DuPont R&D At a Glance

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DUPONT®

The miracles of science™

A Brief History of R&D at DuPont

DuPont's science roots trace back to 18th century France in the person of Antoine-Laurent Lavoisier, often called the "father of modern chemistry." Eleuthere Irenee du Pont, one of Lavoisier's students and proteges, founded the DuPont Company in 1802 based on Lavoisier's technology for the manufacture of black gunpowder.

The technology base of the company was broadened in the late 1800s with the introduction of nitroglycerine and nitrocellulose. The chemistry and engineering capabilities required for manufacturing these products became the basis of the major 20th century expansion of the company. The strong acids and associated chemicals such as diphenylamine, a stabilizer, led to development of many associated chemicals. A broad range of cellulose-based products resulted in involvement in plastics, fibers, films, and finishes--markets still important today.

The next important breakthrough in the company's technology came as a result of fundamental research. The head of research noted at the time: "We are including in the budget an item of $20,000 to cover what may be called, for want of a better name, pure science or fundamental research work…the sort of work we refer to...has the object of establishing or discovering scientific facts."

In a short time, the fundamental research group under Carothers had developed an understanding of radical polymerization and established the basic principles of condensation of polymerization and structure of condensation polymers. Neoprene synthetic rubber and nylon fibers were developed and commercialized soon thereafter.

Today DuPont invests over $1 billion a year on research and development in a wide range of technologies and is home to one of the world's largest industrial R&D facilities, the Experimental Station. The budget includes the kind of fundamental research that led to the discovery of nylon while focusing considerable effort on process improvements. Of particular interest today is research in environmentally friendly technologies.

Overview of DuPont Central Research and Development

Introduction

One key component of DuPont Science and Technology is the effort of Central Research and Development (CR&D), which employs a little under 1000 people at the Experimental Station and Chestnut Run facilities in Wilmington, Delaware.

CR&D is the foundation of our science efforts and has been responsible for most of our major product breakthroughs. CR&D provides both leveraged scientific services to the corporation and long-term research activities. In the past several years, CR&D has transitioned to an enhanced research model that has significant benefits to the corporation, including:

- Long-term research focused on providing options and creating new revenue.
- Creation of the DuPont Technology Leadership Team (DTLG) to select projects and oversee our portfolio to assure growth.
- A research review process to ensure that project goals and business cases are reconciled regularly.
- Leveraged services that provide cutting-edge technology and support to the corporation.

Leveraged Technologies

Almost half of CR&D personnel are responsible for leveraged services that provide scientific expertise to the company. Our Leveraged Technologies organizations are:

- *Corporate Center for Analytical Science*
  Providing cutting-edge capability, applied problem solving and rapid response services.
- *Corporate Center for Engineering Research*
  Developing new engineering science for asset productivity.
- *Information and Computing Technologies*
  Delivering scientific computing, including visualization and bioinformatics, the DuPont Information Repository, Business Intelligence Center, Research Operations and patent support activities for CR&D.

Apex Research

In 1998, DuPont began a transformational change in its approach to long-term, discovery research. DuPont changed from an organization based on scientific competency areas meant to provide discoveries for DuPont to commercialize to the Apex research process. The Apex process starts with proposals submitted for research projects and must contain a technical and business case for the research to be pursued for DuPont. Each of the proposals is evaluated by a group of senior business leaders within DuPont (DTLG) who determine if the proposal meets the criteria to resource the proposal. Through this process we manage our long-term research as a portfolio of projects.

Transitioning to this project structure, CR&D developed processes to evaluate, activate, staff, track, develop and, if necessary, terminate projects. Apex ensures a continued match between the business case and the technical accomplishments of projects.

Apex research is divided into three areas:

- *Biochemical Science and Engineering*
- *Materials Science and Engineering*
- *Chemical Science and Engineering*

DuPont Research and Development at a Glance

DuPont businesses are organized into five market focused platforms – Agriculture and Nutrition, Coatings and Color Technologies, Electronic and Communication Technologies, Performance Materials, and Safety and Protection. Research is conducted within these platforms and by Central Research & Development, which conducts long-term research.

