Classics in production and operations management

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Introduction

Central to the establishment of a formal discipline is the identification of the body of fundamental knowledge underlying that discipline. Most disciplines within the overall "business" supra-discipline have identified the researchers and the works which are classics in those fields. For example, Shafritz and Whitbeck's (1978) *Classics of Organization Theory*, Merrill's (1970) *Classics in Management*, Thompson's (1981) *The Great Writings in Marketing* and the Fall 1990 of the *Journal of the Academy of Marketing Science*, on the Special Issue "History of marketing thought", all identify classic theorists and works in their respective disciplines. These works provide valuable insights to the early development of their respective bodies of knowledge and are valuable in explicating the bases for the current theoretical perspectives of the disciplines. No such compilation has been attempted in the field of production and operations management (POM).

Most collections of classic works are the result primarily of subjective criteria applied by an editor or a small group of editors. The research reported here applies more objective criteria and draws on the collective wisdom of the academic POM community to determine the classic contributors and works within the field of POM. The research consisted of two phases. An open-ended exploratory survey was used to establish the criteria for judging a contributor as "classic" and a preliminary list of classic contributors. A survey instrument developed from the exploratory phase results was used to determine the classic contributors to the POM field.

Two research questions were addressed in this project:

(1) What are the criteria which should be used for judging a person or work to be a classic in the field of production/operations management?

(2) Which works or persons can be judged as classics within the framework of criteria established by question (1)?

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Methodology

Exploratory phase

The exploratory phase of the project consisted of a survey of members of the Production and Operations Management Society (POMS) who taught POM. The purpose of this survey was to obtain data about which scholars and works are considered to be classics. This in turn required a set of criteria appropriate to determining whether an individual or work is "classic".

Seven-hundred surveys were mailed, 80 of which were undeliverable. Of the 620 surveys which were delivered, 85 were returned for a 13.7 per cent response rate. From the 85 surveys returned, 60 usable responses were obtained.

The exploratory survey instrument consisted of three main parts. Part 1 was a list of eight potential criteria by which to determine classic works and individuals. The criteria were obtained from published collections of classic works in other business sub-disciplines (see Table I).

Table I.
Criteria for determining a "classic"

Criterion	Shafritz and Whitbeck	Merrill	Pugh
Vitality		✓	
Historic significance	✓	✓	✓
Seminal importance			✓
Frequency of quotation			✓
Degree of interest to management generalists	✓	✓	
Recognition by serious students in the field	✓		
Readability	✓		
Time since publication	✓		

Respondents were asked to rate the criteria from "not important" to "very important" on a four-point scale using the following definitions for each of the criteria:

- *Vitality* is a measure of how lasting the contribution has proved. Was this work important at the time but no longer valid, or is it as important today as when it was written?
- *Historic significance* is a measure of the extent to which the contribution constituted a breakthrough in the field. To what degree did the contribution alter the POM discipline?
- *Seminal importance* gauges the potency of the contribution to spawn further work in the field.
- *Degree of interest to management generalists* is a measure of whether the contribution was of purely academic interest or of broad interest to management practitioners as well.

- *Recognition by serious students in the field* is a measure of how well the contribution is integrated with the body of knowledge in which "serious students of POM" are steeped.
- *Readability* gauges the ease with which the contribution may be read and understood.
- *Time since publication* recognizes that some seemingly important contributions really do not remain important after sufficient time has elapsed for their detailed study by the POM community. Truly classic contributions thus must "stand the test of time".

Part 2 asked the respondents to list in order of importance five *individuals* they consider to be classic contributors to the field of POM, along with the criteria they used to select the individuals. Part 3 asked the respondents to list in order of importance five *works* they consider to be classics in the field of POM along with the criteria they used to select the works.

Second phase

Phase two of the project was conducted during the following year. A survey instrument was designed on the basis of the results of the exploratory survey and the lists of contributors in POM texts, and which the respondents could complete in a much shorter period of time. The survey population consisted of a random sample of 200 members of POMS, and a convenience sample of 92 participants at two POM national conferences. One hundred-and-twenty usable responses were obtained, 36 from the random sample of POMS members (18 per cent response rate), 84 from the convenience sample of national conference participants (92 per cent response rate). All of the survey respondents hold PhD degrees, and all but two were teaching POM classes and conducting research in the POM field.

