The Gospel of Statistics and Its Prophet: The Ideas and Praxis of W. E. Deming

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Jean-Guy Prévost
Université du Québec à Montréal

William Edwards Deming (1900-1993) is probably one of the 20th-century statisticians whose involvement with industry, academy and government statistics was the most enduring. Probably best known as "the man who discovered quality", Deming is still, nearly two decades after his death, something of a cult figure in the field of management and a respectable number of monographs have been dedicated to this aspect of his work.[1] Business writer Andrea Gabor ranks him, along with F. W. Taylor, A. Maslow, H. A. Simon, P. Drucker and others, among the ten «capitalist philosophers» whose influence upon modern business was the most outstanding.[2] The W. Edwards Deming Institute, set up in the year of his death and one of the various organizations seeking to carry on his ideas, describes its mission as "to foster understanding of The Deming System of Profound Knowledge™ to advance commerce, prosperity and peace".[3] Yet, before he reinvented himself as an adviser to Japanese industrialists and the prophet of quality on the aftermath of World War II, Deming had already earned a name in the history of statistics. A theoretical physicist by formation, he went to work in the Fixed Nitrogen Laboratory at the United States Department of Agriculture just after having completed his Ph.D. and most of the papers he published from 1927 to 1939 "dealt with the physical

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1 Andrea Gabor, *The Man Who Discovered Quality*, New York, Random House, 1990. Among other major books devoted to Deming, we may mention: the collection of biographical material assembled by his long-time assistant Cecelia S. Kilian, *The World of W. Edwards Deming*, Knoxville, SPC Press, 1993; Rafael Aguayo, *Dr. Deming, the American Who Taught Japanese About Quality*, New York, Simon & Schuster, 1990; Nancy R. Mann, *The Keys to Excellence: The Story of the Deming Philosophy*, Los Angeles, Prestwick Books, 1987. Interestingly, all testimonies about Deming insist on his personal qualities and present him as an embodiment of traditional American puritanism : rising from material deprivation – but not without cultural capital: his parents were well-educated – to become a scientist; reaching to the defeated Japanese people with dignified respect rather than the victor's contempt; maintaining a way of life defined by simplicity and frugality; living up to deeply felt religious values, etc.

2 Andrea Gabor, *The Capitalist Philosophers. The Geniuses of Modern Business – Their Lives, Times, and Ideas*, New York, Radom House, 2000.

3 See http://deming.org/index.c (consulted 17 June 2010). The W. Edwards Deming Institute was officially set up by Deming itself, but it has been run by his daughters, Diana Deming Cahill and Linda Deming Ratcliff, since its inception. A number of other ventures exist throughout the world that are dedicated to the dissemination of Deming's managerial views, namely the Deming UK Forum (http://www.deming.org.uk/), the Deming Cooperative (http://www.deming.edu/demingcoop.html), and the Association française Edwards Deming (http://www.fr-deming.org/francais.html).

properties of gasses".[4] Deming soon came into contact with Dr. William Shewhart of Bell Laboratories and became interested in problems of industrial quality control. In 1940, he joined the U.S. Bureau of the Census as a mathematical adviser on sampling methods and on the implementation of quality control in all government statistical services. Deming's contributions in this regard consist of a string of papers and textbooks in which he notably conveyed his practical experience, furthering developments in statistical adjustment and error measurement as well as bringing forward ideas such as the distinction between enumerative and analytical surveys, or sampling as a basis for action.[5] His present fame within the statistical community can be measured by the American Statistical Association's decisions to honour him by having one of its most prestigious awards as well as its library named after him and, more surprisingly, by recreating on its premises Deming's home study.[6]

The success which – as a buzzword if not in actual practice – the idea of "quality" and its various correlates and outgrowths – "total quality", "quality circles", "quality-price ratio", etc. – have met since the 1980s in a variety of organizational settings has indeed quite understandably focused the attention on Deming's activity as a management consultant for industry and on the theoretical/practical constructs he developed during that period, such as "the 14 principles for management" or "the System of Profound Knowledge".[7] And while some of Deming's critics have reproached him with replacing management with statistical measurement, some of his admirers have criticized managers for embracing Deming's statistical tools at the expense of his more philosophical or humanistic ideas.[8] Envisioned as a whole, W. Edwards Deming's intellectual contribution and professional path are however especially representative of the spectacular extension in quantifying various domains of life that has been characteristic of the 20th-century and of the rising "trust in

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[4] Robert B. Austenfled, "W. Edwards Deming: The Story of a Truly Remarkable Person", *Papers of the Research Society of Commerce and Economics*, vol. XLII no 1, 2001, p. 55 (http://www.iqfnet.org/Ff4203.pdf [viewed 17 June 2010). From the bibliography compiled in Kilian, *op. cit.*, 17 principal papers were published by Deming between 1928 and 1940, that fall within the fields of physics or chemistry.

