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CITATION FOR THOMAS P. HUGHES, 1990 BERNAL PRIZE RECIPIENT

The tenth recipient of the John Desmond Bernal Award for outstanding scholarly contributions to the study of science and technology is Thomas Parke Hughes, Mellon Professor of History and Sociology of Science at the University of Pennsylvania, and Visiting Research Professor at the Wissenschaftszentrum, Berlin.

In nominating Tom Hughes, the Bernal Prize Committee of our Society honors a scholar who has not only published brilliant books and essays in the history of technology but has also shown the relevance of this work to other disciplines in our field, as well as to general history and to our present problems with a technological world, and who has been active in the United States as well as internationally in reaching further audiences and stimulating other scholars.

In this citation, I shall not list Tom's many activities and honors, nor go through his six book and monographs, six edited or co-edited volumes, many articles in scholarly journals and edited volumes, and his involvement in two television documentaries. (This is the record as of spring 1990). Instead, I will try to highlight what his approach has been and continues to be.

Five years ago, in 1985, Tom Hughes received the Dexter Prize of the Society for the History of Technology for his magisterial book, *Networks of Power*, about the electrification of Western societies between 1880 and 1930. In fact, it was the second Dexter Prize that was awarded to him. The first was given for his biography of Elmer Sperry published in 1971. The citation for the prize says, among other things,

It seems safe to predict that few works produced in the emergence of our collective discipline to date will have as great an impact upon the course of future scholarship dealing with the nature and dynamics of technological change.¹

This prediction has certainly come true. A new generation of historians and sociologists has found inspiration in Tom Hughes's work and has profited from his active support and critical guidance. And Tom Hughes has continued

to produce works that will have impact: his recent opus, *American Genesis*, the story of the tidal wave of technological ingenuity and enthusiasm that swept the United States and created and gave momentum to a particular form of modernity, was a final jury nominee for the Pulitzer Prize in History in 1990. It will be widely read for its analysis as well as its message. Part of that message, the concern about hierarchical control orientation and tight coupling evident in modern technical systems, is being taken up in his work with Renate Mayntz and others on large technical systems.²

Let me try to articulate to you what Tom Hughes's approach is, and I will do so by using his own words, drawn from the introductions to books and articles and other relevant material. The systems approach that was so forcefully applied in *Networks of Power* was the expression of an insight and an approach that Tom Hughes has carried with him since his undergraduate days in engineering school. One of his courses, in electrical power plants, he remembers, "made a lasting impression, not because I wanted to design them but because I saw that they incorporated systematic interconnections with the technical and the economic."³

In one respect, the systems approach is a theory in the sociological sense. Technological change is not a matter of new material artifacts brought into a social environment but the evolution of systems of related parts, which include institutions and values in addition to the material configurations. It is the gradual emergence of such systems and the way they acquire dynamic inertia that is to be studied. The "entrepreneurs of technological change" are central in this process,⁴ and these include industrialists and financial people, as well as engineers. When the relations between the parts, to put it abstractly, have become articulated and stabilized, the built-in dynamic of growth creates specific patterns. Tom Hughes tried to capture one aspect of these dynamics with his notion of "reverse salient."

Defining reverse salients as critical problems is the essence of the creative process. An inventor or applier of science transforms an amorphous challenge — the backwardness of a system — into a set of problems that are believed to be solvable. Engineers in particular are known for their ability to define solvable problems.⁵

Note that it is now the configuration of the system, rather than the intentions of specific actors, that guides further development. There is a dynamic inertia, or "momentum" as Tom Hughes calls it, and he sometimes speculates about the regularities that govern such processes of technological change.⁶

If a would-be Darwin of the technological world is looking for laws analogous to the environmental forces that operate in the world of natural selection, the economic principles of load factor and economic mix are likely candidates.⁷

Load factor, which indicates the difference between actual and possible system output, is what the system's entrepreneurs try to improve. Here Tom Hughes allows himself to assume the role of theory builder, a Darwin of the technological world.

