Successful engineers and indifferent economists

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ABSTRACT

The relative confidence the public displays in the activities of engineers ("success"), as contrasted with the skepticism ("indifference") it displays towards economists, is explored in this paper. It uses the descriptions of engineering activities provided by authors such as Petroski and Bucciarelli, and particularly the detailed history of aviation engineering of Vincenti. The "separability" of problems, combined with the ability to get ones hands "dirty" on a given problem, are seen as the critical differences between engineering and economics.

I. INTRODUCTION

Applying science to economic growth is not simply a function of setting up markets, but of setting up markets that are increasingly productive. For this reason, after the bureaucrats and judges, who are essential to get the process started, come the engineers, who implement the actual production of things. It is said that the engineers formed a profession with the need for large-scale construction and manufacturing projects in America. If we look back at the history of economics, we find that the early Mercantilists also rose to fame in the service of the nascent European States.1 Economists have forgotten that the natural tendency is to intervene-the policy of nonintervention is a very disciplined response. In this sense then, economists are now, and have always been, "social engineers." While the words are unfashionable to our ears, there are even now departments of "social engineering" in Japanese Universities.

Economists cannot but interact with engineers. The infrastructure essential to the functioning of a technological age-roads, canals, dams-are all the responsibility of engineers. Circumstances forced engineers to justify the choice of public works; hence, the origins and development of cost-benefit analysis are largely due to engineers. It began in France with the work of the Ecoles and was rediscovered, curiously enough, independently by the U.S. Army Corps of Engineers in the 1920s and 30s. When engineers have been placed in an economy visibly requiring planning for development they have contributed, as may be seen from the lives of Peter Palchinsky in the Soviet Union, Eugene Halsema in the Philippines, or Valery de Beausett in Taiwan. Indeed the growth of both professions is linked with the need for "large structures" in the modern nation state.2-6

However, the interaction of engineers and economists is not limited solely to such macro issues. As the example of Britain reminds us, engineers were closely linked with many aspects of product development, especially if we remember that neither engineering nor economics existed as separate professions in the early days. Josiah Wedgewood, John Smeaton, and James Watt can all be reasonably described as engineers.7 In our own century, engineers have risen quietly through the ranks and achieved prominence when they reached top management. In U.S. business history, men like Alfred Sloan and E. I. du Pont have left their mark by organizing business firms so as to provide a visible hand within to complement the invisible hand without.

Even though engineers have interacted closely with economists in so many ways, one is hard pressed to find any indication that economists have learned from engineers. Why are engineers respected so much more than economists? If we look at two convenient and visible fields-water resources and computers-many names appear who straddle both engineering and economics: Edmund Halley, Paolo Frisi, G. Venturi, Nicholas Bonda, A.N. Isnard, Charles Navier, Jules Dupuit, Charles Babbage, and Fleming Jenkins. Yet, none of them dealt directly with the interface of the two subjects. The only figure of modern times to have been in all fields is John von Neumann-who dealt with fluid instability, computers, and mathematical economics-but even he did not deal with the mutual interaction (or lack of it) in these areas. Whether there is some significance in von Neumann's increasing reliance upon experiment to guide theory is a point worth returning to.8

I will try to sustain an argument here that successful practical engineering and economic policymaking have a great deal in common.* As this is an exploratory piece, I have quoted often from the engineers themselves or from historians of engineering. However, this should not imply general assent from engineers. It is quite likely that those engineers who choose to describe their own professional are atypical-as indeed are economists who choose to write in English. One has perforce to rely upon engineers who are methodologically aware. In view of the large literature produced by engineers, it is surprising that only a few names can be found. Henry Petroski and Walter Vincenti, for example, have both contributed several articles and books. As Vincenti is quite methodologically self-conscious-witness the title, What Engineers Know and How They Know It--I will begin by using his portrayal of the growth of aeronautical engineering.9

II. METHODS OF ANALYSIS

Vincenti provides us a detailed account of how a problem comes to be formulated. We begin with an ill-defined problem-what are the characteristics of a good airplane?-and the challenge is to turn this question into the language of engineers. The following issues were central to the successful development of the modern airplane.

1. Feedback from practical men, in this case the pilots.

2. Finding the appropriate level of analysis-achieved in aeronautics through the use of "Control-Volume" analysis.

3. The use of experimental parameter variation when the theory was agnostic about the practical effects of design changes.

