hitches)—so, it was a truly European accomplishment. There appears to be real irth a personal computer/workstation, 25 percent add-on models, and 25 percent high-end appliances. They all are scheduled to be delivered next spring.

Strangely enough, Philips does not appear to be convinced of the potential of a videophone-personal computer combination. "We do not see PC's being switched on all day in offices," says Marc Bauchant, "without which there can be no videophone connection." However, the fact that France Telecom is placing special emphasis on a videophone-PC combination should serve as a warning to Philips. The company would do well to take a look at what happens in other corporate environments, where it would quickly see that in many companies PC's are switched on in the morning and only

switched off at the end of the day. In addition, desks contain so much nowadays that an integration of two pieces of equipment certainly is to be recommended, if only to save space.

Recognition

With some 10 other companies, Philips also is participating in the EVE-2 project—the European Videophone Experiment. This is a pan-European project sponsored by the six largest European telecommunications operators (Britain, Germany, France, Italy, Norway, and the Netherlands), all of which have signed a memorandum

of understanding aimed at stimulating the videophone market and developing a standard. Philips will manufacture the reference terminal for this project, so the other project participants must ensure that their terminals are compatible with the Philips' specifications.

Philips also has gained recognition for its competence in other sectors, last year winning the "Industry Forum Design Hannover 1992" prize for its document camera. Last week it succeeded in winning the same prize for its "Session" ISDN videophone, a compact model with a color LCD [liquid crystal display] screen, camera, and coding and decoding electronics.

COMPUTERS

India: Poor Marketing of High-Speed Processors Claimed

93WT0063A New Delhi INDIA TODAY in English
30 Apr 93 pp 69, 72

[Article by Saritha Rai: "Super Breakthrough But..."]

[Text] Four years ago, India was on its knees begging the U.S. to sell supercomputers like the Cray XMP14 to be used for predicting weather. The Americans did sell India one such for Rs 10 crore but put a full-time 'minder' to make sure the computer was not being secretly put to use in areas such as defence and space. When India wanted another supercomputer, the U.S. government disapproved.

Now the Americans are beginning to regret their myopic stand. For India decided that if it could not buy supercomputers, it would make them. Or to be more accurate, make good substitutes. Four Indian research institutes entrusted with the task of making such powerful computers are showing dramatic results. And what's more, one version called Param, made by the Centre for the Development of Advanced Computing (CDAC) in Pune has sold four such machines abroad directly in competition with US sellers.

Supercomputers are basically heavy-duty, high-speed information processors that can complete tasks in hours the tasks that ordinary personal computers would spend years doing. They are vital in fields such as meteorology, aerospace, defence and industry, where millions of calculations are required rapidly. For instance, while making the daily weather forecast for India, taluk level variations in temperatures, air pressure, cloud cover and wind speeds have to be fed into the computer which then crunches the information rapidly and spits out the prediction. However, such giant machines are highly expensive, difficult to maintain and in constant need of costly upgradations.

Realising that in the high-velocity chip business such giant computers would soon become white elephants, the Indian groups came up with an innovative solution. They decided to organise a platoon of computers, called parallel processors, linked by a sophisticated software to act as one giant computer. Working with small teams and on shoestring budgets, they have come up with some remarkably versatile substitutes. Examples of their success:

- Scientists at Bangalore's National Aeronautical Laboratory (NAL) have built the Flosolver, a parallel processor, that is almost half as powerful as the Cray XMP but costs less than a tenth the amount. Indian Institute of Science (IISc), which was to purchase a Cray, has decided to pick up NAL's machine.
- Param, developed by CDAC, uses a complex 64-node linkage that gives it the ability to match supercomputers in speed. Yet at Rs 2 crore it is one of the cheapest in the world, and apart from selling machines abroad, 12 domestic users have bought it.

