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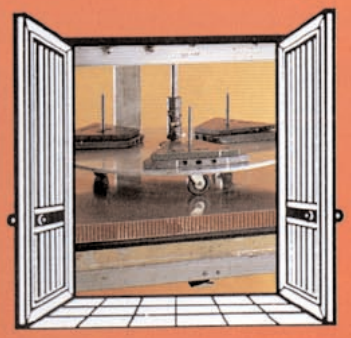


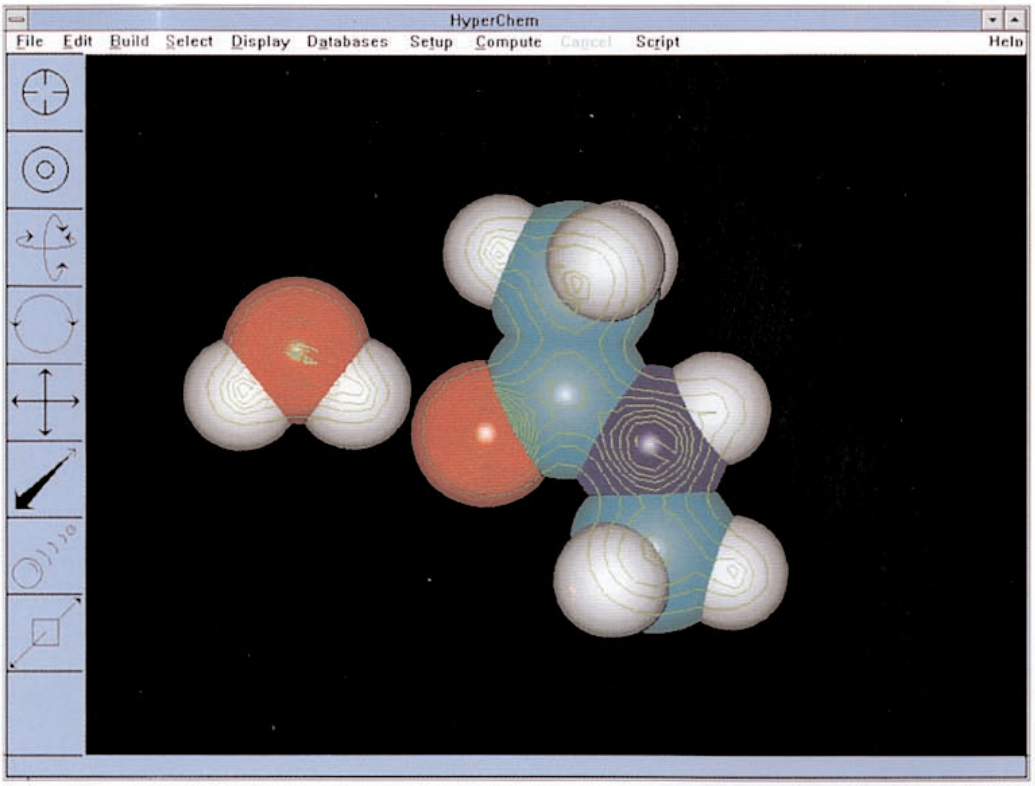
THE M.C.GILL DOORWAY

M.C. GILL CORP., 4056 EASY ST., EL MONTE, CA 91731 • PHONE 818-443-4022 • TELEX 67-7467 • FAX 818-350-5880

C·A·P·E

COMPUTER-ASSISTED POLYMER ENGINEERING

Chapter 1 of the Gill Chair at USC



Photos on this page courtesy of Autodesk, Inc.

Computer-assisted molecular modeling pictured on a video display. The visual mode helps a chemist understand the interactions between molecules based on their orientations, shapes and interatomic forces.

C·A·P·E

COMPUTER-ASSISTED POLYMER ENGINEERING

FOR TRAINING THE NEXT GENERATION OF CHEMICAL ENGINEERS

The Doorway has chronicled the funding of the M.C. Gill Chair of Composite Materials which had its genesis in 1976 and culminated last year with the naming of Dr. Phil Muntz as the first recipient of the M.C. Gill Chair. The following article is yet another example of the interest the Corporation has taken in advancing the study of composite materials.