In 2005 the DuPont Biobased Materials technology platform was established to work with business units across the company - for development and commercialization of biotechnology solutions for a range of industries. Biobased Materials utilizes the broad range expertise of researchers in biology, chemistry, materials science and engineering.

In 2007, DuPont segment sales were $29.7 billion with a net income of $2.9 billion. DuPont invests over $1.3 billion on research and development. The budget includes discovery research, as well as considerable effort on product development and process improvements. In 2007, DuPont commercialized over 1,200 new products with strong representation from all five business segments.

At year-end 2007, the DuPont employed over 60,000 people. Worldwide, about 5,000 scientists are actively engaged in research and development. They work at more than 30 R&D and customer service labs in the United States, and more than 20 labs outside the U.S.

The results of DuPont Research and Development can be seen in The Patent Board™ ranking of global patent activity. DuPont maintained the No. 1 position in the chemicals sector for the fourth quarter of 2007. In 2007, DuPont increased its patent filings by 7% compared to 2006 and patents granted increased 17% to 597, the highest number for the company since 1992. Senior Vice President and Chief Science and Technology Officer Uma Chowdhry comments that "Science is at the core of DuPont. The best way we can protect our science is through a strong intellectual property strategy." *Nature Biotechnology* publishes an annual data page which analyzes the biotechnology patent landscape. DuPont and Pioneer Hi-Bred were granted 161 U.S. biotechnology patents, resulting in the No. 1 position in biotechnology patents.

Some of our best-known brands are: Kevlar® brand fiber, Corian® solid surface material, Mylar® polyester films, Tyvek® spun-bonded olefin fabric, Butacite® safety glass, Zodiaq® solid surface material, Suva® refrigerants, Nomex® heat resistant fabric, Accent® herbicide, Steward® and Avaunte® insecticides, Sorona® fiber, SentryGlas® Plus intrusion-resistant glass laminate, Solae® soy protein, Kapton® polyimide films, HyperCure® primers for automobile refinish, and Pioneer Hi-Bred seeds.

R&D History at the DuPont Experimental Station

Established in 1903, the Experimental Station was one of the earliest industrial research laboratories in the United States. Its objective was to investigate cellulose chemistry so that DuPont could branch out from explosives into new fields. In 1911 the Chemical Department, forerunner of Central Research & Development, was organized as a separate unit. Work was subsequently begun on ammonia synthesis.

A formal program of basic research in physical and organic chemistry, physics and chemical engineering was initiated in 1927. This program brought spectacular results in the early 1930s: synthesis of the first linear crystalline superpolymers which could be oriented to strong filaments (leading directly to the introduction of nylon) and the synthesis and polymerization of 2-chloro-1,3-butadiene (leading to the commercialization of neoprene, the first general purpose synthetic rubber). Basic research on viscose spinning led in 1934 to the commercialization of the first high-tenacity rayon tire cord, and research on the synthesis and polymerization of tetrafluoroethylene during the early 1940s led to commercial production of Teflon® TFE-fluorocarbon resin.

A major round of construction was carried out at the Experimental Station between 1948 and 1960, providing expanded facilities for a host of new research programs. Results of these programs during the 1950s included Hypalon® synthetic rubber (the culmination of work on the chlorosulfonation of polyethylene), two substituted ureas for industrial and agricultural weed control, and the discovery and development of polyimide polymers. Research at the Experimental Station also led to the development of Dycril® photopolymer printing plates, the first of many important DuPont innovations for the printing and electronics industries based on photopolymerization.

In the 1960s, researchers at the Experimental Station prepared the first cell-free biological extract capable of fixing atmospheric nitrogen and developed Lycra® spandex fiber, a continuous filament elastic textile yarn used in bathing suits, sports wear, leisure wear and leotards. That decade also saw the discovery of ferredoxin, a biological electron-transfer agent of fundamental importance; and the development of products ranging from plastic fiber optics to superior catalyst supports for chemical process and pollution control.

During the 1970s, Experimental Station research resulted in the development of Kevlar® highstrength aramid fibers; perfluorosulfonic acid membrane products used as separators in electrochemical cells; chromium dioxide magnetic particles for use in audio and video tape; and elastomeric relief plates for flexographic printing which are prepared directly from film negatives and thus eliminate engraving and molding. A sampling of other major products developed at the Experimental Station during the 1970s includes Toves® water gels (non-nitroglycerin, water compatible, cartridge explosives), Lucite® dispersion lacquer and new procedures for the “aca” discrete clinical analyzer, which enables hospitals to analyze serum and other body fluids quickly and accurately.