[5] Since 1930, Deming had been publishing in the area of mathematical statistics, with 7 papers in this area between 1930 and 1939. From the period he joined the Bureau of the Census, Deming's efforts were concentrated on sampling issues. The three books he published in this subfield were: *Statistical Adjustment of Data* (1943), *Some Theory of Sampling* (1950), and *Sample Design in Business Research* (1960), all at Wiley, the foremost American publisher in the domain of statistics.

[6] See http://www.amstat.org/careers/deminglectureraward.cfm and http://www.amstat.org/meetings/jsm/2006/ PDFs /JSM06AwardsBooklet.pdf (viewed 17 June 2010).

[7] To these, we may add "the Deming Cycle for Learning and Improvement" (also known as the Plan/Do/Study/Act cycle), "the Deming Chain Reaction" and "the seven deadly diseases" which afflict Western management. Even though these ideas are more fully exposed in Deming's two last books, *Out of The Crisis* (1986) and *The New Economics* (1994), they clearly were elaborated in the course of his consulting practice.

[8] A. Gabor writes for instance: "By statistical Luddites, Deming is often dismissed as a 'mere' statistician who has usurped the role of management expert." (*The Man Who Discovered Quality*, *op. cit.*, p. 31). In *The Capitalist Philosophers* (*op. cit.*, p. 195), the same author quotes a former automobile manager who worked with Deming as saying: "Give Ford a tool, like statistical process control. And they'll grab right on to it. That's the easy part. After a while you can go as fair with [the tool] as you can. The hard part is changing how you tkink about work."

numbers" that has gone hand in hand with it.[9] At the same time, Deming was careful to locate the power of statistical theory vis-à-vis a more general theory of knowledge and therefore identify some practical consequences of the former's limitations. Among the notions that have been characteristic of Deming's "statistical philosophy" – a dimension that has been somewhat overshadowed by the interest granted to his managerial views – mention should be made of "variation" as a permanent and pervasive feature of reality, of probability as "a basis for action" and of the necessary distinctions between "enumerative" and "analytical" surveys (the former deals with estimating quantities, while the latter is concerned with underlying causes). To be sure, the ideas behind those notions – especially the first two – were already present in the writings of earlier statisticians, but Deming certainly gave them a singular twist.[10] Through his efforts in spelling them clearly and, more importantly, in translating them into a set of protocols, practices and routines, tracking variation and considering sampling from the viewpoint of action to be taken became common watchwords, if not mottoes, for statisticians in the field.

The intent of the following presentation, which draws upon Deming's writings as well as upon secondary literature, is to offer a somewhat more integrated and more dynamic view of some of Deming's achievements and legacy upon the present practical concerns and activities of national statistical offices regarding quality and ethics. Since the 1980s, there has indeed been a rapidly growing interest in the issues related to statistical ethics, followed by a proliferation and generalization of sets of principles and codes of practice among public – national and supra-national – statistical bodies: it is our argument here that Deming's more practical views on professional statistical practice, defined from the point of view of the statistical consultant – the statistician as private scientific entrepreneur – have played a significant role in defining the parameters of this debate. Closely tied to the concerns about ethics are the growing efforts, within the same settings and with a roughly similar chronology, to implement a conception of quality that largely exceeds the traditional methodological concerns about data quality: here again, Deming stands as an obvious influence and it is our argument that the Demingian distinction between product and process underlies this generalized view of quality.

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[9] Theodore M. Porter, *Trust in Numbers: the pursuit of objectivity in science and public life*, Princeton, Princeton University Press, 1995.

[10] It may be mentioned that early in his statistical career, Deming published, with commentaries, *Facsimiles of Two Papers by Bayes* (Department of Agriculture, Washington, 1940).

Statistical ethics and the professional model

In a paper published soon after the International Statistical Institute (ISI) approved, in 1985, its *Declaration on Professional Ethics*, R. Jowell wrote that it marked "the end of about forty years of explicit resistance from eminent statisticians worldwide to the notion of codifying their statistical ethics".[11] The ISI Declaration was the result of a committee chaired by Jowell himself and of which Deming was also a member. A few years before that, in 1980, the American Statistical Association (ASA) had itself agreed on an *Interim Code of Conduct* that would later evolve into its present-day *Ethical Guidelines*.[12] Statisticians in various countries adopted similar codes of practice and declarations on ethics at about the same time.[13] In 1992, the UN Economic Commission for Europe endorsed a *Declaration on the Fundamental Principles of Official Statistics*, while in 2005, a *European Statistics Code of Practice* was adopted to be implemented by all European governance authorities, statistical authorities and their staff.[14] In the span of two decades or so, the issue of statistical ethics had moved from the remoteness of tacit knowledge to the exposure that comes with explicit codification.