- Meanwhile, the blindingly-fast Chipps 16, a parallel processor developed by the Bangalore-based Centre for Development of Telematics (CDOT), is already being used by the Department of Science and Technology for meteorological research and by the Tata Institute of Fundamental Research for radio-astronomy calculations.
- The Defence Research Development Organisation, which needs supercomputers in its programmes ranging from missiles to combat aircraft, is now reportedly satisfied with a computer developed by the Hyderabad-based Advance Numerical Research and Analysis Group (ANURAG).

These machines have brought in enormous saving in costs and foreign exchange. For instance, the equivalent of the Rs 2 crore Param machine would cost around Rs 5 crore in the international market. And when the NAL team puts together an upgraded version of the Flosolver, they would not only be able to match the Cray in performance but would cost a twelfth the price of a Cray machine. At the cost of a Rs 25-crore Cray machine, Indian centres have funded the entire mission to design and build parallel computers.

Now comes the real crunch. After the initial surge, there seem to be very few takers for these machines in the country. Orders have suddenly started drying up as, barring a few, the country's research institutes have shown little interest in the possibilities that such parallel computers offer at a reasonable price. Says Dr. Vijay P. Bhatkar, executive director of CDAC: "Apart from a technology development programme, what we also need simultaneously is a programme for installing these machines in academic and research institutions."

That is vital. Because parallel computers are likely to be the buzzword of the future in the high velocity environment that is computer technology. Though the world parallel processor market today is only US\$400 million, a fraction of the global computer market, experts predict that by the mid-90s these computers will become mainstream in both technical and business sectors. Professor Roddam Narasimha, director, NAL, says: "The larger your computer requirements, the sooner parallel computers will take over." But the Indian market is still a little slack. "The problem is that we still want to buy things from abroad," adds Narasimha.

Also, the marketing of these machines has not been aggressive enough. NAL's Flosolver, for example, started off as a machine to solve fluid dynamics problems but has been found to adapt efficiently to usage in diverse fields like cryptography for defence manufacturers. Yet, the Flosolver's problem now is to shrug off its image as a parallel computer with limited use. It is only now that NAL and CDAC have set up marketing teams.

The problem also is that most scientists are tuned to believe that selling is against their culture. Despite

having a good thing going, the corporate sector has still not come forward to push parallel computers. Says Dr. Bhatkar: "The technology and software environments are changing all the time but the industry isn't quick enough."

Things are changing. But slowly, NAL is tying up with Wipro Infotech on a joint project to manufacture user-friendly, foolproof parallel computers. CDOT is exploring possibilities of technology transfer to Tata Elxsi. As K.S. Perianayagam, CDAC's centre coordinator, says: "We've come into parallel computers by default but now we've got to try and get maximum commercial mileage out of it."

With funds from the government getting rather scarce, the centres involved in parallel computing are faced with a resource crunch at crucial stages of their development. Says Dr. U.N. Sinha, chief of the Flosolver team, "If we get enough money, we get a chance to remain in the frontline of research." CDAC has sought government support of Rs 40 crore for the next five years for its next-generation Massively Parallel Processing Supercomputer, a thousand times more powerful than the current one. The race for building such computers is on between the U.S., Europe and Japan. And now India is all set to be a major contender.

What computer experts are calling for is the kind of support that the Space Department and Atomic Energy Commission have received for their missions. Says Dr. Bhatkar: "It is imperative that there is a clear vision for a sustained effort in supercomputing for at least the next 10 years." Otherwise, much of the breakthrough that Indians have made in supercomputers will vanish super-fast.

LASERS, SENSORS, OPTICS

India: Foreign Interest in Automated Silicon Plant

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[Article by N.N. Sachitanand: "Automated Amorphous Silicon Plant"]

[Text] Rarely does an Indian organisation invest substantially in a sunrise technology in which the developed countries are just showing interest. The Department of Non-conventional Energy Sources (DNES) has commissioned a fully automated pilot plant to produce amorphous silicon solar photovoltaic (SPV) modules based on a glass substrate. The plant produces, on a two-shift basis, enough modules to deliver one megawatt annually. "It is the only plant of its kind in the world with the glass substrate-in-and-finished-panel-out concept," says Dr. J. Gururaja, Joint Secretary of the DNES.