The M.C. Gill Corporation is taking another positive step in the education and training of the next generation of chemical engineers. The company is actively supporting a new graduate course concept called CAPE (Computer-Assisted Polymer Engineering) at the University of Southern California (USC).

Rotating this molecular model on a screen assists in predicting certain mechanical properties of polymers formed from this molecule.

This first-of-its-kind course, titled "Computer-Assisted Polymer Engineering—an Integrated Approach," is the brain-child of Professor Victor Chang. He has been developing and refining its philosophy and content for more than five years before offering it during USC's 1992 Summer Session. Professor Chang's goal is to give students a clear awareness of the principles of interrelations among the chemistry of polymers, processing conditions and product performance.

The laboratory portion of the new course permits students to acquire hands-on experience using state-of-the-art computer-assisted engineering programs to set up and solve real problems. Awareness and experience in next generation polymer engineers are critical competencies if industry expects to realize the full potential of such new developments as Computer-Assisted Design (CAD) and Computer Integrated Manufacturing (CIM).

According to Chang, the installation of contemporary CIM systems in the polymer industry has not met expectations. There are several reasons for this: polymer systems are complex and do not yield easily to studies of cause and effect relationships. They also undergo kinds of behavior which are unfamiliar to many scientists and engineers. Furthermore, it is difficult to optimize polymer systems because there appears to be an infinite number of choices one can make.

Effective and efficient designing of products and processes demand good communications and the combined efforts of materials scientists, designers, mold makers, process engineers and product engineers. These specialists should possess a sufficient educational foundation involving both experiences with the commercial software and with systems thinking for defining and solving problems—problems often made ambiguous by a large number of seemingly inseparable variables.

CAPE is motivated by the following three key objectives:

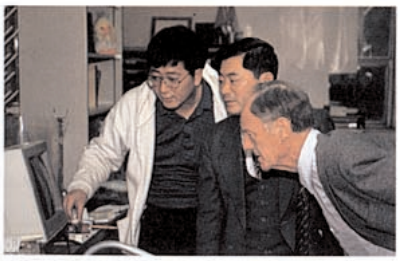
1. Highlight the interrelations between structure and the four p's: processing, properties, product and performance.

2. Emphasize systems thinking for solving polymer product design problems with state-of-the-art Computer-Assisted Engineering (CAE) packages.

3. Appreciate quantitatively the fundamental principles, via computer assisted approaches, that govern polymer properties, compatibility, adsorption, adhesion, processing and performance.

In addition to classroom lectures and laboratory exercises, Professor Chang has taken a "theory in practice" approach to achieve the course objectives. This involves inviting experts from industry to define actual cases or problems that can be set up in the CAE software for simulation and, possibly, optimization. Dr. Mel Kantz, Director of Research and Development at M.C. Gill has been collaborating closely with Professor Chang to develop real "problems" involving composite materials and structures for CAPE students.

He and Professor Chang are now working with a PhD student and a visiting scientist, Ms. Dingdu Shi, who is in charge of the Composites Laboratory of the Institute of Aeronautical Materials in Beijing, China, and whose work is being funded by the United Nations Industrial Development Organization (UNIDO). Gill-developed data and CAE software at USC will be used in this CAPE project to model and optimize high performance composite systems.



A USC technician assists Dr. Chang in demonstrating a practical application of CAE for M.C. Gill.

MEL KANTZ
M.C. Gill Corp.
Director of Research & Development

Mel joined M.C. Gill in April 1991. He is responsible for managing the development and qualification of new products and processes. Prior to joining Gill, Mel was the Technical Director of Ferro Corporation's Composites Division in Los Angeles and the Supervisor of Research at Congoleum Corporation's Technical Operations Center in Trenton, New Jersey. His range of technical experience includes the development and characterization of polymers and molding processes for fiber reinforced thermosetting, thermoplastic and hybrid high temperature systems. He has authored 25 technical papers and co-authored the chapter on chemical characterization of polymer composite materials in the International Encyclopedia of Composites.