The early 1980s and 1990s have seen a further expansion of facilities at the Experimental Station. Building 500, one of the two new laboratories housing life sciences research, is an award-winning, state-of-the-art discovery chemistry facility. Scientists discovered Cozaar®, an anti-hypertensive drug, as part of the DuPont Merck joint venture. DuPont has since exited the life sciences business.

Today nearly 2,000 scientists and researchers – including roughly 500 with Ph.D.s – pursue science-based solutions for global markets including agriculture and nutrition, electronics, safety and protection, coatings and performance materials. Collaborating to build on a legacy of scientific discovery, they create materials that make people safer and more comfortable and improve their performance at work, home and play. These include DuPont™ Suva® refrigerants, the DuPont™ BAX® food safety systems and DuPont™ Sorona® polymer. Research and development now under way includes nanotechnology, emerging displays technologies, fuel cells energy sources and biomaterials produced from renewable resources such as corn. These developments could lead to foods that help prevent diseases and brittle bones, "smart" materials that can adjust performance on their own, microorganisms that produce biodegradable products and innovative materials for personal protection. Looking to the future, the Experimental Station will remain the site of some of the most advanced productive industrial research in America.

Experimental Station Inventions

NYLON INTERMEDIATES
TIO_2 PROCESS
INK JET TECHNOLOGY
H_2SO_4 PROCESS
SORONA®

KEVLAR®
NOMEX®
LYCRA®
TYVEK®
ORLON®

PET BOTTLES

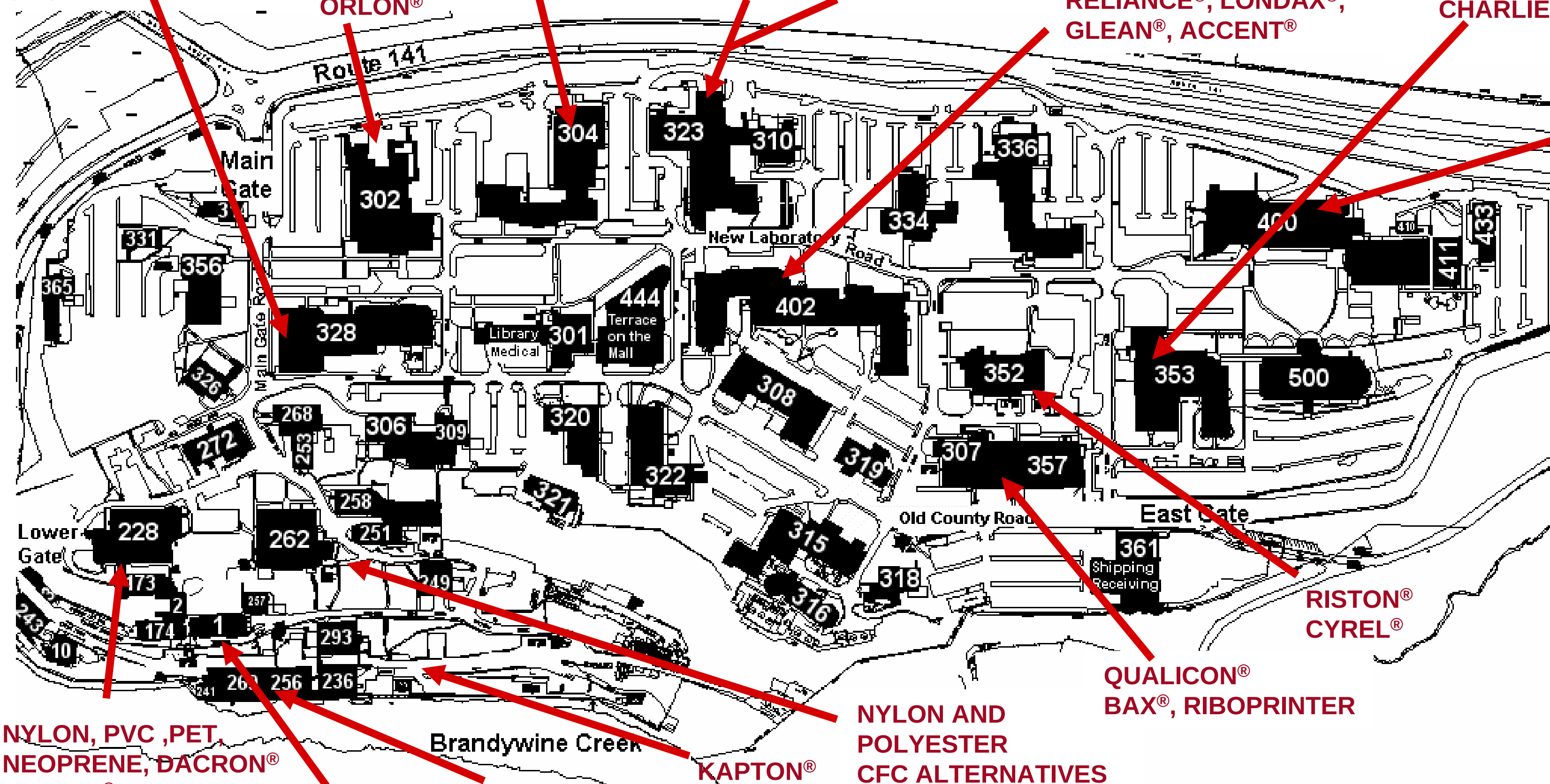
HYPALON®
ELVACITE®
ELVAMIDE®
BUTACITE®
SELAR® RB
MINLON®