Deming's involvement in the issue of statistical ethics can be traced back at least to 1958, with a paper he delivered on the occasion of a meeting held by the Institute of Mathematical Statistics. Entitled "On a formal structure of professional practice in sampling", it was first published as a section of Deming's 1960 monograph *Sample Design in Business Research*. Further versions appeared in major journals in 1965, 1966, and 1972.[15] Given Deming's acknowledged role in the processes that led to the adoption of codes by the ASA and the ISI and given the fact that no less than twenty-five statisticians – many of them luminaries in the profession – provided comments on the draft of his 1965 paper, his contribution undoubtedly deserves attention. To be sure, Deming was not alone in giving

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[11] Roger Jowell, "The Codification of Statistical Ethics", *Journal of Official Statistics*, vol. 2 no. 3, 1986, p. 217.

[12] American Statistical Association, "Ethical Guidelines for Statistical Practice", approved by the Board of Directors, 7 August 1999 (http://www.amstat.org/about/ethicalguidelines.cfm). For historical background, see Jonas H. Ellenberg, "Ethical Guidelines for Statistical Practice: A Historical Perspective", *The American Statistician*, vol. 37, no. 1, 1983, p. 1-4.

[13] In France, for instance, the *Association des administrateurs de l'INSEE* adopted a *Code de déontologie statistique* in 1984 (see Jacques Antoine, *Éléments d'histoire sur la déontologie des enquêtes*, 2006 [http://www.insee.fr/fr/insee-statistique-publique/colloques/jhs/pdf2006/texte_antoine.pdf]). In Britain, a Code of Conduct was endorsed by the Royal Statistical Society in 1993 (http://www.rss.org.uk/pdf/Prof%20memb%20-%20code%20of%20conduct%20new%20charter.pdf).

[14] *Fundamental Principles of Official Statistics* (http://unstats.un.org/unsd/methods/statorg/FP-English.htm); European Statistics Code of Practice (http://www.dzs.hr/Eng/international/code_of_practice_en.pdf).

[15] "Principles of Professional Statistical Practice", *Annals of Mathematical Statistics*, vol. 36 no. 6, 1965, p. 1883-1900; "Code of Professional Conduct", *Sankhyā: The Indian Journal of Statistics, Series B*, vol. 28, no. 1-2, 1966, p. 11-18; "Code of Professional Conduct: A Personal View", *International Statistical Review*, vol. 40, 1972, p. 215-219.

thought to these matters. In the early 1950s, the ASA had been engaged in a discussion about statistical standards and the desirability of a code of ethical practice. One of the issues at stake was the question whether these standards "should emphasize specifics rather than dwelling on honesty, loyalty, and dependability, which apply with equal force to all human behavior".[16] A first list of these specifics was proposed by W. W. K. Freeman in 1952 – it adressed notably the issues of bias, tests, confidentiality, data interpretation, etc.[17] – and he has been described as "the pioneer of a code of professional practice for statisticians."[18] In 1954, an ASA Ad Hoc Committee on Statistical Standards that had been entrusted with proposing both "standards to which any published statistical results should conform" and "standards of organization and procedure believed essential or desirable to assure valid statistical results" reported with the suggestion that further investigation be conducted as to the interest of statisticians in adopting such standards.[19] Following this report, two surveys made among members of the ASA led to the conclusion that further action be defered "until there is more interest in formulating standards".[20] In my view, it was Deming's 1958 intervention that revived the issue by putting forward a full-fledged version of standards covering both procedure and reporting. Two aspects of Deming's contribution are especially interesting in that they embody the tensions that have shaped the nature of the debates that led to the adoption of statistical ethical guidelines as well as the kind of codification privileged by statisticians. These are:

1. the professional character of a model that has been originally structured to define the relationship between the statistician and his client according to a strict division of responsibilities;

2. the technical and non-advocative conception of statistical work that derives from the fact that this model has been thought out in relation to statistical theory and the problems of survey sampling.

Deming's code of professional conduct, as exposed first in his 1960 monograph and in its successive redrafts, takes the form of a rather strict delimitation of responsibilities between the statistician and his client. It seems to have originated from Deming's own practical experience and clearly reflects his independent status at that time, that of a consulting statistician rather than a salaried company or government statistician; but it insists that "responsibilities and standards of workmanship" of the statistician as well as "obligations" of the employer were to be the same, irrespective of setting. Interestingly, Deming wrote "that his code (was) not copyrighted, and that he would in fact be pleased

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16 A. T. Court, "Statistical Standards", *The American Statistician*, vol. 6 no. 1, 1952, p. 6.