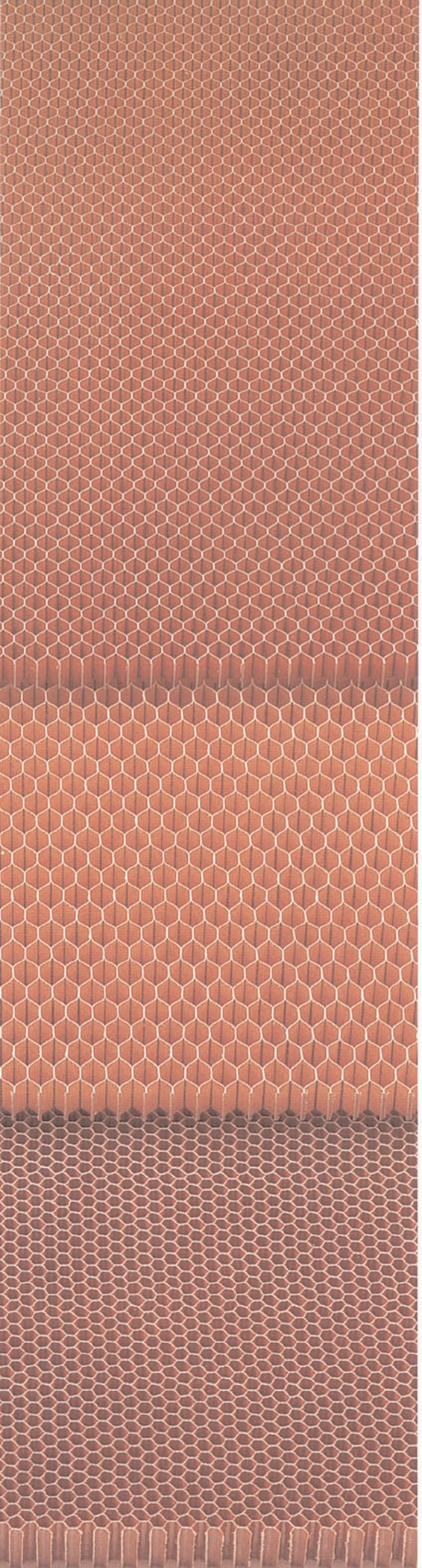
He earned his Ph.D. in Materials Engineering from Drexel University, MS in Physical Chemistry from the University of Dayton, and BA in chemistry from Temple University.

VICTOR CHANG
Associate Professor

Dr. Chang received his B.S. and M.S. degrees in Chemical Engineering from the National Taiwan University, Taipei, Taiwan, Republic of China and a Ph.D. degree in Chemical Engineering from the California Institute of Technology in 1976. His research interests are centered on the interrelations among molecular structure, microstructure and properties of polymers and composites. He has established a Southern California sealant, composite and adhesive technical group which meets monthly. He is a member of ACS, AIChE, SPE, and Society of Rheology.

Research Interests: Viscoelastic properties of polymers; acoustic emission and micro-cavitation in polymers; finite element analysis of bonded elastomer disk; induced molecular orientation in thermosetting foams; wetting, spreading, and adhesive joint strength; thermodynamics and swelling behavior of ionic polymer networks; and computer assisted molecular engineering of adhesives and sealants.

Dr. Chang is offering a seminar titled "Precision Injection Molding: Simulation and Practice" beginning March 30th. Contact him directly at the University of Southern California, telephone (213) 740-2225.



We intended to make it for our use only. But, since the quality surpasses all tests, others now buy from us, too!

What do Gillfloor® 4004, 4017, 4109, and about thirty other M.C. Gill sandwich panels have in common? If you said Gillcore® honeycomb, go to the head of the class. But did you also know you can purchase Gillcore by itself? In sheets as thin as .060″ or as thick as 24″? As long as 98″ (longer if spliced) or as wide as 49″?

Vertical Integration — The Key To Quality

Before the M.C. Gill Corp. manufactured its own Nomex® honeycomb, the company had an opportunity to qualify a flooring panel at a major airframe manufacturer. If the panel qualified, it meant potential sales of hundreds of thousands of dollars to the company.

As a matter of course, honeycomb core was purchased from a reliable, highly respected vendor. The rest was done in-house — facings were designed and produced, component materials pressed into panels, and testing of final product initiated.

The story does not have a happy ending. None of the panels could meet, much less exceed, the airframer's specifications. The reason? Core failure. The deadline for qualification submission passed and the window of opportunity closed.

