Reprinted from:

Koshland, Daniel E., Jr. 1994. Ahead of schedule and on budget. *Science*, 266: 199.

Editorial

AHEAD OF SCHEDULE AND ON BUDGET

Daniel E. Koshland, Jr.

A FUNNY THING HAPPENED on the way to the complete human genome sequence. The project is ahead of schedule and on budget, according to reports at the recently completed *Science*-Human Genome Organization-sponsored Human Genome Meeting, held from 2 through 5 October in Washington, D.C. The federal government has never seen anything like it. The Central Intelligence Agency is looking into Machiavellian theories to explain this astounding reversal of conventional wisdom. The explanation is simple: The leaders of the project were farsighted, were determined to succeed in the true goal, listened to the knowledgeable community, and then provided brilliant leadership to achieve the goal without the burden of ideological proscriptions or impractical administrative mechanisms.

Jim Watson for the National Institutes of Health (NIH) and Charles DeLisi for the Department of Energy (DOE) decided that it should be "big science" in the sense that it would cost $3 billion but that it would be run as a collection of "little science" projects depending on the entrepreneurial energy and ingenuity of little scientists; that is, like a consortium of mom-and-pop grocery stores delivering the services of a supermarket. The project leaders at both NIH and DOE (now Francis Collins at NIH and Ari Patrinos at DOE) have followed in that tradition. They are in constant touch with the people doing the work but show leadership and establish priorities by providing funds in proportion to the emphasis wanted at each interval and allowing investigator-initiated programs to compete for those funds. Thus, at the beginning, the physical map was a major priority, while the actual application of sequencing was de-emphasized. No one was prevented from doing sequencing, but the main effort was to develop new methods of sequencing, so that a massive effort would occur in the final days with optimum efficiency. Near the end the funding will go for sequencing with only minor adjustments to the physical map.

The goal of the project was to be of great value to society, a quantum jump in the advances of medicine, and to be a great boon to basic research. it would also generate the ethical questions created by the new knowledge. Therefore money in

the project was set aside to consider the ethical questions as well as the scientific advances. This sensitivity to the public needs to obtain and understand a desirable goal and the practitioners needs for sensible guidelines along evolutionary, not revolutionary, lines are at the core of the project's success.

A massive project extending into the future cannot run by continual democratic votes by the participants. It needs leaders with vision and managerial skills. Those leaders must, in turn, absorb the suggestions, advice, and criticisms of the practitioners and the desires and fears of the public that is the main beneficiary. In this case, the leaders decided to modify only slightly the modus vivendi of the community (the investigator-initiated research organization) by changing with time the funding priorities. From their own vision and their openness to suggestions from the community, they decided on lofty but feasible goals. Watson, for example, set the time limit of the project at 15 years to combine technological feasibility with personal incentives (he wanted a period short enough for the initial participants to be present at the conclusion). He and his co-leaders and successors then made administrative decisions about the timing of the priorities (physical mapping first, sequencing later) on the basis of information from experts who were realistic in regard to technological feasibility and cost.

Let us imagine how health care might progress if this model were followed. First, you do not announce in advance that you will not consult doctors because they have a vital interest in the outcome. Second, you analyze the problem — an excellent well-functioning system for those who can afford it, but one that many cannot afford. Third, you devise the "health care reform" to help the people who cannot afford it, with a minimal modification of the successful structures. Extending the Medicare structure to help a greater fraction of the population would be so simple as to astound bureaucrats. Such an option could be performed in stages, with financial feedback as each new stage is reached. Such practical gradualism would not appeal to newspaper headlines or to politicians determined to conceal how much it would cost, but it might generate a place in history for the leaders who introduced a gradual and realistic system. A place in history is one that the leaders and participants in the genome project will certainly get and will eminently deserve.