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EDUCATION & TRAINING OF PROFESSIONAL INDUSTRIAL HYGIENISTS FOR 2020

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Introduction

I greatly appreciate the honor of speaking to so distinguished an audience, members of which provide a unique leadership in techniques for creating safe and healthy working environments world-wide. The opinions I shall express here are based on experience in many projects and many countries and, hence, are of a generalized nature. They are not intended to be critical of practices in the United States which has led the world community for so long in the field of industrial hygiene. Nevertheless, I would advise that it is time to review today's organization of education as other countries are moving ahead in implementing professional education for those who will practice in 2020. In particular, I identify the urgent need for curriculum review and development to meet the changing demands on an industrial hygienist's basic knowledge and practical skills.

This presentation is based on a paper[1] presented at the 1991 AIH Conference, but I will start with four questions:

1. Are we giving sufficient attention to the professional education of industrial hygienists?

2. Are we achieving an adequate measure of control of hazards at the workplace?

3. What is our record of success in this field?

4. Do we have clear objectives, both as a profession and as individuals?

I will discuss some aspects of these but will not attempt to provide answers, hoping thereby to stimulate discussion and to conceal the fact that I do not know the answers myself. I will, however, follow this discussion with a review of the overall need for training in industrial hygiene, and will conclude with some comments about needed changes in the education of future professional industrial hygienists.

A dilemma we currently face is whether we are going to be specialists working on specific aspects of industrial hygiene or general practitioners in industrial hygiene. Is the day of the general practitioner over? I personally do not believe that we should follow the continuing trend towards even greater specialization among our cousins in the medical profession; rather, we should maintain and strengthen our general practitioner status. While there must obviously be specialists for specialist industries or processes, I am convinced that every working industrial hygienist should adopt some "hobby" interest to address and develop in depth while maintaining general practice over a wide range of our field.

To make an analogy, in vision there is a central focus where one sees an object in great detail. This represents the central object of our research interest -- the harder we look, the more we perceive. But all around this central area of developed attention there is a much larger area of peripheral vision where we do not see detail, but where we do detect movement to which we can then direct our attention and examine in detail. In the same way a practicing hygienist has to be aware of movements in the whole broad field of industrial hygiene while maintaining and developing his/her specialized knowledge in a relevant subject appropriate to that particular time and place.

One other matter we should consider before turning to the four questions is the difference between education and training. The former we consider to be academic and philosophical; a system often unresponsive to the immediate demands and which may indeed have a quite unique inertia (some 1,000 years elapsed after the Romans left Britain before Latin was dropped from the mainstream curriculum of British schools). Finally, outside of business schools, education is generally not a money spinner. Training, on the other hand, is generally considered to be vocational (hands-on). It is much more responsive to need and is often profitable -- particularly where mass production methods can be applied.

Development of training may follow the following pattern. First, a need arises and is recognized. If this is sufficiently serious, legislation may be enacted and sometimes a requirement for the licensing of practitioners is introduced. This clearly identifies a need for people with appropriate skills. The opportunity for a career as a licensed practitioner becomes recognized, and individuals see the advantage of investing resources (time and capital) in being trained. A short-term training program can then lead to almost immediate gain by working in the field defined by the legislation. A prime example of this is seen in the licensing for asbestos removal and remediation which has led to the introduction of many training programs to meet the need for appropriately qualified persons. In the case of education, however, the student looks for benefits not next year, but in 10, 20, or even 30 years ahead. The education system is much slower in responding to changing demands of the marketplace, and to be successful must predict the qualifications needed for work many years ahead (if only to benefit from donations from prosperous alumni).

Education is essentially proactive; training is reactive. The following redefinition distinguishes the two methods of gaining knowledge and skill:

> *The principal objective of training is to meet the needs of the marketplace; that of education should be to shape the marketplace.*

Both education and training are, of course, required for the career development of the practicing industrial hygienist.

Q.1. Are we giving sufficient attention to the basic professional education of industrial hygienists?