4. Use of dimensional analysis to facilitate the move from small to large scale.

It so happens that these are precisely the points that serve to make the bread and butter tool of the economist-what we call Partial Equilibrium Analysis (PEA).

The first items one needs to be clear about is who is the user of one's knowledge. Both the engineer and the economist have to work to please the "customer." In the case of aeronautical engineering and design, it was not at all dear at first how to fix upon this "customer." Vincenti observes,

In a broad, underlying way, the history of flying-quality specifications is the history of an idea. The notion that specifications could usefully be written for something as subjectively perceived as flying qualities had itself to be realized intellectually and verified in the real world. It was not at all an obvious or obviously useful idea at the outset.9

The French and the Americans were rivals in aircraft development and they had quite different philosophies. The French believed that a plane should be so stable that a pilot would simply hold the wheel and steer-much as a chauffeur does. The Americans, on the other hand, gave the pilot a much more active role and were willing to accept more instability because the pilot would be there to correct any severe imbalance.

The question of how to obtain ... equilibrium has developed into a controversy dividing aviators into two schools. One school holds that equilibrium can be made automatic [i.e., inherent] to a very large degree; the other, known as the American school following the methods of the Wright Brothers, claims that equilibrium is a matter for the skill of the aviator, who, with practice, acquires perfect control of his machine.[9]

As everyone now knows, the American philosophy won out by the 1920s and increasingly a folklore was built around those aircraft that pilots liked to fly and these were the planes that engineers tried to improve.

When one looks for a user of economic ideas, the first persons who come to mind are the businessman or the bureaucrat. It will be most convenient, and most realistic, to look at what a bureaucrat would want. Let us suppose a tax on cigarettes is planned. The bureaucrat will want to know how high the price might rise after the tax, how many consumers might be affected, and what the potential tax revenue would be. An economist who told the budget office that prices could go up or down and tax revenues might rise or fall, may well be saying the truth but as he provided no useful information it is unlikely that he would be able to justify a salary. Whether we look at engineers or economists, our theories must end up effectually satisfying someone with a concrete result.

The next step in the analysis is probably the hardest one in either engineering or economics. How does one decide upon the boundaries of the problem in such a way as to provide something amenable to analysis. For aeronautical engineering, this was achieved through the seminal efforts of Ludwig von Prandtl. In a series of memoranda and papers, Prandtl established the importance of control volume analysis. How should the airflow over a wing be studied? Where does one begin to look at the incoming airflow and how far beyond the wing should our attention extend? For the problem to be amenable to control by the engineer, some manageable parameters must be set, but how? The problem requires sound practical judgment. Vincenti is full of praise for Prandtl's solution.

[E]ngineers frequently must deal with flow problems so complex that the underlying physics is not completely understood, or the differential equations that describe the phenomena point by point cannot practically be solved throughout the flow. In such situations control-volume analysis, by working with information only on boundaries and ignoring the interior physics, can often supply limited but highly useful results of an overall nature.

Vincenti is particularly careful to point out that engineering separates itself from physics at just such points, because physicists feel compelled only to understand while the engineer, in addition, has also to construct.

Control-volume analysis is a weapon ... the physicist does not require. The point is not that the physicist is less prone to mistakes than the engineer, it is simply that the costs of a mistake in engineering are often so much greater.... Engineers, like certified public accounts, must therefore adopt standardized procedures of thought and practice to protect them from themselves-that is, to make the chance of human error as small as possible initially as well as to facilitate checking later. Control-volume analysis, by setting up an explicit method of bookkeeping for the various flow quantities, provides such a procedure for the many engineers who must deal with fluid-- mechanical devices....