The experience simply reinforced M.C. Gill's long standing philosophy of vertical integration. He knew that he could offer his customers more consistent quality, competitive pricing and prompt delivery schedules if he wasn't dependent on outside sources for raw materials. And slowly but surely, he began to develop the capabilities to manufacture as many raw materials as possible.

It wasn't accomplished overnight. Equipment had to be designed, purchased outside or built in-house, processes developed, operators trained, customer specifications met and qualifications obtained, and quality control procedures established.

Last, But By No Means Least

One of the last raw materials to be produced in-house was aramid fiber (Nomex) honeycomb core and for good reason. Unlike some of the other raw materials we make, the manufacturing process for this product is extremely complicated. Also, understandably, former raw material vendors are quite hesitant to provide helpful hints based on their experience; therefore, the experimental period necessary to produce a core that would meet M.C.'s exacting standards was lengthy.

But master it we did and the result was Gillcore, an aircraft grade aramid fiber honeycomb impregnated with phenolic resin. It has high strength-to-weight and rigidity-to-weight ratios, is resistant to moisture and corrosion, and has good fatigue and impact resistance. The phenolic resin allows Gillcore to conform to rigid smoke, toxicity and flammability standards.

GILLCORE®

Quality Control

Like all our products, Gillcore undergoes an exacting series of quality control tests. Generally, it is made to customer specifications, and testing is carried out in accordance with them. We always conduct the following series of inspections and tests on every block or lot of Gillcore we produce.

1. Cell count. A measurement of ten cells is checked in six different random locations on *every honeycomb loaf*. This is done to ensure that cell sizes are consistent within any given loaf.

2. Compressive strength. Measures the core's strength in resisting a compressive load, i.e., how much force is necessary to crush the core after it has been bonded in a sandwich panel configuration.

3. Plate or core shear. Measures the core's resistance to being pulled apart or sheared. Core shear failure results in deformation of the material thus weakening it considerably.

4. Density, in pounds per cubic foot (pcf). Every sheet of honeycomb core is checked after it has been sliced from the loaf to ensure that densities remain consistent in every lot, and from lot to lot.

Finally, we often submit our sandwich panels to the roller cart test which measures the fatigue resistance of honeycomb core. It is an extremely rigorous test in which two 21.5″ x 40″ panels are securely bolted to the bed of the tester.

Once the panels are in place, a "carousel" with three wheels rotates at 20 rpm on a 20″ diameter circle. Each wheel can be fitted with weights to correspond to a given specification. For example, one airframe manufacturer specifies that properly bonded 9 pcf Nomex honeycomb core sandwich panels must pass at 120,000 revolutions with 128 pounds on each wheel and an additional 35,000 revolutions with 158 pounds loaded on each wheel. The test is an approximation of how the floor will stand up in the center aisles of passenger aircraft to food/liquor cart and foot traffic.

As a rule, honeycomb core buyers must rely on the manufacturer's test results for the physical and mechanical properties. But, all honeycomb core is not the same and there are two quick visual tests the buyer can use as a rough yardstick of quality.

First, check the cell configuration for uniformity. All cells should be hexagonal in shape. If the cells are irregular, it is doubtful the core can produce required core shear values.

Second, look for uniformity of color across the slice. If there are dark and light areas, it indicates an unequal distribition of resin or heat (light areas mean not as much resin or heat as dark areas). If this shading is in evidence, chances are the density is not uniform across the slice and premature fatigue failure often will result.

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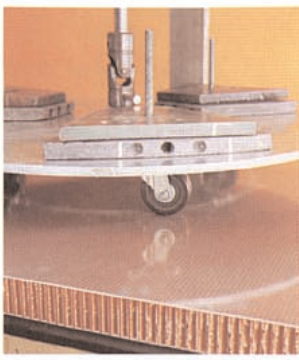
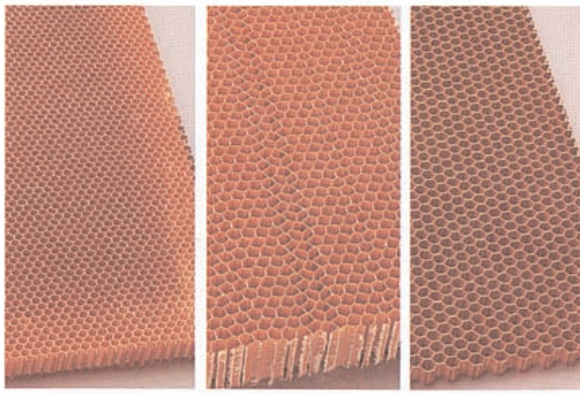


Roller Cart Test measures the fatigue resistance of honeycomb core. (The clear skin was used for photographic clarity.)