SUPERTOUGH NYLON
SUPERTOUGH DELRIN®
DUPONT'S GLASS REINFORCED NYLON
ZENITE® LCP
ZYTEL® DMX

RELIANCE®, LONDAX®,
GLEAN®, ACCENT®

NORDEL®
HYTREL®
VITON®
KALREZ®
VAMAC®
NOBEL PRIZE WORK
CHARLIE PEDERSEN

COZAAR®
SUSTIVA®



RISTON®
CYREL®

QUALICON®
BAX®, RIBOPRINTER

NYLON AND
POLYESTER
CFC ALTERNATIVES

KAPTON®

SURLYN®
TEFLON® FEP
ELVAX®, ELVALOY®
NAFION®, SP POLYIMIDE

ALKYD
RESINS

NYLON, PVC, PET,
NEOPRENE, DACRON®
TEFLON® DISPERSION
2,4-D HERBICIDES
UREA HERBICIDES
COLLOIDAL SILICA
VAZO®

DUPONT
The miracles of science™

DuPont Chief Innovation Officer
Dr. Thomas M. Connelly
on
Integrated Science

"DuPont has tremendous strengths. One that distinguishes us from other technology companies is the breadth of our involvement in, literally, everything from biology to traditional materials science to electronics and related applications. More and more we're recognizing that new opportunities are going to come at the interfaces of these technologies. Historically DuPont has been based in chemicals and materials and the related disciplines. For us, Integrated Science means adding biology capabilities to our traditional strengths. I stress that we're adding biology. It's not a question of trading our position in chemicals and materials for biology. It's bringing on that additional capability and then looking for opportunities where more than one science comes together. That's where we'll find our future opportunities."

Impact on Sustainable Growth:

"Future opportunities don't necessarily come where you found your last opportunities. The discovery process requires us to look in new areas in order to grow."

"Breakthroughs in chemistry and materials science characterize most of our 20th Century. And, we will continue to grow and prosper in those areas in the 21st Century. But, it is time to add new dimensions to what we do. That's where biology comes in. We'll look for opportunities where our capability in biology branches into our strength in materials and electronics. We will look for discontinuous, breakthrough-type technologies"

"Sustainable growth has three dimensions. The environmental component – producing environment friendly products using safe technology. The market sense – producing differentiated products to compete in the market. And, the economic component – earn economic return so we can invest anew."

"I see a need for technology in each of them. I see plenty of opportunities for Integrated Science to play out in our sustainable growth."