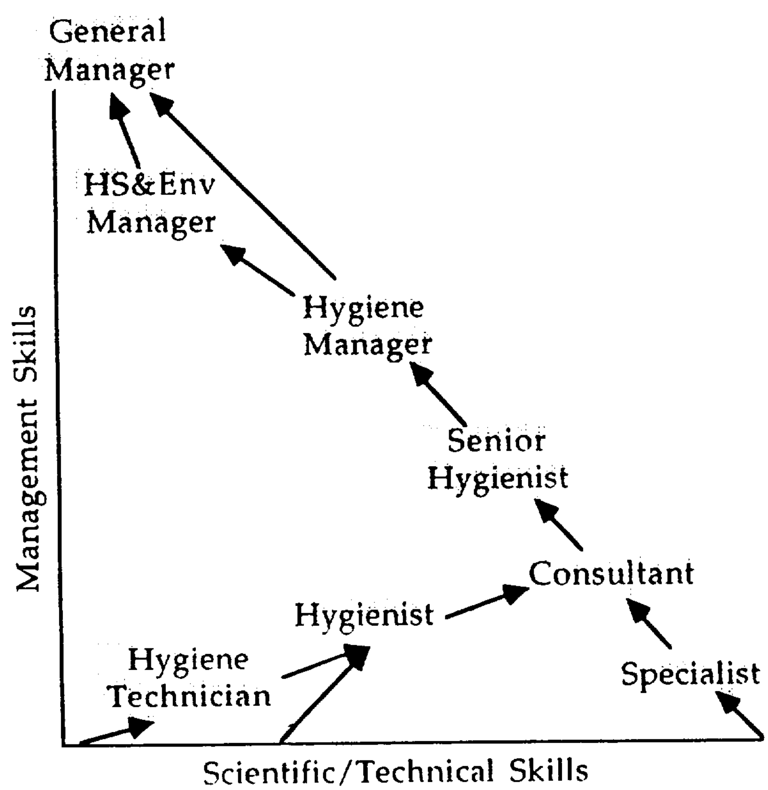
I have searched both the *AIHA Journal* and *Applied Environmental and Occupational Hygiene* and have found few papers on education in recent issues. There is an important paper by Terry Tredell[2] relating to education in the practice of industrial hygiene, but it largely concerns the role of mentors in the process. While many excellent professional development courses are presented at the Annual Conferences, papers on education itself appear to be restricted to the subject of AIDS and workers' training programs. It may be noted that my paper at the 1991 Conference was presented in the session entitled, "General Practice III - Regulatory Issues." Should education be regarded as a regulatory issue? I believe that regulation only becomes necessary where education has failed. Alternatively, how many papers on industrial hygiene needs have been published in education journals? I can claim just one.[3]

Outside of the United States the subject was reviewed in depth at an international meeting in Luxembourg in 1986 (published in 1988)[4] which was followed by a meeting in Geneva in 1989 with the title of "Approaches to Occupational Hygiene Training." An important follow-up meeting was again held in Geneva in 1991 with the title "The

Occupational Hygienist in Europe," but, in fact, it extended far beyond that region. At present in draft form, the report quotes eight functions from the previous meeting based on ILO Convention 161,[5] article 5, and lists four areas of required knowledge: supportive (background disciplines); related (toxicology, physiology, etc.); occupational hygiene (core subjects); specialization in depth (industrial ventilation, radiation protection, noise control, etc.). It is an important contribution to progress as it lists the necessary curriculum in considerable detail.

Another recent overseas article[6] that has some relevance to the U.S. scene was the report of the Joint Education and Training Committee of the British Occupational Hygiene Society and the British Institute of Occupational Hygienists. Exhibit 1 is taken from that paper:

Exhibit 1. A Model of the Occupational Hygiene Profession



At the top of the triangle is the General Manager who must have some knowledge of health, safety, and environmental matters to apply his management skills successfully. The Industrial Hygiene Manager and the Health, Safety, and Environment Manager must both have management skills, but are primarily the custodians of the scientific and technological knowledge on which the organization depends. The Senior Hygienist may function with little management responsibility, but must have proactive skills in investigation and control of health hazards and carries some responsibility for decision making. That person may be responsible for directing the work of hygienists and hygiene technicians. The consultant brings specialist skills but generally has less responsibility for decisions and usually has none for implementation. The specialist is a person who has specific knowledge related to either processes or hazards, but who does not necessarily have the broad understanding needed for decisions of an executive nature.

This model provides a basis for identifying the education and training needs of both management and specialists in our field. In the past we have concentrated heavily on the scientific and technical role of the industrial hygienist, with inadequate consideration of the management skills also required in the senior positions.

Education needs can also be deduced from the recent publication, *Industrial Hygiene Work Force Characteristics: Employment, Education and Practice*.[7] Some of the key points of the 24-page report indicative of the present educational base of the profession are presented in Exhibit 2. The report itself should be consulted for full details, though some mysteries remain: How is training distinguished from education in #7? Perhaps training is what industrial hygienists give to others and education is what they receive themselves? If so, only 3.4 percent of their time is spent in education -- this represents only seven days per year. Is that enough? Those in general practice reported that 37 percent of their time was allotted to management issues, 30 percent to investigation, 10 percent to training, and 8 percent to laboratory/research activities.