Dial Indicator Table monitors consistency of honeycomb thickness along entire length.



The Visual Checks: unequal resin color can result in premature fatigue; irregular cells indicate doubtful shear value; complete uniformity assures top quality.

Consistent high strength performance and light weight.

If the core you've purchased cannot pass either of the quick visual tests, there is every possibility it is somewhat less than the quality you have every right to expect.

Availability

Gillcore is available by the slice or by the standard loaf (24″ x 48″ x 96″). The governing factors for honeycomb purchases generally are cell size and density. The most common cell sizes are 1/8," 3/16," and 1/4." Densities range from 1.8 pcf to 12.0 pcf, using 1.5 to 6 mil paper thickness. End use almost always dictates cell size and density. If high strength and load bearing properties are indicated, small cell size and high density will prevail.

Flooring in commercial passenger aircraft is an example of an end use that defines core parameters. Aisles, galleys, lavatory areas and entries receive the most wear and therefore require the strongest material—normally 8 to 12 pcf core and 1/8″ cell size. The heavier densities (5 pcf and up) and their attendant high property values are usually made with a 1/8″ cell.

Large cell size and lower density are good for vertical surfaces where weight is more critical than strength, e.g., a food or beverage cart. The panels are nonstructural. Weight is important because the lighter the cart, the less wear and tear on the aisle flooring.

Because M.C. Gill deliberately built a capacity in excess of our internal requirements, turnaround time for delivery can be as short as 3 to 7 days (depending on quantity and urgency), but is normally about two weeks for the more common cell sizes and densities, and a little longer for those we may not have in stock.

If you have a need for Gillcore, but are unsure of the correct cell size or density, tell us what your end use is. We can offer some guidelines as to the type of core that will best suit your needs. We want to provide you with the best product possible to satisfy your specific requirements. Meeting your needs is the main reason we're in business.

Specifications

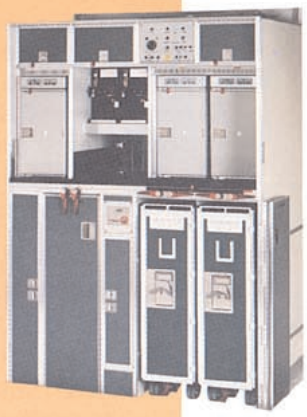
The following specifications to which Gillcore qualifies are included to show that we're serious about ensuring that our customers are receiving the best honeycomb available.

- Boeing BMS 8-124
- Lockheed STM28-105
- McDonnell Douglas DMS 1974
- Mil-C-81986

Finally, we believe you should choose Gillcore because we can offer (a) consistent quality, (b) prompt delivery, (c) dependability, (d) integrity, and (e) fair pricing available only from a company that's been in business for more than 47 years. We think you will find we're a pretty good company to do business with.

A Myriad of Applications

In addition to flooring panels, other passenger aircraft interior uses for Gillcore include sidewall, ceiling, galley, and lavatory panels. It is used in such exterior applications as trailing and leading edges, flaps, ailerons, access panels, and doors. Other aviation related uses include nose cones, helicopter blades, and radomes. Boat builders use Gillcore for panels to divide berthing areas and staterooms. Although most of our customers may think of Gillcore as a component of flat sandwich panels, our CNC 5-axis profiler gives us the capability to shape it in virtually any configuration desired.



An MD-11 galley fabricated by Weber Aircraft with Gillcore sandwiched between facings.

PHILLIP GILL, THE NEW PRESIDENT OF ROYAL AND SPACE-FLEX DIVISIONS

On December 1, 1992, Phillip Gill was appointed President of Royal Plastic and Space-Flex Company, the M.C. Gill Corporation's two operating divisions that manufacture contoured and complex-shaped parts.

