prove it is finite, they can take out one of the members of the list and then use the fact that that member is not contained in any other in the list to say something about the remaining members. "It tells you something about the other members and it puts a lot of structure on the list," Seymour says. He and Robertson used this technique to show that lists with one member missing are finite and so with the member added back they must still be finite. It is not at all obvious that this method should have worked so well, Seymour notes and, in fact, he remarks, "It seems silly that it should be so helpful."

But once they discovered their method of attack, Robertson and Seymour were able to prove two variants of Wagner's conjecture. First, they showed that Wagner's conjecture is correct for any list of graphs that go on surfaces with an upper bound to the number of handles on them. Then they showed that it is true for lists of graphs that contain at least one planar graph.

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This work, say Seymour and Robertson, took a couple of years and has already resulted in seven papers, each about 40 pages long. More papers are to come. Each paper, Graham remarks is "dense." Seymour and Robertson used only pen and paper to get their result. "I wouldn't even know how to use computers for this work," says Seymour.

Now, according to Graham, Wagner's surprising conjecture is "looking better." And although it still seems impossible to list all the minimal graphs that cannot be drawn on particular surfaces, the fact that the list is finite "is an encouraging sign. We may be able to characterize them or to describe them in other ways." It is too soon to apply these results to practical problems such as those that occur in the design of computer chips, but, Graham notes, the results, at the very least, lead to a better understanding of what it is about a network that may require many layers of circuitry, and they are of great interest to mathematicians who are trying to understand the properties of abstract surfaces and how to characterize graphs that can be drawn on them.—**GINA KOLATA**

A New Kind of Epidemiology

In February, a group of epidemiologists published the results of a prospective study of possible risk factors for cancer. The participants gave blood samples at the start of the study and were followed for 5 years. But unlike other prospective clinical trials that cost millions of dollars, this one cost only $6000. It is among the first of what promises to be a slew of a new kind of epidemiological study called "retrospective case control"—studies that are reusing data and material (usually blood) from other prospective clinical trials to answer questions that the original studies did not address.

In the study published in February, for example, Walter Willett of Harvard Medical School and his associates used blood from participants in the Hypertension Detection and Follow-up Program (HDFP), a study of 10,940 men and women that was conducted by the National Heart, Lung, and Blood Institute. All of the participants were carefully followed, their causes of death recorded, and their blood samples stored.

Ten years after the start of this study, Willett and his colleagues went back and selected the participants who got cancer, chose for each of them two controls who were matched for age, sex, smoking history, month of blood collection, blood pressure at the start of the study, randomization in the study to treatment or control group, reported use of antihypertension medication, and, for the women, number of children and menopausal status. Using these cases and controls, they could then ask whether the persons who developed cancer had lower levels of vitamin A, vitamin E, or carotenoids in their blood at a time before their cancer was diagnosed. (*Science*, 16 March, p. 1161). They saw no such relationship, but, says Willett, "We set a new record for low costs."

At about the time that the HDFP study was begun, the NHLBI also initiated two other large prospective studies of heart disease. The blood and serum samples from those studies are being used now to address epidemiological questions. B. Frank Polk of Johns Hopkins University Medical School and his associates are planning to use the blood from the Multiple Risk Factor Intervention Trial (MRFIT) to look for a relationship between vitamins in the blood and risk of cancer. Basil Rifkind, director of the Lipid Research Clinics at the NHLBI, says that stored serum from the Lipid Research Clinic studies is now being analyzed to see if apoproteins in the blood are better predictors of heart disease risk than cholesterol or lipoproteins and also to look at the cancer and vitamins hypothesis.

Other investigators are looking at stored blood from still other studies. For example, George Comstock of Johns Hopkins University Medical School has over 25,000 blood samples from residents of Washington County, Maryland, which he has been saving since the early 1970's for retrospective case control studies. The county has a cancer registry, so he knows which of the residents developed cancer. He is looking at the vitamin hypothesis and also is collaborating with Nancy Gutensohn of the Harvard School of Public Health to pool his samples with samples from several large Norwegian populations, the HDFP, and the Kaiser-Permanente population to see if persons who develop Hodgkin's disease had antibodies to Epstein-Barr virus in their blood before they were diagnosed.

The appeal of retrospective case control studies is that they are so terribly cost effective. As Rifkind explains, instead of taking 5000 or 10,000 people, measuring the vitamins in their blood, and then following them for 5 or 10 years to see which get cancer, he is able to take 136 cancer patients, match each with two controls, determine the vitamins in the 408 serum samples stored from before the patients got cancer, and get his results almost immediately and with very little expense. In addition, most of the samples remain untouched and so can be used to answer other questions, such as the question about apoproteins and heart disease.

But, Rifkind cautions, these studies do not always work. Some substances that investigators want to study break down—two of the apoproteins are a case in point. So, he says, "You can't just do one huge prospective study, store the blood and serum for 15 years, and then answer every question you want. Although, some of us have thought of that."

—**GINA KOLATA**