Eighty-three percent were full-time, salaried workers, and 5 percent were full-time consultants. Sixty-three percent have doctoral or masters degrees. Fifty-one percent of certified industrial hygienists work in industry, 38 percent in consulting, and 29 percent in education. Educators appear to include the lowest proportion of CIH's. It is interesting to note that the average size of industrial hygiene staff is 10 in government service, 6 in consulting services, and 4 or less in employment classified as "elsewhere." Remarkably, 33 percent of industrial hygienists report that they work in organizations with less than 500 employees. Ten percent report to the Vice-President of the organization, and 18 percent to the Industrial Hygiene Supervisor.

Exhibit 2. Notes from *Industrial Hygiene Work Force Characteristics: Employment, Education and Practice* (Bureau of Health Professions, US DHHS July 1992)

This 24-page report contains a detailed analysis of responses to 28 questions and should be consulted for more complete details. The following notes identify points most indicative of the present educational base of the industrial hygiene profession.

1. 48% responded to the questionnaire which was sent to 7,000 members of AIHA in 1988.
2. 83% reported full-time salaried employment; 5% were full-time self-employed consultants.
3. 63% possessed masters or doctoral degrees.
4. 51% of those in industry were certified; 38% of those in consultancy; 29% of those in education.
5. Average salary of those qualified at B.S. level was $38K; at M.S. level $47K; at Ph.D. level $57K. (Note: Those with M.S. or Ph.D. in other disciplines averaged $5K more than above.)
6. 46% reported their work as general practice.
7. 37% of prime time was allocated to management; 30% to field investigation; 10% to training; 8% to laboratory/research activities; 3.4% to education.
8. 22% were employed in government agencies (average size of IH staff 10);
17% were employed in consultancy services (average size of staff 6);
7.1% were employed in education; 3.8% in laboratory/research; 38% in all identified industries, of which chemical and pharmaceutical led with 12% (average size staff of 4 or less).
9. 33% were in organizations employing <500 people; 69% in those employing <5,000; 96% in those employing <50,000.
10. 18% reported to industrial hygiene supervisor; 10% to vice president; <10% to other identified individuals.
11. 10% reported to personnel department; 9% to medical; 9% to environmental; 8% to safety; 8% to engineering/facility.

The financial incentive for education may be shown by average salaries of $38,000 for people with B.S. degrees, $47,000 for those with M.S. degrees, and $57,000 for those with doctorates, but this may be confounded by differing age distributions. Noteworthy is the fact that those who gained higher degrees in subjects other than industrial hygiene earned $5,000 more than their peers. Does this suggest that we have some way to go to gain general recognition of industrial hygiene degrees?

At the 1992 Professional Conference, Constantin and Pennington[8] of DOE presented some first estimates of industrial hygiene education needs, and indicated that a more extensive study might be made in the future.

The conclusion must be that renewed effort is needed in the U.S. to identify present educational needs and to systematize systems for meeting future needs. Such a study as suggested by DOE would be of particularly great value to educators who should plan their programs some years in advance of their application.

Q.2. Are we achieving an adequate measure of control of hazards at the workplace?

A more specific question for the educator is, "Are we featuring control adequately in our curricula?" My experience of work in many countries, including the United States, indicates that we are not -- at least uniformly. There are certainly numerous large organizations in many countries with effective control programs, but many smaller operations fail. Even in the large units, quantitative evaluation may take an undue proportion of budget and control may be skimped. The present definition of an industrial hygienist reads:

> *An industrial hygienist is a person having a college or university degree or degrees, in engineering, chemistry, physics, medicine, or related physical and biological sciences who, by virtue of special studies and training, has acquired competence in industrial hygiene. Such special studies and training must have been sufficient in all of the above cognate sciences to provide the abilities:*
>
> *(1) to recognize adverse environmental factors and to understand their effect on people and their well-being*
>
> *(2) to evaluate, on the basis of experience and with the aid of quantitative measurement techniques, the magnitude of these stresses in terms of ability to impair people's health and well-being*
>
> *(3) to prescribe methods to eliminate, control, or reduce such stresses when necessary to alleviate their effects.*

Why does the industrial hygienist have responsibility only to "prescribe" methods to eliminate, control or reduce...? As a profession we are very active in recognition and evaluation, but often fall back on "more measurements are needed" when control is overdue. I would personally like to see a future definition of industrial hygiene read:

> *"The control of those factors in processes, environment, or work practices that may affect the health or well-being of people, or damage their environment."*

Reevaluation is required on the use and interpretation of animal experiments in occupational toxicology, and in the value of epidemiological studies of effects of exposure in small groups of workers. We can never determine the risks at the 10^{-6} level in processes where only 10 workers are employed; are we willing to accept that much higher risks will go undetected in small-scale operations? Perhaps a better economic and health return may be found in introducing control measures wherever reasonable doubt exists.