Cost-Effective

This facility is important because amorphous silicon (a-Si) has been touted as the photovoltaic material for

the future. Although a-Si has a lower light-to-electricity conversion efficiency than crystalline silicon, it is purported to be cost-effective because of its lower cost per peak watt output.

Amorphous silicon modules are cheap as the active material is only a superthin film deposited on a cheap substrate such as glass and the manufacturing process can be automated to high volume production for economies of scale.

The worldwide production of a-Si modules is around 18 to 20 MW equivalent a year with the main producers located in Japan, the U.S. and Europe. The prices being charged are the same as for monocrystalline silicon modules, though the production cost is lower. This is so as the producers try to recover their R&D costs from the initial output itself.

Amorphous silicon is already popular for powering consumer electronic products. In India, a-Si SPV systems may be cost-effective in applications such as solar lanterns, battery chargers, pumpsets and village-level centralised power systems.

The DNES pilot plant is located in an 18-acre plot next to its Solar Thermal Energy Research Centre at Gwalpahari village in Gurgaon district, about 35 km from New Delhi. The plant was ordered on Glasstech Solar of Denver, Colorado, U.S., in 1987 at a price of \$4.2 million, which included testing and characterisation equipment worth six lakh dollars. Unfortunately, after shipping the plant to India in mid-1989 and working on its erection for a few months, Glasstech Solar folded up in bankruptcy.

Challenging Task

The completion of the plant was then taken up by DNES, with BHEL, which manufactures crystalline silicon SPV modules and systems in its Bangalore Division. Professor A.K. Barua of the Indian Association for the Cultivation of Science, Calcutta, a prominent researcher on a-Si and involved in conceiving the project in 1984, was co-opted as the chief scientist for the project. It was a challenging task, recalls Dr. Om Nangia of BHEL, who is now the manager of the plant.

Though the equipment was well made, BHEL had to write the entire automation software comprising process control parameters and traffic. Among the process parameters to be supervised are temperature in various chambers, flow rates of the different gases, power level of the RF plasma and vacuum maintenance. Traffic control comprises a series of interlocks to control movement of the substrate glass panels in the various zones of the process line.

The control system also takes care of the safety aspect of the plant since many of the gases used are toxic. Special monitors, which can detect specific gases in the parts-per-billion range, home on any small leakage from a cylinder, chamber or line, and are programmed to sound

an alarm or even shut down the section or entire plant. The entire automation is handled with a distributed digital control system.

The process plant is housed in a covered building, 40m x 75m, having a Class 100,000 environmental cleanliness rating. Separate utilities building houses a high purity (oxygen less than one ppm) and a nitrogen plant of five cubic meter an hour capacity. Nitrogen is an important process gas for the transparent conducting oxide (TCO) deposition process.

The process begins with the glass plate substrate being fed in at one end for cleaning. Although the plant can finally handle 3 ft x 1 ft plates for now the size used is 1 ft x 1 ft. The glass used is three millimetre non-toughened float which lets through at least 87 per cent to light of 683 nanometre wavelength. The dimensional tolerance over the length and breadth is up to 0.3 mm. Absolute flatness is essential

Thin Film Coating

After its cleaned, the glass plate moves on a conveyor to the section where a silicon dioxide film, about 70 nm, is deposited on it. The silicon dioxide is generated by reacting silane gas with oxygen. Over the silicon dioxide film comes a layer of TCO about 700 nm thick. The TCO (tin oxide) obtained by reacting tin chloride gas with water vapour. Some methanol is also let into the chamber to enhance the reactivity and anhydrous hydrogen fluoride is added to improve the conductivity of the TCO. After the deposition, tests measure the total transmission, scattering of light and conductivity of the TCO layer.