The second phase questionnaire consisted of two parts. Part one contained the same list of criteria for classic contributors as had the exploratory survey. As in the exploratory survey, respondents were asked to rate the criteria on a four-point scale from "not important" to "very important". Part 2, rather than using the open-ended format of the exploratory questionnaire, presented the respondents with a list of 37 names of potentially "classic contributors". The names were developed from those listed in POM texts (see Table II), those listed by two or more respondents to the exploratory survey, and additional names were added by the researchers. One of these names (Crosby) was added because the author's work was nominated as a classic in the exploratory survey. Two names (Feigenbaum and Mood) were added because of their frequency of citation in the quality literature. Respondents to the second phase of the survey rated, on a scale of 1 (disagree) to 5 (agree) their agreement with the statement "This person is a classic contributor to the field of POM".

Contributors	POM text: Chase and Aquilano	Heizer and Render	Schroeder	Stevenson	Weiss and Gershon
Atanasoff		✓			
Babbage			✓		✓
Boulton					✓
Danzig	✓		✓	✓	✓
Deming	✓				
Devol					✓
Dodge	✓			✓	✓
Ford	✓		✓	✓	✓
Gantt	✓			✓	✓
Gilbreaths	✓	✓	✓	✓	✓
Gorden					✓
Harris	✓			✓	✓
Juran	✓				
Mayo	✓			✓	✓
Ohno	✓				
Orlicky	✓	✓			✓
Pritsker		✓			
Romig	✓			✓	✓
Schaffle					✓
Shewhart	✓	✓		✓	✓
Skinner				✓	
Smith		✓	✓	✓	✓
Taylor	✓	✓	✓	✓	✓
Tippett	✓			✓	✓
Towne					✓
Watt			✓		✓

Table II.
POM contributors listed in POM texts

Note: These texts are considered to be representative of all POM texts for the purpose of this study

Exploratory phase findings

Research question (1)

Eight potential criteria were presented to the survey respondents to rate on a scale of 1 (not important) to 4 (very important). The eight criteria and their mean respondent ratings are shown in Table III.

Ten other criteria were mentioned by at least one respondent (global impact; how prolific; high quality work; creativity; continuous contribution; contribution to society; integration of work; how progressive; how up-to-date; innovation of research). None of these criteria was mentioned frequently enough to allow an assessment of its strength.

Research question (2)

Each respondent was asked to identify classic contributors to the field of POM. Sixty names were proposed by at least one respondent, of which 32 were

mentioned only once. Table IV lists the 28 names which were mentioned by two or more respondents.

The respondents were then asked to list the criteria they used to judge these contributors as "classic". Table V shows these criteria.

Criterion	Mean rating	Percentage rating "important" or "very important"
Vitality	3.492	95.385
Historic significance	3.323	78.462
Seminal importance	3.323	84.615
Readability of work	3.031	72.308
Degree of interest	2.953	66.154
Recognition by serious students in field	2.862	66.154
Time	2.815	66.153
Frequency of quotation	2.553	56.923

Table III.
Respondent ratings for criteria: exploratory phase

Contributor	Frequency	Ranking
Skinner, W.	23	1
Taylor, F.	20	2
Deming, W. E.	17	3
Hayes, R.	15	4
Schonberger, R. J.	13	5
Orlicky, J.	12	6
Wheelwright, S.	10	7
Clark, K.	8	8
Shewhart, W.	7	9 (=)
Gilbreath, F. and L.	7	9 (=)
Wight, O.	7	9 (=)
Buffa, E.	7	9 (=)
Hall, R.W.	5	13 (=)
Garvin, D.A.	5	13 (=)
Danzig, G.	5	13 (=)
Gantt, H.	5	13 (=)
Schroeder, R.G.	3	17 (=)
Shingo, S.	3	17 (=)
Hill, T.	3	17 (=)
Brown, R. G.	3	17 (=)
Juran, J.	3	17 (=)
Hax, A.	3	17 (=)
Abernathy, W.J.	3	17 (=)
Starr, M.	3	17 (=)
Chase, R.	3	17 (=)
Whybark, C.	3	17 (=)
Wild, R.	3	17 (=)
Modigliani, F.	2	28