Q.3. What is our record of success in this field?

To set our record in context, I would refer you to the writing of E.S. Turner,[9] "The Road to Ruin. Shocking History of Social Reform," in which he shows clearly that some 100 years usually elapse between the first recognition of a problem and the time when society finally takes some action to control it. Even in that context, our performance cannot be considered outstanding, as illustrated below:

Lead

Year	
370 B.C.	Plumbism described by Hippocrates
50 A.D.	Pliny describes use of respirators for protection
1921 A.D.	ILO White Lead Convention (banned the use of white lead in paint)
1984 A.D.	OSHA Lead Standard (29 CFR 1910.1028)
1991 A.D.	$1 billion plan to reduce lead poisoning.

Neither Britain nor the United States ratified the ILO convention.[10] Today, the United States has the massive task of deleading its houses, while Britain faces a similar task to delead its drinking water system.

Asbestos

Year	
1900 A.D.	First asbestosis case was observed
1955 A.D.	First report of lung cancer risk
1986 A.D.	OSHA Asbestos Standard issued (29 CFR 1910.1101)
1991 A.D.	Asbestos trial in Baltimore set a precedent with 9,032 claims
1991 A.D.	Asbestos abatement in full swing.

The Hoover translation[11] of the work of Agricola (1556) suggests that lung cancer was recognized in asbestos mines as long ago as the 16th century -- though most miners did not live long enough to develop the disease.

Cotton

Year	
1854 A.D.	Novelist Elizabeth Gaskell describes death from byssinosis, and also exhaust ventilation for carding machines
1863 A.D.	First medical description of byssinosis
1930 A.D.	Incidence of byssinosis determined
1986 A.D.	OSHA Cotton Dust Standard (26 CFR 1910.1043).

Elizabeth Gaskell's novel[12] provides a vivid description of byssinosis symptoms and death. She also describes how employers would not install ventilation equipment because of cost, and that workers disliked it because it increased their appetites as they no longer chewed cotton dust. Appetites they could not afford.

Benzene

Year	
1897 A.D.	Santesson reports 4 fatal cases of aplastic anemia
1910 A.D.	Selling reports chronic occupational benzene cases in U.S.A. (leucopenia)
1913 A.D.	Koranyi's study stops treatment of leukemia with benzene
1931 A.D.	Alice Hamilton refers to lymphatic and myeloid leukemia
1938 A.D.	Renati & Vigliani report 10 cases of occupational leukemia
1946 to 1990 A.D.	TLV reduced progressively from 100 ppm to proposed 0.1 ppm (ACGIH)
1918 A.D.	Legge (UK) introduced xylene as safe replacement
1928 A.D.	U.S. substitutes toluene as solvent and rubber latex as cement.

Q.4. Do we have clear objectives, both as a profession and as individuals?