17 W. W. K. Freeman, "Discussion", *The American Statistician*, vol. 6 no. 1, 1952, p. 18-20.

18 Roger Jowell, "The Codification of Statistical Ethics", *loc. cit.*, p. 218.

19 "Report of the Ad Hoc Committee on Statistical Standards", *The American Statistician*, vol. 8 no. 3, 1954, p. 19.

20 "Report of the Ad Hoc Committee to Explore Opinion on Standards", *The American Statistician*, vol. 10 no, 1, 1956, p. 13.

if other statisticians would copy it, at least until they have something better".[21] Deming's code of conduct is built around the ideal of professionalism, that is the principle that "a professional man takes orders, in technical matters, from standards set by his professional colleagues as unseen judges; never from an administrative superior".[22] In this understanding, the professional is defined by the possession of expert knowledge that is not readily available to his client and sometimes may have to take decisions that cannot even be understood by the client. Law and medicine are proposed by Deming as examples of professions from which statisticians should learn.

The logical basis for delineating respective responsibilities between the statistician and the client is provided by statistical theory. Having been elaborated on the basis of his experience as a sampling expert and at a time when sampling methods were undergoing significant developments, thereby transforming statistics into something much more ambitious than the mere collection, tabulation and crude description of data it had been up to then, Deming's code of conduct relies on a rather strict understanding of statistical theory. Notably, it draws a neat distinction between the kind of knowledge that is provided by statistical theory and the knowledge that comes under the authority of the substantive expert, that is the expert on the subject matter about which a survey is to be made. (As an example, Deming mentions the definitions of employment and unemployment, which are a matter for the substantive expert, while the statistical and sampling designs belong to the statistician.[23]) Responsibilities of the client therefore bear upon all substantive aspects of the problem – which include a number of issues that would usually be deemed methodological if not outrightly statistical, such as the choice of the method to elicit information, the classes and areas of tabulation, the actual investigation, etc. – while those of the statistician pertain largely to providing the client with a set of choices and procedures as well as their limitations.[24] It follows from this sharp distinction between client/substantive knowledge, on the one hand, and statistician/statistical theory, on the other, that the statistician "should not recommend to the client that he take any specific administrative action or policy. (…) The statistician, if he were to make recommendations for decision, would cease to be a statistician".[25] Here, the statistician surely departs from the arguably more advocative professional models of medicine and law, and Deming's restrictive view surely represents a step back from the more integrated definition of the statistician's job he held in an earlier paper and which combined (i) planning of data collection, (ii) describing methods to be used, (iii) making predictions (which implies

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[21] As written by the editors of *Sankhyā* in their foreword to "Code of Professional Conduct", *loc. cit.*, p. 11.

[22] W. E. Deming, "Principles of Professional Statistical Practice", *loc. cit.*, p. 1885.

[23] *Ibid*., p. 1887. Generally, statistics (and this is especially true following the advent of sampling methods) has a more esoterical character than the subject matter to which it is applied. This imbalance may explain why statistical theory can contribute to increase the theoretical content of a subject matter, while the reverse does not occur – Deming gives management and genetics as two areas where statistics has made a deep impact.

[24] *Ibid*., p. 1891-1892.

[25] *Ibid*., p. 1893.

knowledge of the subject matter as well as statistical theory), and (iv) making recommendations for action.[26] In the 1960 and further descriptions of the statistician's responsibilities, these end with explaining the client "the meaning of the results of the survey in terms of statistical significance" (understood here as substantive significance) and "evaluat(ing) uncertainty in terms of possible uses of the data".[27] Now, of course, the strict delineation of responsibilities that comes from these distinctions between subject matter and statistical theory or presenting results and making recommendations makes a lot of sense in the context of the client/consultant relationship and of its legal aspects,[28] but in the context of large statistical organizations, substantive and statistical issues are entrusted to people working within the same institution. The distinction put forward by Deming may however reappear under the guise of that between statisticians who are specialized in a certain subject matter and statistical methodologists or sampling experts. The reticence to recommend a given course of conduct also reappears in the non-committal attitude – often designated as neutrality or objectivity – that is widely praised among public statisticians, for instance in the distinction between "policy-relevant information" – which it is the job of statisticians to produce – and "actual policy analysis" – from which they should refrain.[29]

The resistance or reticence opposed by a number of statisticians to the promulgation of ethical guidelines and the nature of the codes adopted by the ASA and the ISI stem in fact from the tension between the model of professionalism, which relies on the combination of expert knowledge and regulation of membership, and that of science, where frontiers of knowledge are in constant flux and mutual recognition is more informal. The ASA 1983 *Ethical Guidelines for Statistical Practice* as well as the ISI 1985 *Declaration on Professional Ethics* are thus characterized by their educational, as opposed to regulatory or aspirational, character – to borrow Jowell's distinction – that is they seek to "illuminate" issues of potential ethical conflict rather than proclaim "lofty ideals" and "control malpractice".[30] As in Deming's own code, though in much more general terms given that they were meant to apply to a vast variety of organizational settings, these documents set out to define relationships between the statistician and his client (enlarged to "the public, government, clients or employers, and other professionals" in the ASA *Guidelines*, and to "funders and employers,

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[26] "On a Classification of Problems of Statistical Inference", *Journal of the American Statistical Association*, vol. 37 no. 218, 1942, p. 176.