These requirements together also illustrate the fundamental role of ways of thinking in engineering. Although engineering activity produces artifacts, conceiving and analyzing these artifacts requires thoughts in peoples minds; the clearer these thoughts, the more likely it is that the artifacts will be successful.9

The solution of the problem of practical boundaries was equally critical in economics. Having said for over a hundred years that prices depend upon demand and supply, economists were gradually forced into stating just how this dependence arose. In the nineteenth century, it was often claimed that prices depended upon the ratio of demand and supply. As a ratio is well defined only for numbers, this would make demand and supply to be given numbers and the dependence on prices was hard to visualize. Gradually, it became clear that demand and supply must each be functions of price and the equilibrium price was the price which equated demand and supply, i.e., where the two functions intersected. The apparatus was refined and made practical when Alfred Marshall selected those parameters that needed to be directly considered in forming demand and supply. For example, the price of coffee will obviously be important in determining the demand for coffee. In addition, demand will depend upon consumers' income, upon the price of tea, a competing beverage, and upon the price of sugar, a complement to coffee. For all practical purposes, all other factors could be ignored. By this means, economists could fix upon a small, finite number of factors influencing demand and supply. It was the practical knowledge of the economist that enabled him to determine which commodities were substitutes and which complements. To use the apparatus to determine policy we ask for the impact of a tax on the supply of coffee. This raises the supply, by shifting the supply curve to the left, and enables us to predict that prices will rise and quantities sold fall after the tax. It is a simple and extraordinarily useful apparatus. Note that the power of the method depends upon the tax affecting only the supply curve. If the tax also caused the demand curve to shift it would be very much harder, if not impossible, to make any specific predictions about the impact of the tax. Just as control-volume analysis gains its power by delineating the boundaries of a problem in such a way that it is still interesting and amenable to analysis, the real payoff from an analytical characterization lies in our ability to run a series of hypothetical experiments. The engineer checks out the viability of design by submitting his work to a variety of imagined strains; the economist aids the politician by providing a list of tax rates and their impact for the politician to choose from. If we consider each imagined change to be a parameter, then we are asking for the results of parametric variation. Once the apparatus of partial equilibrium analysis was set up economists could engage in parametric variation analysis with ease-we call it comparative statics. Engineers face a problem that is harder in that the equilibrium may not be a position of rest, but rather a steady state of some process; however, this is amply compensated for by the ability of engineers to engage in experimental evaluation. Vincenti notes this point emphatically.

The engineering utility of the methodology rests primarily on the fact, as our case study makes clear, that there is no essential relation between experimental parameter variation and physical theory. Indeed, the strength of experimental parameter variation is precisely its ability to provide solid results where no useful quantitative theory exists. It is of course true that engineers use theory whenever they find it feasible and advantageous to do so. The independence of experimental parameter variation from physical theory, however, makes use of theory often a matter of choice, not of necessity.9

It is worth appreciating that the results of experiment enable one to fill in all sorts of theoretical lacunae and thereby make the engineer less dependent on scientific theory as well as considerably more practical.

The paradoxical fact that the function of experimental parameter variation may be to free engineering from limitations of science is perhaps easier to see in the modem context, where the newness and origins of the method are not in question.9

So far we find that the practical economist and engineer both need to aim at showing the relevance of their knowledge to a customer, and it is the specifications set by the customer that determine the goodness of the product designed by the expert. The execution of the design is dependent upon finding a way to delimit the problem so as to be analyzable yet not so limited as to be uninteresting. Every such delimited problem must make assumptions about the parameters governing the boundary of the system. The utility of the analysis is complete when the expert can make predictions about the behavior of the system when the boundary parameters change. However, the possible range of parametric variations is so large that it is usually worthwhile to narrow the range of possibilities. In aeronautical engineering one usually uses a wind tunnel experiment and extrapolates the result to the real world. In economics, one uses sample surveys to elicit information about population demand parameters. In both subjects one needs to know how best to transfer the experimental information to the real world. Economics came up with the solution first. In the 1880s, Alfred Marshall introduced the concept of elasticity to describe a dimensionless property of demand and supply curves. In a set of independent discoveries engineers inspired mathematicians to describe dimensional analysis-a misleading name since it really is concerned with justifying dimensionless entities. It so happens that only by rearranging the experimental or survey data so that the information is expressed in dimensionless numbers that we can often transfer the results from one context to another. Both subjects have the same informational needs.

III. JUDGMENT AND PRECISION

While both economists and engineers need technical abilities, it is at least equally important that they are able to extract the relevant solvable problem in any real world situation. It is no surprise that both economists and engineers need many gifts. Let us begin with a description of the talents expected from a good Roman architekton, or modern engineer.

