Peter Fishburn

Steven Brams, William Gehrlein, Fred Roberts, and Maurice Salles

1. Who were the most influential people who acted as mentors during your career:
   (a) In your general work in mathematics?
   (b) In social choice and voting theory?

1a. During my career, I was supported and encouraged by people who allowed me to pursue my own interests. Principals were Russell Ackoff (operations research and decision theory), Duncan Luce (utility theory and mathematical psychology), Nicholas Smith (decision and utility), Jimmie Savage (decision under uncertainty and subjective probability), and Ronald Graham and Andrew Odlyzko (discrete math).

1b. I had no guiding presence in social choice and voting, but two special people—William Gehrlein and Steven Brams—were invaluable collaborators.

2. What attracted you to the study of social choice/voting in general and to approval voting in particular?

I was the undergraduate chair of elections at Penn State in 1957–1958 where I learned about voting procedures and the contretemps of a few candidates. That experience influenced my focus on theory rather than practice in social choice. The

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books of Kenneth Arrow, Duncan Black and Amartya Sen affected my later research. Duncan Luce provided the means to write *The Theory of Social Choice* at the Institute for Advanced Study in Princeton during 1970–1971. Steve Brams guided me into approval voting in the mid-1970s.

3. What results that were obtained in social choice/voting by you and/or your many co-authors personally strike you as being the most important contributions? What particular papers or books from your long list of publications do you consider to be the highlights of your career?

Important personal contributions include the aforementioned book, results on Arrow's theorem with infinite voters (1970), single-peaked preferences (1972) and paradoxes of voting (1974). Important collaborations with Bill Gehrlein involve probabilities of voting paradoxes (1976) and coincidence probabilities for simple majority and positional voting (1978), and with Steve Brams on the foundations of approval voting (1978). Many later works have precedents in the preceding contributions.

Other career highlights are the books *Utility Theory for Decision Making* (1970) and *Nonlinear Preference and Utility Theory* (1988), an extensive retrospective on the utility theory of von Neumann and Morgenstern (1989), and results in the theory of ordered sets in *Interval Orders and Interval Graphs* (1985).

4. You collaborated with a great number of researchers, including several over a period of many years. What, in your experience, makes for a fruitful and long-lasting collaboration?

Fruitful long-term collaboration requires congeniality, mutual respect, open communication, willingness to share, an ability to ask penetrating questions, and a desire for joint exploration.

5. In the study of subjects like voting and fair division, how much importance do you attach to laying the theoretical foundations for their study compared to seeing your findings, where practical, tested empirically or actually tried out in real-world settings?

My abiding interest has been theoretical foundations. Real-world tests and applications are clearly important but were of marginal interest.

6. What are the contributions by other researchers in social choice/voting that you view as being the most important or influential?

Contributions by others that seem important in hindsight include Condorcet's essay on cyclical majorities (1785), Kenneth May's axiomatization of simple majority (1952), Ken Arrow's impossibility theorem (1960), John Banzhaf's results on weighted voting (1965), Y. Murakami's formalization of representative majority (1966), Richard Niemi and Herbert Weisberg's voting paradox probabilities (1968), Richard Zeckhauser's analysis of majority rule with lotteries (1969) and Amartya Sen's impossibility of a Paretian liberal (1970).

This clearly is an old geezer's list. I have not kept up with the literature since I retired, so recent contributions are absent.

7. We know that you did a lot of research in other areas of mathematics, mathematical psychology, measurement, decision theory, economics, etc. Could you tell us a bit about your work in those areas, and what attracted you to them?

As noted above, Russ Ackoff, Duncan Luce and Jimmie Savage were instrumental to my interests in decision theory, utility theory, choice under risk or uncertainty, subjective probability, and allied areas of economics and mathematical psychology. What attracted me to these subjects were (a) the possibility of formulating axioms that justify models of choice, (b) methods of measuring the terms in those models and (c) ways of applying the models under partial or complete information.