The plate is again cleaned, screen printed, heated to 500°C and sub-cells of 11 cm x 11 cm are separated by laser scribing. The laser used is a neodymium-YAG and a separation line 120 microns wide is achieved.

After laser scribing, the plate is tested on-line for electrical parameters. This allows only the good plates to get through for amorphous silicon deposition. Before entering the deposition chambers, the plate is flipped over and mated to a stainless steel carrier plate and this sandwich is heated to 180°C for three minutes.

The a-Si deposition section is a series of 17 chambers maintained at a high vacuum of one-millionth of a torr. Each chamber has a vacuum pump. Before deposition the particular chamber is purged with hydrogen gas and then the reaction gases along with the dopant are introduced.

The a-Si deposit has three layers—P (150 angstroms), I (3,000 to 4,000 angstroms) and N (300 to 400 angstroms)—in that order. For getting the P layer, a mixture of silane, methane, hydrogen and diborane (dopant) gases are used. The I layer needs only silane and hydrogen with no dopant, while the N layer is obtained by reacting silane and hydrogen with phosphine as a dopant.

After deposition, a silver layer, 1,000 to 2,000 angstroms thick, is deposited over the N layer by vacuum sputtering. The glass plate is again flipped and the stainless steel carriers are removed. Next comes screen printing of silver ink, leaving a pattern for cell isolation. The lines of sputtered silver not covered by the ink are etched out, leaving 75 isolated sub-cells, each 11 cm x 11 cm.

The module is transferred to a computerised on-line tester for simultaneously testing all the 75 sub-cells. Any module having more than five bad cells is rejected. If the module passes the test, then silver ink current collection pads are screen printed. All the good cells are connected to these pads.

A final on-line test is conducted on the module using a metal halide lamp to evaluate the current and voltage characteristics. The finished module is then coated with a synthetic liquid polymer which hardens in the atmosphere and protects the surface of the module from dust, scratches and moisture.

Before shipping, all the modules are tested in a solar simulator for determining the power output. Every module is also subjected to a 400-hour exposure to metal halide light (which resembles the sun's spectrum) to find out the amount of initial degradation in the conversion efficiency. (Amorphous silicon suffers from an initial drop in efficiency of conversion of sunlight to electricity.)

The cycle time in the process from input of glass substrate to the finished module is two hours. In full flow every two minutes, one module can roll out.

The erection of the plant was completed in November, 1990, and trial depositions were carried out in June 1990. But the full deployment of the automation software was done only by June 1992.

As of now the plant is operating at around 50 per cent of its rated capacity. Many systems using the panels made at this plant are now on field trials. The total cost of the project is around Rs. 11 crores which is excellent since such a plant today would cost around \$12 million.

One of the first tasks before the project managers is to reach the rated capacity of one MW a year. Simultaneously, production costs are to be reduced. Now the cost of the product around Rs. 175 per peak watt.

One way to reduce cost is by material substitution. Silver ink, for example, accounts for 25 per cent of the material cost. It can be eliminated if the metallic silver coating on the amorphous silicon deposit is itself used to form the conductors. Yet another cost-saving move is to substitute the imported polycarbonate frame with indigenous anodised aluminium frame.

Among the imported speciality gases silane may soon be indigenised by Metkem Ltd. Costs will also be cut by the increase in yield of good modules, which is now at a low 60 per cent. The stainless screens used for screen printing have been indigenised. The glass for the substrate is

imported but a couple of major float glass projects are coming up in the country and in the next few years the glass substrate may be available here. Dr. Nangia, says it will be possible to reduce material costs by around 40 per cent and the module costs can be brought down to around Rs. 120 per peak watt.