The announcement was made by his brother Stephen Gill, M.C. Gill President and CEO, who until the December date had served in those capacities at the two divisions. "Phil was the logical choice to build that business and capitalize on the increasing opportunities available in the market for contoured parts," said Gill.

Entire Career at M.C. Gill

Like Stephen, Phil has spent his entire business career at the M.C. Gill Corporation. Spending time in all departments—including Maintenance at the business end of broom and mop—Phil is as knowledgeable about M.C. Gill's operations as anyone with the possible exception of the company's namesake and founder.

A graduate of Oregon State University, Phillip received his B.S. in Chemical Engineering in 1967, and five years later was named Technical Vice President in charge of Quality Control, and Research and Development, a position he held for 18 years.

A Leader in Product Development

As such, he shouldered the responsibility for the technical excellence and advances of the M.C. Gill product line. Under his able leadership, the R&D group has counted a number of product innovations that has kept the company in its position of leadership in the manufacture of cargo liners and sandwich panels for the world's aircraft.

His accomplishments are many and include development and design of our polyester and phenolic cargo liners, e.g., Gilliner 1366 and Gilliner 1367; such flooring advances as Gillfloor 4109; and most of the resin and adhesive formulations we use today.

In addition he designed process equipment and made initial production runs of the company's vertical cloth prepregger, epoxy film adhesive, unidirectional prepregger using both fiberglass and carbon rovings, aluminum and Nomex honeycomb, and cargo liner in continuous rolls.

The preceding are but a few of the technological advances Phil has pioneered. Although many in the aviation community may not know him personally, they are well aware of his accomplishments.

Royal Responsibilities

Phil will be primarily responsible for the marketing strategy required to keep Royal and Space-Flex as the quality leaders and for guiding their sales and profitability growth. From a technical and production standpoint, Phil says, "I just hope to lend a little of the M.C. Gill expertise to this side of the operation. Then, we'll explore new opportunities for the acknowledged capabilities of both divisions for quality and leadership in the manufacture of contoured parts," he concluded.

Those of us who have worked with Phil will miss him, his wit, and his humor. His contributions both to the industry professionally and the company personally are legion. But, M.C. Gill's loss is Space-Flex' and Royal's gain. The M.C. Gill Corporation sends Phil off to make that part of our company grow and contribute to our continuing diversification efforts.

THE FUNNY SIDE

A farmer bought a chain saw that the salesman guaranteed would cut 15 trees a day. A week later the farmer returned the saw, saying it must be faulty because he could only average three trees per day. The salesman picked it up, pulled the starter cord, and the motor promptly revved up into its customary loud whine.

"Hey!" said the startled farmer. "What's that noise?"

★ ★ ★ ★

When opportunity knocks, some people only complain about the noise.

"Have you anything for gray hair?" a man asked his druggist. "Nothing but respect," the bald druggist replied.

★ ★ ★ ★

"Your methods are 50 years behind the times," the pompous government official said to the veteran farmer. "I'd be surprised if you got a bushel of wheat to the acre out of that field."

"So would I," replied the farmer. "That's corn."

You know it's going to be a bad day when:

- You call Suicide Prevention and they put you on hold.
- You want to put on the clothes you wore to the party last night, and they're nowhere to be found.
- Your twin sister forgets your birthday.

★ ★ ★ ★

Sign in a clothing store: "Be sure the end justifies the jeans."

★ ★ ★ ★

Burglar alarm: protection racket.

DON'T FORGET, we now have available ring binders that will accommodate about seven or eight years (28 to 30 issues) of past Doorways.

We believe you'll appreciate having your Doorways in their own binder, and if you agree just contact the Marketing Services Department with your request.

Trivia

The United States plastic industry accounts for more than three million jobs.

★ ★ ★ ★

It would take 20,000 bottles of Windex to clean the 355 miles of bookshelves at the New York Public Library.

★ ★ ★ ★

The occupation that will gain the most jobs in the next ten years is cashier.

★ ★ ★ ★

Nearly half of American workers have been to college for at least one year.

One in eight American nonagricultural workers is self-employed or owns a business on the side.

★ ★ ★ ★

Seven percent of Americans say they change their plans because of astrology reports.

★ ★ ★ ★

Immigration accounts for more than one-fourth of U.S. population growth.

★ ★ ★ ★

53 percent of imported manhole covers are made in India.