Employment of Women Chemists in Industrial Laboratories

Abstract. *In 65 chemical and pharmaceutical laboratories women comprised 22 percent of the professional personnel. The majority were in jobs requiring only B.S. degrees and in laboratories emphasizing long-range research. The overall turnover rate for women was much higher than for men, but within the upper grades the rate was only moderately higher, and within the lowest grade was no higher. Laboratory directors reported that turnover differentials did not inhibit the employment of women, provided they could be expected to remain for a certain minimum time.*

The utilization of women in research laboratories entails questions of their selection, tenure, and potential for advancement as compared with those of men. This report is based on a questionnaire survey and follow-up discussion and correspondence with directors of 65 leading chemical and pharmaceutical laboratories on these questions (*1*).

Women comprised 22 percent of the total professional research personnel of the 65 laboratories. Only a few laboratories were near the average, however, and there were marked differences related to the size of the laboratories and the nature of their operations (Table 1). Any classification of the operations of these laboratories is certain to be inexact and overlapping, but they can be roughly divided into two types:

Type-I laboratories are those that are engaged primarily in long-range research. In type I, women averaged 28 percent of professional personnel. Directors of such laboratories reported that women were often better than men for routine tasks requiring very careful attention to detail.

Type-II laboratories are those that are engaged primarily in research and development for immediate market. In these, women comprised only 6 percent of personnel. Directors said they would not, and often could not for legal reasons, use women on jobs involving heavy equipment. Women were not used on research jobs closely related to round-the-clock production processes entailing irregular hours or night work. Women were not used on development work which might entail travel to install or service equipment, materials, or processes sold to customers. Nor did research directors find it practical to assign women to development tasks requiring team effort.

The highest utilization of women was found in the very large type-I laboratories which have many grades of professional work. In these, women averaged 36 percent of the total professional work force. These "research factories" have large numbers of fairly routine jobs involving large-scale screening and testing work performed by beginning professionals and by persons with only B.S. degrees. It was in such jobs that they employed large numbers of women. The director of one large laboratory put the matter this way:

> We don't see many good men with B.S. degrees. High-ability men go on for the M.S. or the Ph.D. If they do come in their stay is short. We get better quality in women at this level and hence prefer them.

In general, the smaller the laboratory, the fewer the specialized jobs and the fewer women employed.

It is often said that the employment of women professionals is inhibited by the "3 M's"—marriage, maternity, and moving—which make for a high rate of turnover. Sixty-five percent of the firms in the survey reported that average turnover rates were higher for women than for men, the others that the rates were roughly the same for women as for men. Here again, overall averages were found to be misleading. If turnover rates are compared within professional levels (Table 2), they tell a different story. At the lowest level, that is, in jobs requiring only B.S. degrees, turnover rates in three-fourths of the firms were about the same for men and women. It seems a safe assumption that the men leave in order to further their careers, whereas the women in leaving usually curtail, or at least interrupt, theirs. At the higher professional levels a larger, but still small, percentage of firms reported higher turnover rates for women than for men. There are relatively few women at the Ph.D. level, and these are in general "career-minded" and tend to stay with companies for many years. If they drop out for family responsibilities, they tend to return. The overall turnover rates for women appears very high when employees at all career levels are lumped together, mainly because women are disproportionately represented at the lowest level, where turnover is highest for both sexes.

Table 1. Women as percentage of total professional personnel by type and size of laboratory.

Laboratories: Primary activity and size*	No.	Women of total professional staff (%)
I. Long-range research	44	28
Large	21	36
Medium	15	26
Small	8	9
II. Research and development for immediate market†	21	6
Large	14	8
Medium	4	4
Small	3	2
I and II	65	22

* Large laboratories are those with more than 100 professional employees; medium, those with 25 to 100; small, those with fewer than 25.
† Three type-II laboratories have major metallurgical divisions.

The directors of many of the biggest laboratories, in which large numbers of women were employed, said differentials in turnover were not sufficiently great to be a deciding factor in employment of women. The key factor is whether at a given level of employment the applicant, either man or woman, will stay long enough to justify hiring and training costs. Ninety percent of the laboratories said that, before hiring for jobs at the B.S. level, they required assurance of at least a 1-year stay; 5 percent set the minimum at 1½ years or more (Table 3). Almost all said that for hiring at the higher levels they did not adhere to any fixed tenure requirements; but a majority said also that they would not be likely to hire a woman M.S. or Ph.D. who might be expected to work less than 2 years. One director said:

Table 2. Comparative turnover of men and women classified by academic degree (in percentage of laboratories).

Women's turnover as compared with men's	Academic degree*: B.S.	M.S.	Ph.D.
Much higher	5	8	10
Slightly higher	20	32	20
About the same	75	60	70

* The classification is based on the degree required for the grade of work performed.

Table 3. Minimum length of service expected of professional personnel with only B.S. degree.

Minimum tenure expected (months)	Laboratories (%)
Less than 9	0
9-11	10
12	70
13-17	15
18 or more	5

It simply comes down to this. If a woman with a higher degree is really career oriented and we think she will spend all or at least most of her time working, we'll hire her; if not we won't.

Another commented:

In general, length of service is less for women at the upper levels than for men but there are many exceptions. We hired some Ph.D. women 15 years ago who are still with us. We hired several real fireball Ph.D. men 2 years ago, and they have already left us.