Table IV.
Classic contributions to POM

Contributor	Criteria: Vitality	Historic significance	Seminal importance	Readability	Interest	Recognition	Time	Frequency of quotation
Skinner, W.	✓	✓	✓				✓	✓
Taylor, F.	✓	✓	✓		✓	✓	✓	✓
Deming, W. E.	✓	✓			✓			
Hayes, R.	✓		✓					✓
Schonberger, R. J.	✓	✓	✓	✓	✓			
Orlicky, J.		✓	✓		✓	✓	✓	✓
Wheelwright, S.	✓		✓				✓	✓
Clark, K.			✓	✓	✓	✓		
Shewhart, W.		✓	✓		✓	✓	✓	
Gilbreath, F. and L.	✓	✓	✓	✓	✓			✓
Wight, O.		✓	✓	✓				
Buffa, E.			✓		✓			
Hall, R.	✓	✓		✓			✓	
Garvin, D.		✓		✓				
Danzig, G.		✓	✓	✓		✓		✓
Gantt, H.	✓	✓	✓			✓		✓
Schroeder, R.G.			✓		✓			✓
Shingo, S.	✓			✓				
Hill, T.						✓	✓	
Brown, R. G.			✓			✓		
Juran, J.		✓	✓	✓	✓			
Hax, A.				✓				
Abernathy, W.J.	✓		✓				✓	
Starr, M.	✓		✓	✓	✓			
Chase, R.		✓				✓	✓	✓
Whybark, C.				✓				
Wild, R.		✓						
Modigliani, F.		✓	✓			✓		
Criteria usage frequencies	12	16	19	12	10	11	9	10

Table V.
Classic contributors by selection criteria

Each respondent was asked also to identify classic works in the field of POM. Sixty works were proposed by at least one respondent. Of these, 33 were mentioned only once. The 27 works which were mentioned by two or more respondents are listed in Table VI; along with the frequency and authors' rank. The authors' rank is based on the frequency of listing in Table IV.

The exploratory survey provided the following information which was used to design the second phase survey instrument:

- All eight of the criteria proposed were used by the respondents to select classic contributors and works.
- Sixty individual contributors were identified as being potentially classic.
- Sixty works were identified as being potentially classic.

Work	Author(s)	Frequency	Ranking
"Manufacturing – missing link in corporate strategy"	Skinner	14	1
"Link manufacturing process and product life cycles"	Hayes and Wheelwright	10	4, 7
Material Requirements Planning	Orlicky	10	6
"The focused factory"	Skinner	8	1
"Why some factories are more productive than others"	Hayes and Clark	8	4, 8
Out of the Crisis	Deming	7	3
"Restoring our competitive edge"	Hayes and Wheelwright	7	4, 7
"Dynamic manufacturing: creating the learning organization"	Hayes, Wheelwright and Clark	6	4, 7, 8
"Competing through manufacturing"	Wheelwright and Hayes	6	7, 4
"Zero inventory"	Hall	6	13
"Managing our way to economic decline"	Hayes and Abernathy	6	4, 17
"Quality on the line"	Garvin	6	13
The Goal	Goldratt and Cox	5	29
"The productivity paradox"	Skinner	4	1
Modern Production Management	Buffa	4	9
"World class manufacturing: the lessons of simplicity applied"	Schonberger	4	5
"Learning curve"	Abernathy	4	17
"The quality trilogy"	Juran	4	17
The Principles of Scientific Management	Taylor	3	2
Quality Is Free	Crosby	3	–
MRP-II	Wight	3	9
"Manufacturing strategy"	Hill	2	17
Zero Quality Control: Source Inspection and the Poka-yoke System	Shingo	2	17
"A dynamic version of the economic lot size model"	Wagner and Whitin	2	–
Production and Operations Management	Chase and Aquilano	2	17
"The service factory"	Chase and Garvin	2	17, 13
"Global production and operations strategy	Starr	2	17

Table VI.
Classic works in POM

- There were some inconsistencies between the lists of classic contributors and classic works.

Second phase findings

Research question (1)

The phase two survey respondents rated on a scale from 1 (not important) to 4 (very important) the same list of criteria for judging a person or work "classic" as was used in the exploratory phase of the survey. Table VII shows the results of the phase two survey and compares them with the exploratory phase results.

Research question (2)

Respondents to the second phase survey rated on a scale from 1 (disagree) to 5 (agree) their concurrence with the statement: "This person is a classic contributor to the field of POM." The results, shown in Table VIII, are compared with the rankings from the exploratory study based on frequency of listing by respondents.

Table VII.
Second phase survey respondents' ratings for criteria

Criterion	Exploratory mean rating (ranking)	Second phase mean rating (ranking)
Vitality	3.48 (1)	3.58 (1)
Historic significance	3.44 (2)	3.52 (2)
Seminal importance	3.37 (3)	3.43 (3)
Readability of work	2.88 (5)	3.08 (4)
Degree of interest	2.68 (8)	3.03 (6)
Recognition by serious students in the field	3.20 (4)	3.04 (5)
Time	2.73 (7)	2.89 (7)
Frequency of quotation	2.86 (6)	2.83 (8)

A form of the univariate clustering procedure using least significant differences (LSD) was employed to determine which contributors belonged together in the highest ranking set. Analysis of variance (ANOVA) indicated that significant differences existed among the contributors' ratings ($p < 0.0000$). The first cluster was generated by using the LSD approach to determine which other contributors' scores were not significantly different from the top contributor's score (Deming, at 4.50). Three other contributors were clustered with Deming using this procedure. A second cluster was generated by using the LSD approach to determine which other contributors' scores were not significantly different from the member of the first cluster with the lowest score (Juran, at 4.15). Combining these two clusters (see Figure 1) produces a "fuzzy set" of those contributors with some claim to having significantly higher ratings than do the non-members of the set.