When I joined Bell Labs in 1978, Ron Graham and others directed my attention to discrete math topics, including ordered sets, graph theory and combinatorics. This opened up new opportunities to do the kind of mathematics I enjoyed and involved many new collaborators. Along with Graham and Odlyzko, I am deeply grateful to Larry Shepp, Jim Reeds, Bill Gehrlein, Tom Trotter and Fred Roberts. Others who involved me in their research areas were Robert Calderbank (coding theory) and Paul Erdos (convex sets and planar geometry).

8. Your work does not include a large volume of work that is based in game theory, except for some foundational aspects of utility theory, and for some work in approval voting. Can you tell us why you chose not to place more emphasis in game theory?

I do not recall a conscious decision to avoid doing more in game theory. Perhaps other fields offered more opportunities to do the mathematics that I enjoyed most.

9. You have completed much of your research in a number of different areas of mathematics but you did not actually pursue any academic degrees in mathematics itself. What led you to your choices?

My undergraduate degree in industrial engineering and my Ph.D. in operations research used lots of math. The latter was heavy in both pure and applied mathematics. The undergraduate course led naturally to a graduate program in operations research.

10. Your career trajectory was quite different from that of the typical life-long academic researcher in social choice/voting. What drew you to this field?

During my years in advanced research at the Research Analysis Corporation (RAC) in the 1960s, I developed an interest in social choice as an offshoot of decision theory. I then devoted my year at the Institute for Advanced Study to research and writing in social choice theory. Of those who encouraged this new direction later, Steve Brams deserves special mention.

11. You spent a lot of your career as a researcher in an industrial laboratory. Can you tell us how much you needed to justify the relevance of your work there? Also, how did the role of research in such a lab change over the years?

As noted at the outset, I chose most of my research topics. This was true at RAC (1963–1970), Penn State (1971–1978) and Bell Labs (1978–2001). Very

little justification was needed beyond my employers' faith in my qualifications and productivity.

I was hired by Bell Labs in an economics department, but a few years later, the department was abolished. I moved into mathematics and stayed there until I retired in 2001. In the meantime, the breakup of the Bell System had serious repercussions for the Labs, and when its math group was decimated, I remained in a reduced department. The pervasive orientation of the department was discrete mathematics. When I strayed too far into social choice, word came from on high that, to put it tactfully, I should do less in that area.

Many years earlier, the advanced research department at RAC was abolished. I have the odd distinction of being the last regular researcher to leave as the department disintegrated. Then, after my year at the Institute, it was on to Penn State as a Research Professor. During our time there, my wife Jan completed a Ph.D. in Religious Studies. She was then hired by the faculty of the Theological School at Drew University, and I ended up at Bell Labs in the bargain.

12. As someone who worked at the interface among many disciplines, what kinds of background and skills made it possible for you to do this so successfully?

My broad training in pure and applied mathematics made it possible to do research in many subjects and to engage in interdisciplinary work with very bright people. Curiosity and a willingness to share and be challenged by others surely helped.

13. You had an extraordinarily productive career over a long period of time. What was it that motivated you to remain so productive over the entire span of your career?

I loved doing research and discovering new results. I liked to write and see things into print. Of vast importance were great places to work, gifted co-authors and marvelous support personnel. Throughout my career, I had a private secretary or a dedicated mathematical typist, so there was always excellent help to turn my handwritten documents into good copy. A desire for recognition cannot be gainsaid, but was a secondary concern.

14. When you retired, it seems that you ceased to do research of the kind that you were so noted for and, instead, decided to pursue other activities. What led you to this decision? What other activities have engaged you since you have retired?

Times changed. Fewer resources were being devoted to basic research, the technical support I had enjoyed diminished, and I was unwilling to retrain for a computerized world. It was a blessing to earn a living doing what I loved, but as we entered a new century it was time to move on.

My wife retired in 1995 as Dean of Drew's Theological School to pursue her own interests. I retired six years later. My favorite things since then are yard work, cornet practice, crossword puzzle solving, family activities, a daily Scrabble session with Jan, reading novels and the New York Times, and TV.

15. Are there any other thoughts that you would like to share regarding anything that we have not touched on?

The history and breadth of my research areas were always attractive and resulted in a few dozen surveys. A case in point is the monograph *Interprofile Conditions and Impossibility* (1987), which exposits Arrow's impossibility theorem and numerous contributions to social choice based on his approach and succeeding developments.