[27] *Sample Design in Business Research, op. cit.*, p. 12; "Principles of Professional Statistical Practice", *loc. cit.*, p. 1893. Deming adds: "Actually, ways in which the results may throw light on foreseeable problems will be settled in advance, in the design, and there should be little need for the client of for anyone else to re-open the question" (*ibid*., p. 1893-1894).

[28] See notably "On the Presentation of the Results of Sample Surveys as Legal Evidence", *Journal of the American Statistical Association*, vol. 49 no. 268, 1954, p. 814-825, and "Standards of probability sampling for legal evidence", *The American Statistician*, vol. 12 no 1, 1958, p. 25-26, where the line between statistician and substantive expert is finely drawn.

[29] As evidenced for instance by Statistics Netherlands in its *Statistics that Count. Strategic plan for the medium range 2002-2005* (http://www.cbs.nl/NR/rdonlyres/07F6110F-D3DC-4006-B12D-784A5B8AB34E/0/statsthat count.pdf).

[30] R. Jowell, "The Codificaton of Statistical Ethics", *loc. cit.*, p. 218-222.

colleagues, and subjects" in the ISI *Declaration*), so as to delineate responsibilities.[31] And if the frontier between aspirational and educational may sometimes be thin, it is clear that neither of those codes has been designed as a set of rules to be enforced by a regulatory body. In this sense, both are the equivalent of a personal code of conduct writ large. Even though their members may describe themselves as professionals, organizations such as the ASA and the ISI thus remain closer to the model of scientific societies – ISI members have to go through an election procedure – than to the bodies that are officially designed to protect the public from the occasional malpractice of professionals such as lawyers or doctors. Statisticians may of course be subject to regulatory bodies set up in other settings, but as a scientific profession, the codes to which they adhere are built around the tension between science and professionalism. In the whole debate about statistical ethics, Deming's code of conduct has remained a reference, as testified by its reprinting in the 1986 *Encyclopedia of Statistical Science*.[32]

[31] "Ethical Guidelines for Statistical Practice: Report of the Ad Hoc Committee on Professional Ethics", The American Statistician, vol. 37 no. 1, 1983, p. 5-6; International Statistical Institute, *Declaration on Professional Ethics*, 1985 (http://isi.cbs.nl/ethics.htm).

[32] "Principles of Professional Statistical Practice," in *Encyclopedia of Statistical Science*, vol. 7, eds. S. Kotz and N. Johnson, New York, Wiley, 1986. Deming's code is also presented as a discussion of ethics by S. B. Vardemen and M. D. Morris in their "Statistics and Ethics: Advice for Young Statisticians", *The American Statistician*, vol. 57 no. 1, 2003, p. 21-26.

The politics of quality

Quality has been a long-standing concern of statisticians. It can be defined somewhat narrowly, that is with quasi-exclusive concern for accuracy, and thus with reference to concepts such as "bias, goodness of fit, or error in hypothesis testing".[33] In this understanding, "error" appears as the counterpart of quality, or, conversely, the quest for quality is conceived as the reduction of total (i.e. sampling + measurement) error.[34] This has indeed been a preoccupation of statisticians associated with the development of probability sampling techniques, i.e. the generation to which Deming belonged, since they could argue that, paradoxically, an increase in sampling error could lead to a decrease of measurement error and bias, and therefore of total error, while being altogether more economic.[35] But quality can also be envisioned in a much broader manner, as do nowadays many national statistical offices (NSOs) who suscribe to a extended concept of quality that encompasses five or six components: to accuracy, they generally add relevance, timeliness, accessibility, interpretability and coherence.[36] It is interesting to observe that even though this comprehensive view of quality and the components it includes would have been equally plausible for NSOs to uphold in the 1950s, 1960s, 1970s, or 1980s (and one could argue that, tacitly at least, they did aim at meeting those "qualities"), the exhortative discourse about quality (or total quality) took hold only in the 1990s, replacing or rather subsuming the revered topoi of excellence, objectivity and integrity that had up to then made the normative core of statistical activity.[37] Since 2001, biennial conferences on Quality and Methodology on Official Statistics have been held and reference to quality, total quality, quality assurance is now pervasive – with sometimes explicit reference to the Total Quality Management (TQM) movement, the International Organization for Standardization (ISO) norms, or even Deming's own 14 points.[38]

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[33] G. J. Brackstone, "Managing Data Quality in a Statistical Agency", *Survey Methodology*, vol. 25 no. 2, 1999, p. 139.