A "fuzzy set" has boundaries that are imprecise or loosely defined. Fuzzy logic derives from the information processing/artificial intelligence disciplines. While overlapping does occur between items included in the set and those

Contributor	Rating	Second phase ranking	Exploratory phase ranking
Deming	4.50	1	3
Taylor	4.45	2	2
Skinner	4.24	3	1
Juran	4.15	4	17 (=)
Buffa	4.06	5 (=)	9 (=)
Gantt	4.06	5 (=)	13 (=)
Gilbreaths	3.98	7	9 (=)
Wheelwright	3.94	8	7
Hayes	3.93	9	4
Shewhart	3.87	10	9 (=)
Danzig	3.81	11	13 (=)
Orlicky	3.79	12	6
Schonberger	3.68	13	5
Feigenbaum	3.67	14 (=)	–
Shingo	3.67	14 (=)	17 (=)
Chase	3.65	16	17 (=)
Abernathy	3.64	17	17 (=)
Wight	3.52	18 (=)	9 (=)
Whybark	3.52	18 (=)	17 (=)
Babbage	3.43	20	29 (=)
Brown	3.41	21	17 (=)
Crosby	3.38	22	–
Clark	3.27	23	8
Garvin	3.26	24	13 (=)
Hall	3.25	25	13 (=)
Hill	3.24	26	17 (=)
Modigliani	3.23	27	28
Starr	3.21	28	17 (=)
Goldratt	3.20	29 (=)	29 (=)
Mayo	3.20	29 (=)	29 (=)
Hax	3.16	31	17 (=)
Woolsey	3.05	32	29 (=)
Schroeder	3.02	33	17 (=)
Swamidass	2.82	34	–
Martin	2.70	35	–
Wild	2.69	36	17 (=)
Mood	2.57	37	–

Table VIII.
Classic contributor ratings

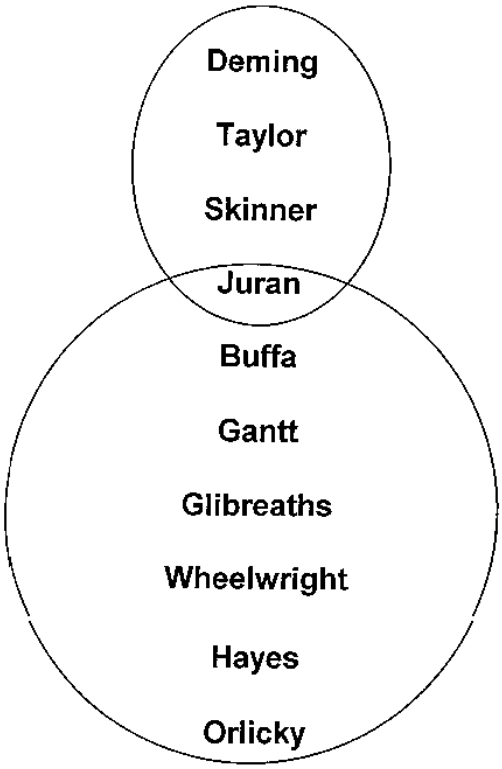

Figure 1.
Fuzzy set of classic contributors

outside, there is for each item a clear bias towards inclusion or non-inclusion within the defined boundaries.

In this "fuzzy set", Juran's rating is not significantly different from Deming's, and Orlicky's rating is not significantly different from Juran's. Therefore, the members of this fuzzy set are proposed as the classic contributors to the field of production and operations management without regard to their particular ranking order.

Discussion

Response rate

The response to the exploratory phase survey was low, probably because of the time and thought required to complete the questionnaire. Two of the three parts of the survey instrument were open-ended. In addition, respondents were asked to evaluate all possible authors in the field, as well as all possible works. For many, this was a daunting task. We did not ask the respondents to write down the first names and titles that popped into their heads. Rather, we asked them to use the eight criteria stipulated and to provide support for their decisions. Responding to this type of survey was time-consuming and, for many, required a fair amount of research.