How is Research & Development Changing:

"Number one, our R&D efforts are going to emphasize moving our technology capabilities **closer to the marketplace**. For this, there are two reasons. The first is answering the needs of our customers; the second is to better access the commercialization process. Being closer to market will help choose more relevant research topics for our efforts. It will speed getting ideas out of the lab and into the marketplaces."

“Our second focus will bet getting **faster**. The best way to increase productivity is to reduce the time from conception to commercialization. Speed drives R&D productivity. We’ll be working hard to streamline our innovation process.”

“The third focus is a **more collaborative** approach to research. Our largest and most visible example of this approach is our alliance with the Massachusetts Institute of Technology in the area of bio-based materials. We already have a smaller, but equally important, academic collaborations underway to develop new technologies. We will partner with people in our industries to develop technology, but also to commercialize products. We will be involved in government partnerships – certainly in semiconductors and biology.”

“Lastly, we will focus on being **globalized**. We serve a global customer base. We need to be able to understand and meeting their needs. We ought to have an appropriate global presence for R&D facilities. We have to have global thinkers. We’ll work on the most urgent global needs, not just those in the country where the researcher or lab is.”

“When you bring together a market need with world-class science you create opportunities for growth and profitability. Market need is the way we’ll be going.”

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Lavoisier Library

Lavoisier Library was built in 1950 at the DuPont Experimental Station and is one of the largest corporate research libraries in the United States. The Library collection contains over 50,000 classified monographs, over 50,000 bound journal titles, and subscribes to over 900 current journals.

Lavoisier Library is open 24 hours a day, 7 days a week and is staffed from Monday to Friday from 7:30 a.m. to 4:15 p.m. The Library serves the research community throughout the Company. A 30-minute Lavoisier Library tour is offered on the first and fourth Tuesday of each month at 8:30 a.m.

Library Information Scientists provide customers with Ready Reference and manual and electronic searching via the Internet and a variety of online databases including DIALOG® and STN®. SCION, DuPont's proprietary company reports database, can also be readily accessed online. Both bibliographic and chemical structure searching are performed. We provide access to electronic journals including all those available from the American Chemical Society. Library customers have web access to DuPont's electronic card catalog DUCAT, which provides a window to the holdings not only at Lavoisier Library but to all other libraries and information centers within the Company.

'M. & Mme. Lavoisier'

The Library's main reading room contains the reference book collection. The stack area contains all circulating LC-classified monographs. The journal bound volume collection begins in the basement and continues on the mezzanine and the top floor. The reference collection in the reading room contains all four editions of the Kirk-Othmer Encyclopedia of Chemical Technology, the Ullman's Encyclopedia, Beilstein, Gmelin, Thermodynamic Tables & Compendia, Methods in Enzymology and Chemical Abstracts in hardcopy from 1907.

Journal article photocopies, book and journal circulation, Micropatent® copies of patents, translations, and engineering drawings can be ordered through the Corporate Information Science website at www.es.dupont.com/cis. Web access electronic ordering forms are provided for customer convenience. Search requests, including requests for patents and/or chemical structures, can also be ordered through the website electronic form. Technical and business questions can be answered through our contact links which appear at the bottom of each webpage. The Corporate Information Systems (CIS) website also provides links to a variety of services including Barnes & Noble deskcopy ordering, electronic Table of Contents through Carl Uncover, Current Contents Connect® through ISI, and electronic Technical Insights through Tech Insights, Inc.

Three of the portraits in the reading room illustrate the connection between E. I. duPont and the great French chemist, Antoine Lavoisier who is considered the 'Father of Modern Chemistry' and for whom the Library was named. One portrait depicts a young E. I. duPont working as an apprentice to Lavoisier, where he learned many things from the 'master,' including how to make gunpowder. Another portrait shows a more mature E.I. duPont posed in front of one of the Brandywine powder mills The portrait commemorates the formation of the DuPont Company in 1802 as a gunpowder producing company . Another is a copy of '*M. & Mme. Lavoisier*' where Lavoisier and his wife are shown in the laboratory of the time. The original, painted by the celebrated painter Jacques Louis David in 1788, is at the Metropolitan Museum of Art in New York. The painting was copied in 1950 by F. W. Wright and hangs in Lavoisier Library to this day.