contain any part used in cars of 1958.

As such replacement was going on, the industry could change to metric standards. As standard parts, nuts, bolts, washers, etc., became available in metric standards, says Ford's William K. Burton, engines, for example, could be designed around these parts to metric modules. "If we had something designed to even inches, we could redesign it to even millimeters and not change the actual size by more than 20-thousandths of an inch." Systems analysis would be needed to find out which components would have to be converted together to minimize problems in making interconnections, and which could be separate steps.

The change to metric units, says Burton, would involve the entire mechanical products industry. Standards for parts like nuts and bolts are made by professional associations, and these must approve standards for metric module parts and decide whether existing European standards are to be adopted or a new international system of metric sizes sought.

Burton estimates the time for a changeover by the automobile industry at "not less than 15 years and not more than 20."

Dr. McNish's study is charged also with finding out what the benefits would be if a conversion to the metric system is made. There would be some educational benefit, he says, but he finds little evidence of a 10 percent time saving. The schools don't spend 10 percent of their time on all of arithmetic, he says.

There would be a bigger educational benefit in engineering. The confusion of English units in engineering is so bad that it is even reputed to drive students away.

In foreign trade the benefit does not seem likely to be as great as some commentators have speculated. But in exports of machinery and transportation equipment, there could be some benefit. In this category U.S. trade with metric countries declined about 25 percent between 1960 and 1966. If one could assume that this decline was all due to the lack of metric standards, then the lack would have cost the U.S. $1.6 billion over those years in this category of export.

But the assumption is not a safe one, because a large part of that category is aircraft and related machinery, and this, all over the world, is standardized on English units. Many other factors also influence foreign trade, and it is therefore hard to predict the specific effect that metrization will have.

Dr. McNish expects his full study to be complete by the end of 1970. By then he should have a good idea of what things would be practical to change and at about what cost.

WEATHER PREDICTION

The past tells the future

There are two basic ways to go about forecasting the weather, just as there are about predicting the future behavior of any continuing process. One, the physical approach, is to attempt to understand the physical laws that govern complex atmospheric processes, then plug readings of current weather conditions into dynamic equations. With the help of computers, the process produces forecasts of weather conditions a day or two in the future. Such hydrodynamic numerical modeling is the technique commonly used by the Weather Bureau in its daily forecasts, and there are many efforts in progress to extend the capabilities (SN: 9/6, p. 185).

The other method is a statistical approach and ignores physical processes. It relies only on past weather records and the search for patterns that may repeat themselves predictably.

The statistical approach has long had a stepchild status. It has never completely died, though it has seemed unable to produce a clear pattern to relate past weather to future weather.

Now two scientists, after seven years of work at the Massachusetts Institute of Technology, say they have found one. The research findings by Dr. Donald B. DeVorkin and John T. Prohaska are a breath of fresh air for the statistical approach and for forecasting of long-range weather trends.

As a result the two claim it is now possible to forecast general monthly and seasonal trends in the weather, six months or longer in advance. In fact, Dr. DeVorkin, Prohaska and Dr. Hurd C. Willett of MIT have now formed a commercial service, Statistical Weather Information Inc., to do just that.

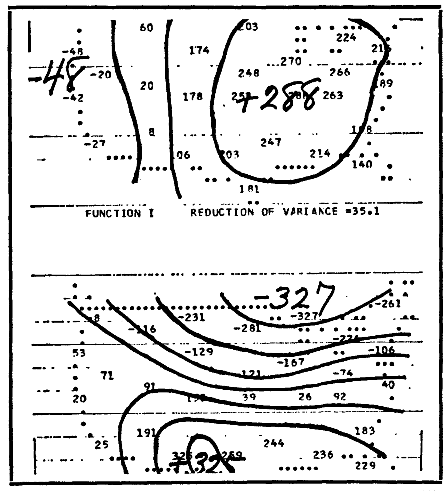
Their meteorological colleagues are expressing cautious interest.

Using computers to analyze monthly weather records since 1899, what the trio basically has found is that atmospheric pressures at some geographical locations tend to show relationships to temperatures at other locations, one to 12 months later. The odds that the relationships are due to chance are calculated to be as low as one in 10 million.

The computers also detected nonrandom relationships between monthly average temperatures in certain parts of the United States and precipitation in other parts during the same month.

They make no effort to explain their findings; they simply use them.

Thus to find out what the monthly average temperature will be in Washington six months from now, the computer compares atmospheric pressure readings for the three previous decades at 132 locations in the Northern Hemisphere.



MIT

Computer sifts past weather records.

This indicates which locations have in the past served as the best predictors of Washington's monthly temperatures. The analysis can then tell how many degrees warmer or cooler than normal the average temperature is likely to be for April 1970.

Once the temperature is known, a similar sifting of the data produces a prediction of the precipitation for April.

While their work is arousing interest, it is regarded as far from conclusive.

"They certainly have demonstrated that there are some nonrandom relationships," says Jerome Namias, chief of the Extended Forecast Division for the Environmental Science Services Administration. "But a scientific evaluation will have to await a little more evidence."

"Their work is further evidence of some statistical pattern to the weather," says Glenn Brier of ESSA. "It is not the key or the solution—we realize there is quite a long way to go—but I am encouraged by the results." As chief of meteorological statistics at ESSA's Air Resources Laboratory, Brier has been doing research on the statistical technique for some time.

"I don't think the results of their system will be spectacular," says Dr. Frederick Sanders of MIT, "but if they can lessen the degree of error in seasonal forecasts at all, it will be significant." He too feels that it will be several years before the method's performance can be judged.

Although simple in concept, a demonstration of nonrandom relationships between average pressure and temperature and average temperature and precipitation had to await the closing of many gaps in weather records of the past half-century. Records for many stations in the Northern Hemisphere were not made available during World

War II, for instance. The team eventually dug them out, and emerged with a consistent record of atmospheric pressure throughout the Northern Hemisphere and of temperature over the United States for the past 70 years.

Past weather information from locations in the Northern Hemisphere was then fed into computers, and experiments making use of some new statistical techniques were conducted. These studies showed that the data would yield predictors of weather to come.

What about the future? The physical technique is not now effective for long-range forecasts. Dr. Edward N. Lorenz of MIT has shown that we probably never will be able to extend the accuracy of the daily forecasts now provided by numerical modeling to longer than two to three weeks. But he feels more general average forecasts with numerical modeling may eventually be possible. "I think for some years to come the statistical method should give better results at ranges of six months than any other method, although ultimately I think numerical techniques should be able to also," Dr. Lorenz says.

"We have a keen interest in any methodology for long-range forecasting," says ESSA's Namias. "It is my personal opinion that a blend of the statistical and physical methods will work best."

YEAR'S FAILURE

Short run for STOL

With high hopes and a pioneering spirit, a small carrier called Washington Airlines last year began service between three local airports using a promising, but unrealized, development in modern aviation—the short takeoff and landing aircraft (SN: 9/7/68, p. 229).

Using German-built Skyservants that can land on less than 1,000 feet of runway, the airline offered quick transportation between Friendship Airport near Baltimore, Md., Washington National Airport, and Dulles International Airport in Virginia. They all serve Washington, D.C. The flights were the nation's first regular STOL service.

But the idea never got off the ground with Washington's air commuters, and last week the company called quits on the service. In its year of service, the line carried only 25,000 passengers, less than a quarter of the 108,000 predicted from forecasts by the Civil Aeronautics Board in a survey of helicopter possibilities in Washington.

"If there had been more, we'd still be in business," says Robert Richardson, operator of Washington Airlines. But toward the end, the planes were running with an average of about three passengers, he says. ◇