[34] This is the view held for instance by R. Platek and C.-E. Särndal in their paper "Can a Statistician Deliver?", around which the *Journal of Official Statistics* organized an impressive symposium (vol. 17 no. 1, 2001, 1-20; the paper was followed by 16 comments and a rejoinder by the authors, p. 21-127).

[35] The rationale for this may be found in Deming's *Some Theory of Sampling* (New York, Wiley, 1950, ch. 2) and in a number of papers published in the previous decade, notably "On Error in Surveys", *American Sociological Review*, vol. 9 no. 3, 1944, p. 359-369, and "Some Criteria for judging the Quality of Surveys", *Journal of Marketing*, vol. 12 no. 2, 1947, p. 145-157.

[36] This is Statistics Canada's list of the dimensions of quality, as mentioned for instance in I. P. Fellegi's reply to Platek and Särndal (*Journal of Official Statistics*, vol. 17 no. 1, 2001, p. 43). Other statistical organizations have produced slightly different lists (Eurostat insists on comparability rather than interpretability, for instance), but variations are minor.

[37] As an instance of exhortation, one could glance at Australia's Chief Statistician Dennis Trewin's "The Importance of Quality Culture", *Survey Methodology*, vo. 28 no. 2, 2002, p. 125-133, where the word "quality" occurs no less than 85 times (which makes an average of 9.4 times per page…).

[38] For instance, D. A. Marker and D. R. Morganstein, "Keys to Successful Implementation of Continuous Quality Improvement in a Statistical Agency", *Journal of Official Statistics*, vol. 20 no. 1, 2004, p. 127 and 129.

Now, the history of this relationship between statistics and quality, and Deming's role in this story as a kind of middleman between science, industry, and government deserves to be explored.[39] An early statement of the characteristics of "a good statistical programme for a government or a corporation" is provided by Deming at the start of his 1950 monograph.[40] In the following table, these characteristics are set along those that are used by NSOs to define quality. In spite of some discrepancy, there is obviously a good fit between both lists.

Deming's characteristics of a good statistical program	**NSOs definitions of quality in statistics**
Usefulness and comprehensiveness of content	Relevance
Reliability of results, sufficient for the purpose	Accuracy
Intelligibility (classifications and definitions that are understood)	Interpretability Comparability
Speed	Timeliness
	Accessibility
Economy of operation	
Accurate in interpretation and presentation	Accuracy
	Coherence

During the 1940s and 1950s, Deming's use of the word "quality" remained however largely circumscribed to the above-mentioned "narrow" concept of quality as data accuracy – often with reference to the census – and to the notion of "quality control" originally developed by W. Shewhart.[41] A cursory examination of methodological papers authored by Deming and other American statisticians in the 1940s and 1950s and dealing with the census reveals that no explicit definition of quality is ever provided. All uses of the word "quality" pertain to data, results, and sometimes operations (with frequent occurrences of "quality control" and "quality check").[42] To be sure, right from the beginning,

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39 Important starting points have been provided by A. Desrosières in "Measurement and its Uses: Harmonization and Quality in Social Statistics", *International Statistical Review*, vol. 68 no. 2, 2000, p. 173-187, and "Les qualités des quantités", *Courrier des statistiques*, no 105-106, 2003, p. 51-63.

40 *Some Theory of Sampling, op. cit.*, p. 3-4.

41 It should be reminded that it was Deming who provided editorial assistance to Shewhart in publishing his *Statistical Method from the Viewpoint of Quality Control* (Washington, D.C., Department of Agriculture Graduate School, 1939).