One of the persistent needs reported by women chemists who have left the labor force for the "3 M's" is for part-time employment (*2*). Almost no part-time job opportunities exist in these 65 laboratories, nor are they likely to become available in the future. About 80 percent of the firms said they never hired women (or men) on a part-time basis. The three reasons they most commonly gave were that (i) space and equipment were limited; (ii) most jobs require continuity and cannot be broken into small parts; (iii) too many tasks require continuous supervision, consultation, or teamwork to make part-time work practicable. Yet there were a few notable exceptions. In one large, well-known firm employing about 50 women with B.S. degrees in chemistry, eight of the women were on part-time assignment, working either three 8-hour days a week or 4 hours a day, 5 days a week. This part-time program, resulting from a special need, had been in operation for 5 years with satisfactory results.

What is the employment outlook in research laboratories for women with training in chemistry? Over three-fourths of the firms said "very favorable." With the smaller firms excluded, the favorable rating was virtually 100 percent. It appears to me that this favorable outlook by laboratory directors rests on two assumptions: (i) the total number of research jobs will expand as rapidly in the next 5 years as in the past 5 years, during which laboratories employed an ever-increasing proportion of the nation's rapidly expanding professional, technical, and scientific force (*3*); (ii) beginning jobs will be increasingly available to women in the large-scale laboratories as men continue to upgrade their training and enter chemistry above the B.S. level (*4*).

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References and Notes

1. The selected laboratories are those that were largest in professional laboratory personnel among the 141 members of the Pharmaceutical Manufacturers' Association as of 9 April 1962. Personnel data from *Industrial Laboratories of the United States* (National Research Council, Washington, D.C., ed. 12, 1960).
2. J. B. Parrish, *J. Chem. Educ.* **41**, 506 (1964).
3. ———, *Res. Develop.* **15**, 32 (1964).
4. Three indicative studies may be cited. A report on 1163 women who received B.S. degrees in chemistry in 1934–39 revealed only 2 percent employed in industrial research [E. L. French, *J. Chem. Educ.* **16**, 576 (1939)]. My forthcoming study of women with B.S. degrees in chemistry from a number of large Midwestern universities in 1958–63 will report 28 percent employed in industrial research laboratories. The U.S. Department of Labor, in "Manpower Resources in Chemistry and Chemical Engineering," *U.S. Dept. Labor Bull. No. 1132* (1953), p. 17, reported that 70 percent of all employed women chemists 40 years of age or over had at least the M.S. degree, and that only 25 percent of those under 40 had at least the M.S. degree.

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Reinforcement Schedule Generated by an On-line Digital Computer

Abstract. *A LINC digital computer was used to generate an autoregressive schedule of reinforcement. On such a schedule the probability of reinforcement is a function of the similarity in duration of the intervals between successive responses. A detailed analysis of the data obtained from monkeys on this schedule demonstrated two distinct tendencies in their behavior: a tendency for periodic response and a tendency for serial dependence between successive interresponse times.*

We now know a great deal about how to shape and maintain operant behavior by the process of differential reinforcement. The most elegant and searching manifestations of this process have been provided by experiments on schedules of reinforcement (*1*). The reason is that reinforcement schedules permit one to make an extremely significant transformation; they make it possible to convert complex patterns of stimuli and responses into serial and temporal ones, much as the nervous system is thought to transform information into temporally coded patterns (*2*).

Digital computers add new dimensions to the study of reinforcement schedules. They enable us to fabricate schedules that are impossible to program by conventional methods and then facilitate detailed observations of the fine structure of behavior.

An example that reveals the potential of computers is the problem of differentially reinforcing low variability in response rate. Although with conventional equipment we can devise schedules which produce low variability—for example, "Differential reinforcement of low rate with limited hold" (*1*)—the low variability is only a by-product of the contingencies. In this report we describe a computer-generated schedule which controls variability directly, and we demonstrate how a detailed analysis of the data reveals the multiple effects of the schedule. Both the programming and the analysis were performed by a small, high-speed LINC computer (*3*).

Our "autoregressive reinforcement schedule" is a stochastic schedule that takes its name from a category of time series in which successive observations depend on a function of the previous term or terms plus a random additive error (*4*). It differentially reinforces low variability in response rate by promoting consistency in the intervals between responses, or the interresponse times. It specifies that the probability of reinforcement of the response that terminates an interresponse time I_i, depends on the similarity of I_i and the previous interresponse time, I_{i-1}. The closer the similarity, the greater the probability of reinforcement. The organism's own behavior then becomes the basis of the response-reinforcement correlation.

To determine whether the conditions for reinforcement are met, the program first computes the quotient of the two successive interresponse times, always placing the larger value in the numerator. The quotient corresponds to a number, equivalent to a certain p-value, in a table stored in the computer memory. A random number is then generated and compared with the table entry. If the table entry is greater, reinforcement is programmed. The function relating probability of reinforcement to the quotient appears in Fig. 1. Probability ranges from 0 to 1.0 on the ordinate and the quotient ranges from 1.0 to 1.4 on the abscissa. If $I_i = I_{i-1}$, $p = 1.0$. If the quotient exceeds 1.4, $p = 0$. A quotient of approximately 1.05 is equivalent to $p = 0.5$.

Three female monkeys, one *Macaca speciosa* and two *M. nemestrina*, were placed in primate restraining chairs and subjected to the schedule. A response was defined as depression of a lever far enough to actuate a microswitch. A fruit drink (0.1 ml) was used as reinforcement. Each experimental session lasted 90 minutes. During preliminary training sessions, each press