The phase two instrument was not open-ended and did not require the respondents to justify their answers. As such, the survey could be completed in a much shorter time. In addition, names and articles were included on the survey, thus allowing the respondents to make direct comparisons against the eight criteria. For the phase two survey, we saw an increase in response rate of 200 per cent (41.10 as opposed to 13.7 per cent).

Because part of the phase two sample was taken from the same sampling frame as was the exploratory phase sample (i.e. the members of POMS), it was possible to compare the responses of these two samplings to test for non-response bias. This was possible only for the selection criteria, since an open-ended format was used in the exploratory phase for classic contributors and a list was provided for the second phase. A Chi-square analysis was conducted for each of the eight selection criteria to test whether there was a significant difference in distribution among the four responses between the exploratory phase and the second phase samples taken from the population of POMS' members. As Table IX shows, no significant differences were found at the 0.05 level for any of the eight criteria.

Criterion	Exploratory phase [n]	Second phase [n]	[k]	Chi-square [$p < 0.05$]
Vitality	64	34	4	3.90
Historic significance	64	34	4	1.52
Seminal importance	63	33	4	2.41
Readability of work	63	33	4	7.37
Degree of interest	63	33	4	1.72
Recognition	65	33	4	1.77
Time	64	33	4	1.71
Frequency of quotation	64	34	4	3.05

Table IX.
Chi-square analysis – explanatory vs second phase

Selection criteria

The eight criteria selected for determining a classic in the field appear to be equally applicable in the POM area as they are in the other areas where they have been used. Respondents used all eight criteria when evaluating potential authors and articles for the designation "classic".

While there are some differences between the rankings of the two surveys, one can infer that there is agreement among the respondents that the criteria of vitality, historic significance and seminal importance are the most important, and the criteria of time and frequency of quotation are among the least important. Both samples agreed that the criterion of readability is more important than are recognition, time and frequency of quotation but less so than vitality, historic significance and seminal importance. There was significant disagreement only over the criterion of degree of interest. This may be because

degree of interest tends to be subjective at the personal level whereas the other criteria tend to be subjective at the level of the discipline. Therefore, groups representing other disciplines would be more likely to disagree over the criterion of interest than over the other criteria in the study.

Selection of authors and works

There were noticeable differences in the selection of classic authors and classic works between the respondents. The low frequency of works by Taylor who, as a classic contributor, ranked second in frequency of listing and by Schonberger, who ranked fifth, is unexpected. The absence from this list of works by Shewhart and the Gilbreaths, who tied for ninth place as classic contributors, is also surprising. In fact, few works published prior to 1970 were listed.

Two explanations are possible for the dearth of older works in the responses. First, authors such as Taylor and Frank and Lillian Gilbreath published numerous works in the field. While their general concepts are readily recalled by members of the POM community, specific titles do not stand out. Second, many of their publications are no longer in print. This has resulted in most POM researchers reading *about* Taylor and the Gilbreaths, but not reading their works directly. These points give rise to a concern about a bias towards recent work in the study of POM. They are also indicative of a discipline that has not "put down roots". Neither implication bodes well for the discipline, and both should spur POM academicians to encourage historical reading by their colleagues and students to help define the boundaries of the field.

Recency errors

In addition to the issues discussed above, the rating of Deming and Juran as two of the top four contributors to the POM field is slightly surprising. This also may be an indication of a recency error owing to the prominence of TQM and other quality methodologies in the field at this time. It will be interesting to revisit this survey in three-five years to see if the authors and their works continue to hold their rankings.

Summary

There are a number of books by "classic contributors" in different fields of business. None, however, has been written in the field of production/operations management (POM). In addition, the few readings texts available in the POM area have been put together based on the preferences of the editors. This paper has provided a list of classic authors and works in the field of POM. The listing was developed, not from the preferences of the researchers, but rather on the basis of a survey of those persons most involved in the field.

Two of the ten classic contributors, Deming and Juran, are known for their work in the quality field – a current "hot topic" in POM. Several others, Taylor, Gantt and the Gilbreaths, are from a previous era (roughly pre-1950) when the POM field was emerging. The other five classic contributors, Skinner, Buffa,

Wheelwright, Hayes and Orlicky, are known for their relatively recent work in the areas of operations strategy and productivity.

Issues of omission and inclusion will always be raised when a paper of this type is composed. However, the authors feel that this is not a one-time endeavour, but an ongoing effort aimed at defining the POM discipline. It will be interesting to revisit this survey in the future and examine how the field has developed over time.

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