Yet, theory builders and historians are uneasy bedfellows. The system approach must also be seen as part of the historian's art of story telling. Concepts are there to make his material comprehensible, and to make his story memorable, rather than to function as building blocks for regularities and explanations. But the order in the historian's story is not independent of the order actually present in the world. Tom Hughes has confessed an admiration for Samuel Smiles's *Lives of the Engineers*, because of its clear perception that some of the engineers he describes were brilliant system builders able to weave technical, economic, and political activity into a seamless web.⁸ Their work, the "expression of man's constructive power in a chaotic world,"⁹ is recognized and revealed for what it is by historians like Smiles, and like Tom Hughes. Tom's work shows how he, like his engineers, is able to weave the technical, the economic, and the political into a seamless web. Seamless, but not amorphous; the plot of the story is highlighted by artful concepts that create order in the complexity.

Such story telling is necessary, Tom Hughes argues repeatedly:

Scientists and engineers analyze the technical systems they build, but historians are needed to comprehend the complex, multifaceted relations of these systems and the changes that take place in them over time.¹⁰

In fact, the historian has a responsibility to enlighten fellow inhabitants of the second creation. In *American Genesis*, Tom Hughes points out how Americans have built a technological world, but "[this] nation of builders does not know itself, [because] most of the history it reads and hears instructs otherwise."¹¹ In fact,

many of the forces that Americans need to understand and control in order to shape their destiny, insofar as that is possible, are now not primarily natural or political but technological. . . . The purpose of the understanding is not simply to comprehend the impressively ordered, systematized, and controlled, but to exercise the civic responsibility of shaping those forces that in turn shape our lives so intimately, deeply, and lastingly.¹²

The historian as humanist is apparent in how Tom Hughes describes our present situation: "The age of technological enthusiasm has passed, but it has left behind a burden of history. Those who know the history and the burden may be able to rid themselves of it or turn it to their end"¹³—instead of repeating and thus continuing it.

In Tom's case this is more than the typical historian's sentiment, however. In his work in the project on large technical systems, there is concern with their complexity, their tight management styles, and the increasing risks that go with them. His diagnosis is directly related to his systems theory:

After high momentum develops, [large technical systems] tend to take on an autonomous character and are difficult to direct or control other than along an inertial projection. Since these mature systems experience most of their social shaping in their early stages, they bring out of the past solutions to past problems.¹⁴

In order to intervene productively, it is essential to know the patterns and regularities of this technological world. The humanist and social critic needs the Darwinian theorist. In *American Genesis*, with its broader canvas, the systems approach is not applied in its specifics, but it does carry the thrust of the book and leads to the resigned but still optimistic conclusion: "The momentum of the modern may be so great in the United States that the next great technological and cultural change may occur among other peoples in another nation."¹⁵ The forthcoming edited volume on Lewis Mumford is important in continuing the humanist and social critical vein. It is also important because it is co-edited by Tom's wife, Agatha, his collaborator through the years.

I have drawn a picture of Tom Hughes as the theorist of our technological world, as the master storyteller who searches for "traces of order in man-made complexities"¹⁶ in order to "reveal mind over chaos,"¹⁷ and as the humanist and critic of our technological culture. The three personae come together in a man who has himself overcome intellectual and institutional inertia and continues to stimulate others to do so — a technological humanist par excellence, and living proof that intellectual and personal depth can indeed transcend disciplinary boundaries and academic cultures.

Notes

1. The Dexter Prize (1986, 566).

2. See, for a first publication, Mayntz and Hughes (1988).

3. Hughes (1986, 573; Hughes 1983, ix).

4. The term was used to characterize Elmer Sperry, who started as an engineer in a small town and became a system builder. See Hughes (1971, xiv-xv).

5. Hughes (1983, 14).

6. Many of his later thoughts are already visible, in less articulated and systematic form, in his essay on the railway system as a technological frontier. See, for example, sentences like the following: "The invention and development of the railway system was a century-long experience

with psychological, institutional, ideological, sociological, and technological facets" and "The complex of persons, ideas, and institutions extending the railway system into the natural frontier established a momentum in history" (Hughes 1965, 71).

7. Hughes (1988, 462). The comparison with Darwin also appears in the introduction (p. 5) and returns in Hughes (1989, 4).

8. Hughes (1986, 573).

9. Hughes (1983, ix).

10. Hughes (1983, 2).

11. Hughes (1989, 2).

12. Hughes (1989, 4).

13. Hughes (1989, 12).

14. Hughes (1988, 92).

15. Hughes (1989, 471).

16. Hughes (1983, ix).

17. Hughes (1986, 572).

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— Arie Rip
Chair, Bernal Prize Committee