An architect should be ingenious, and apt in the acquisition of knowledge. Deficient in either of these qualities he cannot be a perfect master. He should be a good writer, a skil draftsman, well versed in geometry and optics, expert at figures, acquainted with history, informed on the principles of natural and moral philosophy, somewhat of a musician, not ignorant of the sciences ofboth law and medicine, nor of the motions, laws, and relations to each other of the heavenly bodies.10

The similarity with the talents of an economist are remarkable, when viewed through the eyes of one of the most successful of modern economists, Lord Keynes.

The study of economics does not seem to require any specialized gifts of an unusually high order. Is it not, intellectually regarded, a very easy subject compared with the higher branches of philosophy and pure science? Yet good, or even competent, economists are the rarest of birds. An easy subject, at which very few excel! The paradox finds its explanation, perhaps, in that the master-economist must possess a rare combination of gifts. He must reach a high standard in several different directions and must combine talents not often found together. He must be mathematician, historian, statesman, and philosopher-in some degree. He must understand symbols and speak in words. He must contemplate the particular in terms of the general, and touch abstract and concrete in the same flight of thought. He must study the present in the light of the past for the purposes of the future. No part of human nature or institutions must lie entirely outside his regard. He must be purposeful and disinterested in a simultaneous mood; as aloof and incorruptible as an artist, yet sometimes as near the earth as a politician.11

The multiple attributes required for good policymaking as for good engineering is not coincidental, as it is repeated in a very recent study by a practicing engineer, Louis Bucciarelli.

One of the fundamental tasks of the engineer is to design. One can present this in very scientific language. The practice of industrial design must anticipate every eventuality in the development of product or product systems that can be manufactured and distributed economically in order to meet the physical needs as well as the psychological desires of human beings.12

Bucciarelli aptly asks whether the above is meant to be taken as rhetoric. After analyzing the scientific description of design at length, Bucciarelli announces his own hypothesis, "design is a social process." The corroboration of this hypothesis is then the substance of his book, Designing Engineers.

Engineers do have scientific laws to guide them. The most important ones are the laws of conservation. While the conservation of matter provides the template, it is by no means sufficient to guide any practical activity.

Ultimately every bit of energy must be accounted for. What is lost is attributed to an inefficiency, and these inefficiencies must be in accord with the accepted, historical performance of the individual components or subsystems. Like a material substance-water flowing, for example--energy doesn't just vanish, but it can slip away from your grasp. The principle of conservation of energy reigns supreme within the world of the engineer.

While this principle provides the underlying form girding the model, the crafting of a computer representation of the behavior of the desalination plant in the field is not a paint-by-numbers activity.12

The conservation laws only serve to provide an accounting schema, much like the circular flow and the equation of exchange. To these conservation laws are added the principle of micro-reduction. But they need to be supplemented by human input.

Words like story, scenario, and fabricate suggest a flexibility in the object that might strike some as unrealistic or obfuscatory. I don't mean to obfuscate. I want to make myself dear on this point. The object of design, at all stages in the design, is a constructed and contested object in the sense that more than one explanation of its behavior, more than one account, or harder still, more than one analysis of its behavior is possible and meaningful. I mean this in two ways. First, different participants with different perspectives and responsibilities in the design process, who work within different object worlds, will construct different stories according to their responsibilities and interests. Interest here means technical, professional interest.

Second, I want to offer a more radical meaning. Even within the same object world and at the same level (e.g., three electrical engineers discoursing on the DAU and its problem), alternative and different explanations are possible.12

This reminds one of the emphasis on rhetoric made famous among economists recently by Donald McCloskey.13 In other words, the scientific arguments are made persuasive by a social process. Since multiple, and equally convincing, representations of reality are possible, science alone does not determine the solution. This is emphasized by Petroski's repeated critique of the claim that form follows function. Nonetheless, engineers do succeed in making things.14

How does one learn to actually get things done? The evidence from engineering suggests that one learns by doing and the most important form of doing was visualizing: from the Renaissance onwards, when many of the most famous engineers were artists, through the seventeenth and eighteenth centuries, when treatises on engineering were richly illustrated with pictures of actual working models, down to the end of the nineteenth century when the U.S. Patent Office tried to obtain a model for every patent.16 The remnant of this approach was in the slide rule, long the mascot for the engineer. Today we have the computer instead:

The slide rule was the prime symbol of the engineering profession until the 1960s, after which it was made obsolescent by digital computers. Current computer calculations, yielding a dozen or more significant figures, are more precise than slide-rule calculations, which yield but three significant figures, but they are seldom more accurate. Most of the data used in engineering are, by nature, approximate. In general, the precision and the speed of the computer are bought at the cost of the visual sense of the reasonableness of a numerical answer.16

There is something very telling about this image from engineering-we have more speed and accuracy but lack the sense to see how pointless it may be.