42 F. F. Stephan, W. E. Deming, M. H. Hansen, "The Sampling Procedure of the 1940 Population Census", *Journal of the American Statistical Association*, vol. 35, no. 212, 1940. p. 615- 630; W. E. Deming, "Sampling in the 1940 Census of Population," *Population Index*, vol. 7, no. 1, 1941, p. 5-8; W. E. Deming and L. Geoffrey, "On Sample Inspection in the Processing of Census Returns", *Journal of the American Statistical Association*, vol. 36, no. 215, 1941, p. 351- 360; P. M. Hauser, "The Use of Sampling in the Census", *Journal of the American Statistical Association*, vol. 36, no. 215, 1941, p. 369- 375; P. M. Hauser, "Research Possibilities in the 1940", *American Sociological Review*, vol. 6, no. 4, 1941, p. 463-470; P. M. Hauser, "The Use of Sampling in the Census", *Journal of the American Statistical Association*, vol. 36, no. 215, 1941), p. 369- 375; M. H. Hansen and W. E. Deming, "On Some Census Aids to Sampling", *Journal of the American Statistical Association*, vol. 38, no. 223, 1943), p. 353- 357; P. M. Hauser, "Wartime Developments in Census Statistics", *American Sociological Review*, vol. 10, no. 2, 1945), p. 160-169; E. S. Marks and W. P. Mauldin, "Response Errors in Census Research", *Journal of the American Statistical Association*, vol. 45, no. 251, 1950), p. 424-438; M. H. Hansen, "Statistical Standards and the Census", *The American Statistician*, vol. 6, no. 1, 1952), p. 7-10; M. H. Hansen, W. N. Hurwitz and L. Pritzker, "The Accuracy of Census Results", *American Sociological*

Deming had insisted on the fact that Shewhart's view of quality control, far from limiting itself to the industrial end product, was concerned with the whole production process.[43] And accuracy of data collected through the census or through sampling surveys necessarily implied, with regard to measurement error, that careful attention should be given to the whole process. In the context of processing results of the 1940 Census, Deming draws indeed the following table, that parallels the industrial and census processes with reference to statistical control of error:[44]

Industrial term	**Census term**
Process	Operation
Inspection	Verification
Defect	Error
Fraction defective	Error rate
All defective parts discovered are adjusted or replaced by good ones	All errors found are corrected

A more encompassing view of quality may however be found in Deming's 1966 paper on quality control in Japan. Written after some two decades of groundwork with Japanese industrialists and statisticians, this paper defines the statistical control of quality as "the application of statistical principles and techniques in all stages of production, directed toward the economic manufacture of a product that is maximally useful and has a market".[45] Such a comprehensive definition, which Deming presents as Shewhartian orthodoxy but which he had not provided with the same clarity in earlier utterances, calls for an extensive use of statistical methods at all phases of the process, but also for an expanded understanding of the industrial process that includes, for instance, assistance to suppliers and consumer research.[46] Shewhart's distinction between product and process and that between specific and common causes are then recasted so as to encompass the whole system of industrial relations, so as to determine if variation in quality is the responsibility of the worker, of the foreman or management.[47] In a paper published some ten years later, Deming indeed assigned 85% of faults as originating from "common causes" and thus falling under the responsibility of management, a figure

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Review, vol. 18, no. 4, 1953, p. 416-423; M. H. Hansen, W. N. Hurwitz, H. Nisselson and J. Steinberg, "The Redesign of the Census Current Population Survey", *Journal of the American Statistical Association*, vol. 50, no. 271, 1955, p. 701- 719.

43 "Opportunities in Mathematical Statistics, with Special Reference to Sampling and Quality Control", *Science*, vol. 97 no. 2514, 1943, p. 209-210.

44 See notably W. E. Deming and L. Geoffrey, "On Sample Inspection of the Processing of Census Returns", *Journal of the American Statistical Association*, vol. 36, no. 215, 1941, p. 352.

45 "Some Remarks on Statistical Control of Quality in Japan", *Sankhyā: The Indian Journal of Statistics, Series B*, vol. 28, no1-2, 1966, p. 21.

46 *Ibid*., p. 22.

47 "The contribution that statistical methods make in placing responsibility squarely where it belongs (at the local operator, at the foreman, or at the door of higher management) can hardly be overestimated." *Ibid*., p. 23.

he would commonly refer to from then on, and of which he wrote that it was "intended only to indicate that, in my experience, problems of the system overshadow special causes" – the remaining 15%.[48]

From there, we move to the more "militant" Deming, who, from 1981 on, held his famous four-day seminars and whose main writings, *Out of the Crisis* and *The New Economics*, can properly be described as indictments of American capitalism and manifestoes for a "cultural revolution".[49] Quality becomes applicable to a number of settings other than industrial, namely services, private and public, for which the Bureau of the Census provides a paradigmatic case.[50] The frontier between statistical and management consultancy is blurred and becomes virtually inexistent as all aspects of the workplace are susceptible not only of statistical enquiry, but also of what may be described as statistically-grounded common sense (i.e. variation is a feature of reality, the ideal of zero defect is a fallacy, etc.). For Deming, who seemed to have moved far from his earlier non-advocacy stance, "the business of statisticians is to transform the company goals – not to help the management to pursue theirs, but to change those goals." This means notably abandoning "instruments for rating people" and "competition" in favor of "understanding differences between people, interactions between people, and interactions between people and the system that they work in" and "cooperation".[51]