The technical characteristics of the product are also being improved. At present, the plant is designed for making amorphous silicon modules with a single junction. The sub-cell voltage being achieved is 0.8 to 0.85 volts and the module conversion efficiency is six to seven per cent. Professor Barua says triple junction modules have been made at the R&D level. Such multiple junction modules absorb a wider range of the sun-light spectrum, have a higher conversion efficiency (over 8 per cent) and lower initial efficiency degradation. In the next two years, says Dr. Barua the plant can be reconfigured to make multiple junction modules.

Meanwhile, the National Physical Laboratory in Delhi has started design exercises to develop the hardware for a commercial scale 10 MW plant. One of the bonuses of this plant is the TCO section. Glass plates coated with TCO are in demand abroad for large area displays and fetch around five a sq.ft. The TCO section of the DNES plant can roll out are lakh sq.ft. a year on a single shift basis which is 30 per cent than what the amorphous silicon modules need. A high yield of over 90 per cent has been established from the TCO section. And there is a good export possibility here.

SUPERCONDUCTIVITY

India: Superconducting Magnetic Ore Separators Developed

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3 Mar 93 p 19

[Article by G. Swaminathan: "Superconducting Magnetic Ore Separators"]

[Text] Magnetic separation is one of the largest industrial applications of magnetism, next to motors and generators. It is used to separate impurities from ores. In India conventional magnetic separators are being used in Kudremukh project, zirconium processing at Indian Rare Earths and processing of blue dust at National Mineral Development Corporation. Magnetic field intensity achievable through conventional magnetic separators is up to about two Tesla and the magnetic field gradient is of the order 1000 to 2000 Tesla/metre.

A superconducting High Gradient Magnetic Separator (SCHGMS) system has been developed at the BHEL,

Hyderabad with the help of National Physical Laboratory, National Mineral Development Corporation and Bhabha Atomic Research Centre, Bombay.

The system consists of a superconducting magnet designed to produce a peak field of Tesla at 120 amperes and is a two-section solenoid fabricated using Nb-Ti superconducting wire. The coil is epoxy impregnated to improve the performance and to prevent any movement of windings during rapid energisation cycles.

The windings are divided into five sections for protecting the windings during quench. The magnet has a field uniformity of 5 per cent over 15 cm. To operate the device in an industrial environment it is necessary to limit the stray field to less than 0.5 mT at certain distances. This is to ensure location and operation of process controllers and to prevent any disturbance to the operation of superconducting magnets due to the movement of ferromagnetic materials in the vicinity.

To this effect a magnet shield has been designed and installed. This is integrated to the system so that the tail-type cryostat containing the magnet locates itself in the shield. The tail-type cryostat which houses the magnet is designed to reduce the amount of liquid helium surrounding the magnet. The cryostat has a warm bore of 100 mm to locate the canister which is used for high gradient separation.

The slurry handling system consist of stainless steel canister filled with magnetic steel wool and is located in the warm bore of the cryostat. The steel wool produces field gradient and effects separation of weakly magnetic micron-sized particles. The distribution header at the top and the bottom with solenoid valves control the slurry, rinse and wash streams. The slurry is kept in a homogeneous state in a slurry tank from where it is pumped through the filtration circuit during processing. The cycle is precisely controlled by a processor which also controls the power supply. The processor has provision to set variable sweep rates for energising and de-energising the magnet as well as set timings for slurry, rinse and wash cycle.

A number of experiments were carried out on systems like ball clay, magnesite, synthetic rutile and iron ore slime. Iron oxide impurities in ball clay could be brought down to 0.5 from 1.5 per cent. Similarly in magnesite the impurities could be reduced to 0.5 per cent from one in one pass. In case of synthetic rutile the iron oxide impurities could be brought down from 2.5 to 0.5 per cent in while in iron ore slime, the iron oxide could be enriched to 70 from 60 per cent in a single pass.

These trials have proved the efficacy of the system in separating weakly magnetic impurities of micron size from the basic minerals. The development marks an important step in the use of superconducting technology for industrial applications.

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