The crucial step for practically effective method in both engineering and economics lies in describing a tractable problem. That this is a question of human judgment and not cold science in economics is dear from Nobel laureate Milton Friedman's claim that the same industry can be both monopolistic or competitive-it depends on the problem! The role of judgment in aeronautical practice is established in Goldberg's description of the procedures used by the Wright brothers, where each step requires judgment.15

1) Decompose the large problem approximately and intuitively, breaking it into quasi-separate subproblems.

2) Investigate each subproblem separately (or as separately as possible) using empirical testing coupled with adequately predictive, low-cost models.

3) Assemble the subsolutions and test the overall invention, paying attention to unforeseen interactions between the subsolutions.

Within the engineering profession, recent decades have seen a swing away from the use of diagrams towards the use of mathematics. As a result, not only has the distance between the practice and pedagogy of engineering increased but important questions have been raised about the practical viability of the new engineering. Can design become so complex that the computerized programs pass a design that the practiced eye of a practical engineer would have rejected as unsafe?* Much of the debate within modern economics has centered on just this issue-whether economic intuition is being deadened by the emphasis on mathematics. Business schools have long since decided this conflict and altered the MBA programs accordingly to emphasize applications.17

The final blow came when engineering curricula severed ties with engineering practice in order to become more scientific. Ferguson16 describes the reaction of the engineering education community to the 1956 "Grinter Report."

The final report contained two significant recommendations, which were promptly followed by those schools that had received or hoped to receive large research grants. First, those courses having a high vocational and skill content should be eliminated, as should "those primarily attempting to convey engineering art and practice."

That second recommendation called for courses in "six engineering sciences--mechanics of solids, fluid mechanics, thermodynamics, transfer and rate mechanisms (heat, mass, momentum), electrical theory, and nature and properties of materials."

Traditional"art and practice" courses in engineering design were nowhere mentioned, and the "integrated study" often proved to be exercises in analysis. Rather than learn how engineering design had been done in the past and how it "worked," students were encouraged to be creative and imaginative--both ofwhich abilities may result in better designs only after one understands the art itself.... questions asked of students are overwhelmingly what will be called single-answer problems.16

IV. TRANSFER

The interface between engineering and economics extends beyond the common impact of both economists and engineers upon the outer world. There is also a considerable overlap between the internal tensions faced by the two subjects. Economists have known periods when they were the torchbearers of a new science only to be faced with a subsequent hubris, e.g., Ricardian Political Economy in the 1820s and Keynesianism in the 1950s. Engineers, on the other hand, enjoyed a century of prestige, especially in the United States, only to see much of their achievements denigrated in the turbulent 1960s. How did engineering manage to fulfill its promise for so long and how did it make substantial recovery by the 1990s? Vannevar Bush made a very perceptive remark on the public importance of labels. During WWII, the Office of Scientific Research and Development found that the generals respected scientists but disregarded engineers. Henceforth, all OSRD personnel were called "scientists."

This is the way things were at first in our relations with the military in our war effort," Bush wrote. "So all OSRD personnel promptly became scientists." Twenty-five years later, Bush wrote that "the business of elevating the scientist to a pedestal probably started with this move, and it has certainly persisted and misled many a youth." "Even recently when we sent the first astronaut to the moon," he noted, "the press hailed it as a great scientific achievement. Of course it was nothing of the sort; it was a marvelously skilled engineering job."26*

The second half of the above quote is equally revealing. If economists only considered themselves to be technicians ("dentists," as suggested by Lord Keynes) would they be able to garner the prestige of a Nobel Prize for Economic Science?