The definitions of quality put forward by NSOs from the late 1990s on did not of course simply, directly and exclusively borrow Deming's views. Even though Deming's name is the one that first comes to mind when hearing about quality, other authors and promoters of quality have also made their mark. Besides Walter A. Shewhart (1891-1967), whose legacy has been claimed foremost by Deming, mention should be made of Joseph M. Juran (1904-2008), whose career somewhat paralleled that of Deming and whose name is also closely associated with the Japanese postwar economic recovery;[52] of Philip B. Crosby (1926-2001), from ITT, to whom the un-Demingian ideal of "zero defect" is ascribed;[53] of Kaoru Ishikawa (1915-1989), of the Japanese Union of Scientists and Engineeers (JUSE), who translated some of Deming's papers and is known as the father of "quality circles";[54] or Armand V. Feigenbaum (1922-…), to whom the concept of "total" quality is usually credited.[55] But the distinction between the narrow conception of data quality – quality as accuracy –

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48 "On Some Statistical Aids toward Economic Production", *Interfaces*, vol. 5 no. 4, 1975, p. 3. This 85%/15% Deming rule of thumb may be compared to Joseph M. Juran's – another quality "guru" – adoption of the so-called Pareto Principle, i.e. that 80% of problems originate from 20% of the causes (see J. M. Duran, "Universals in Management Planning and Controlling", *Management Review*, vol. 43, no. 11, 1954, p. 748-761).

49 *Out of the Crisis*, Cambridge, MIT Press, 1986; *The New Economic for Industry, Education, Government*, Cambridge, MIT Press, 1993.

50 *Out of the Crisis, op. cit.*, ch. 7 and for the Bureau of the Census, p. 206-207.

51 "Comment", *Statistical Science*, Vol. 5, No. 4, 1990, p. 391-392 (on H. V. Roberts, Applications in Business and Economic Statistics: Some Personal Views", *ibid*., p. 372-390).

52 D. Phillips-Donaldson, "100 Years of Juran", *Quality Progress*, vol. 37, no. 5, 2004, p. 25-39.

53 K. Johnson, "Philip B. Crosby's Mark on Quality", *Quality Progress*, vol. 34, no. 10, 2001, p. 25-30.

54 G. H. Watson, "The Legacy of Ishikawa", *Quality Progress*, vol. 37, no. 4, 2004, p. 54-57.

55 G. H. Watson, "Feigenbaum's Enduring Influence", *Quality Progress*, vol. 38, no. 11, 2005, p. 51-55.

and the encompassing notion of quality statistics – accuracy + relevance + timeliness + accessibility + interpretability [comparability] + coherence – nicely mirrors the contrast between product and process in its largest acception. While accuracy bears on the product (data) and is to be assessed by statisticians themselves, the other dimensions of quality make sense in relation to users. It should therefore come as no surprise that such a definition of quality has been embraced by statistical offices at a time when, notably under the pressure of budget constraints, getting "value for money", adopting a "customer-oriented" stance, a "trademark" or "brand name" approach, and "marketing our products" all became imperative.

Yet, rather than being merely a correlate of the various forms of privatization, marketization and corporatization linked to the advent of new public management and the more general context of neo-liberalism, the story of quality in relation to statistics stems, as we have seen, from a long and complex chain from which the following links have been identified:

i. industrial statistical quality control (Shewhart at Bell Laboratories)
ii. development of sampling methods and quality checks for the 1940 American census (Deming *et al*. at the Bureau of the Census)
iii. reconstruction of Japanese industry (JUSE, Deming, Juran)
iv. dissemination of various enlarged conceptions of quality in industry through the work of quality "gurus"
v. adoption of total quality frameworks by NSOs (1990s)

Conclusion

W. Edwards Deming's path as a statistician whose career embraced the world of government service as well as that of business offers a striking instance of how a number of statistical ideas, concepts, practices, protocols and routines have migrated back and forth between these different settings. Notably, it shows that issues such as ethics and quality, which, in relation to statisticians, have become prominent in the 1980s and 1990s and seemed to spring chiefly from extra-statistical concerns, entertain in fact a long and complex relationship with the recent history of modern statistics. Both issues, as we have seen indeed, were defined by Deming first and foremost with regard to statistical theory. It was the development of survey sampling theory and technique that provided the statistician with the knowledge and skills that would become exclusive to his trade and could therefore delimit his specific responsibilities from that of his client or of other specialists. From the privileged position of the private consulting statistician, Deming was able to draw a code of conduct that could be used as a reference point from which to develop a more generalized set of guidelines applicable to statistician working in various settings. In the same manner, the way he approached quality was thoroughly statistical, centered on the idea of variation and on the way statistics could throw light of how a system of causes and effects may behave. Overall, Deming's case is a telling illustration of how statistics, as a set of theoretical concepts and practical applications, have shaped our institutions as well as our manners of thinking and behaving.

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