This review suggests that economists can be as successful as engineers as long as they limit themselves to statements of partial equilibrium. The "separability" required for partial equilibrium is, however, absent from many questions of policy interest. We want to know what is happening, or is going to happen, in the economy, grosso modo. The market for coffee or for lawn mowers is interesting only to a very limited number of people. It is obvious that most people find themselves swimming with the crowd and doing well when others are also prospering. This requires an analysis of equilibrium in all markets simultaneously. Not only is it very hard to prove that equilibrium exists for such general equilibrium questions (the problem is mathematically identical to a fixed point problem), but the uniqueness and stability vital to ensure meaningful answers for parametric variations (comparative statics) are simply not to be had. One may conjecture that engineers too will be faced with incompleteness and indeterminacy when they have to handle global problems-environmental problems involving long-lived chemicals comes to mind as a possibility.

There are two other aspects of engineering that come to mind as indicative of its success. Ferguson notes the importance of visual and tactile experience in teaching engineers what will or will not work. Goldberg adds to this the graphic point that no one has yet theoretically proved that airplanes can fly. This deters no one from flying because successful practice is a sufficient proof. Even in pure physics, Nancy Cartwright has pervasively argued that the laws hold because we construct the "appropriate" approximation-there is sleight of hand included with the rigor. If economists are to profit from the issues raised by Ferguson and Goldberg, they may well have to change their attitude towards the value of economic theory (meaning mathematical and statistical theory). If economists are to learn from practice-not very likely since not a single Nobel Award has gone to economists from the high-performing Asian economies which grew at miraculous rates in the 1970s and 1980s-they must be willing to include a great deal more local knowledge in their efforts to implement economic policy. Local knowledge is often embodied as personal knowledge, so it is almost definitionally opposed to inclusion in theory. Science is law and local knowledge is friction. On the whole, the prospects of current economic methodology gaining from a study of engineering method seem bleak. The pagans were so called because they worshipped local gods, whose powers were real but limited to a locale. Science is theology, practice is paganism. What are the hopes of a pagan revival in economics?

*Many recent articles in the Journal of Engineering Education show an interest in the interface, but in the opposite direction. They try to incorporate Demming's Total QualityManagement philosophy into engineering.

*Engineers are very conscious of the absence of an integrative framework and of guidance from practice. I have provided several references just for illustrative purposes.

*It is confirmation of Ferguson's fears that Ford Motor Company has in recent years hired a practiced engineer for a summer to train its recently hired graduates and teach them about practical problems. The importance of Ferguson's insights are further elaborated upon in On Line and On Paper (MIT, 1999). Most engineering work still only uses the physics of the 19th century and the extra sophistication has not any direct payoff. I am very grateful to Taher Saif for providing me valuable comments and information about the trend in engineering.

REFERENCES

1. Buck, P., "Seventeenth-Century Political Arithmetic: Civil Strife and Vital Statistics," Isis, vol. 68, 1977, pp. 67-84.

2. Ahlstrom, G., Engineers and Economic Growth, Croom Helm, 1982.

3. Porter, T.M., Trust in Numbers, Princeton University Press, 1995. 4. Graham, L., The Ghost ofthe Executed Engineer, Harvard, 1993.

5. Halsema, J., Ej Halsema: Colonial Engineer, New Day, Manila, 1991.

6. Cullather, N., "Fuel for the Good Dragon: The U.S. and Industrial

Policy in Taiwan," Diplomatic History, 1996.

7. Smiles, S., Lives ofthe Engineers, John Murray, 1862.

8. Rashid, S., John Von Neumann, Scientifc Method and Empirical Economics, Routledge, 1994.

9. Vincenti, W., What Engineers Know and How They Know It, The John Hopkins University Press, 1990.

10. Reynolds, T., The Engineer in America, Chicago, 1991.

11. Keynes, J.M., Essays in Biography, W.W. Norton & Company, Inc., 1963.

12. Bucciarelli, L., Designing Engineers, MIT, 1994.

13. McCloskey, D.N., The Rhetoric ofEconomics, University of Wisconsin Press, Madison, WI, 1985.

14. Petroski, H., To Engineer is Human, St. Martin's Press, New York, 1985.

15. Goldberg, D.E., "Change in Engineering Education: One Myth, Two Scenarios and Three Foci,"Journal of Engineering Education, vol. 85, no. 2, April 1996, pp. 107-116.

16. Ferguson, E., Engineering and the Minds Eye, MIT, 1993.

17. Quddus, M., and S. Rashid, "The Overuse of Mathematics in Economics: Nobel Resistance," Eastern Economic journal, 1994, pp. 251-266.

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