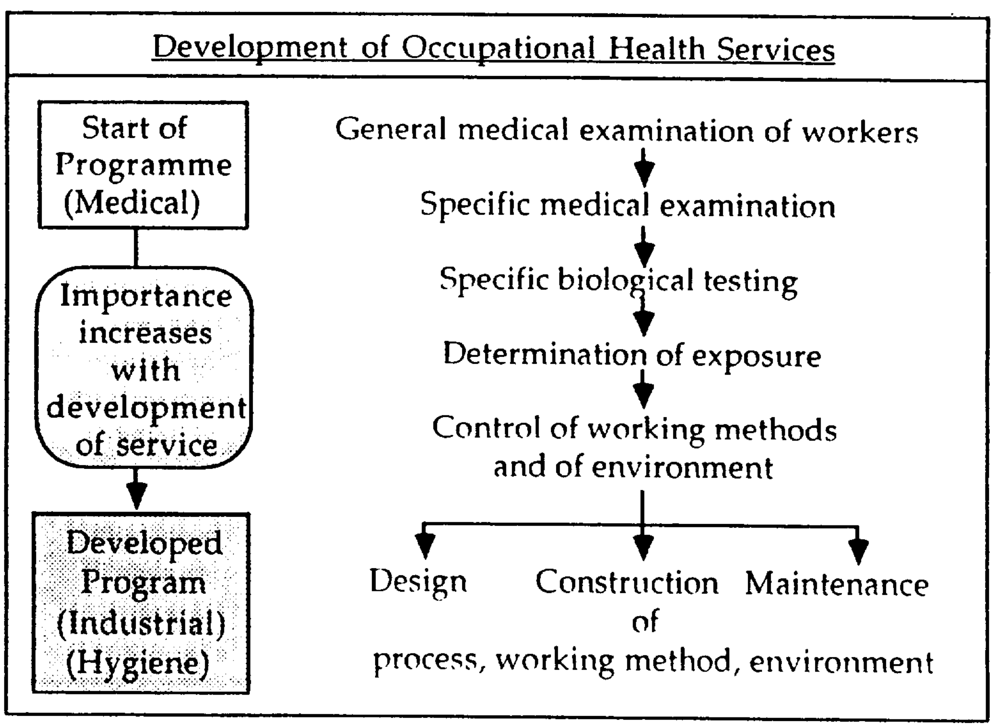
Mark Mikatavage[13] has proposed that the objectives should be to:

1. Reduce occupational skin disorders to 55/100,000 workers (that is, by 15%).
2. Reduce to 15% proportion of workers averaging > 85 dBA noise exposure.
3. Eliminate blood lead levels above 25 µg/dL.
4. Establish exposure standards in 50 states to prevent occupational lung diseases.
5. Reduce cumulative trauma disorder to < 60/100,000 (that is, by 40%).
6. Reduce hepatitis B infections to < 1250 (that is, by 500%).

Such objectives are beyond the reach of individual industrial hygienists and of the profession as a whole, although support should be given to those who have the power to introduce the system needed. (This is unlikely to be feasible outside a totalitarian country where the need is unlikely to be recognized.)

Industrial hygiene forms an integral part of occupational health, so it is appropriate to consider the normal pattern of development of the latter in any country. A generic structure is shown in Exhibit 3:

Exhibit 3



This could be a typical developmental process within a company or a country, and to provide the necessary skills a matching program to develop education and training is outlined in Exhibit 4:

Exhibit 4

Development of Program →			
Principal Activities			
Examination of workers	Examination of working methods and environment	Enactment and enforcement of legislation Social awareness	Design specification and standards setting
Principal Training Needs			
Occupational health physicians and nurses	Industrial hygienists and safety specialists Inspectors	Managers, workers and administrators Other health professionals	Design and service engineers

We then see a progress from (1) educating physicians and nurses needed at the primary stage of development, to (2) educating industrial hygienists, safety practitioners and inspectors needed to ensure better control of working practices and conditions, to (3) educating managers, workers, and administrators to meet their responsibilities and, finally, to (4) engineers required to design-out hazards, prepare specifications to ensure safe and healthy working methods and equipment, and to ensure that these conditions are maintained.

Overall, we need to look at the general training needs in health and safety with particular respect to industrial hygiene. An outline is presented as Exhibit 5.

Exhibit 5. Education and Training in Occupational Hygiene

Group - 1a Administrators with direct responsibility	
Introductory	2 week general course
Consolidation	1 year organization, technical, project
Continuing Education	seminars & short courses
Group - 1b Administrators without direct responsibility	
Introductory	2 week general course only
Group - 2a Employers' Associations - employers	
Weekend familiarizations	
Group - 2b Employers' Associations - specialists	
Introductory	2 week general course
Consolidation	1 year organization, technical, project
Continuing Education	seminars & short courses
Group - 3a Workers' Associations - specialists	
Introductory	2 week general course
Consolidation	centered on specific problems
Continuing Education	1-day course on specific topics
Group - 3b Workers' Associations - representatives	
1 week course + project	
Group - 4 Research & Trade Associations - specialists	
Introductory	2 week general course
Consolidation	supervised fieldwork
Continuing Education	as needed by developments
Group - 5 Line managers	
Introductory	2 day general course
Consolidation	1 week law & practice
Continuing Education	2/3 days every 3 years
Group - 6 Supervisors	
Introductory	2 day course
Consolidation	2 weeks practice & project
Continuing education	regular on-the-job briefing
Group - 7 Workers	
Introductory	during vocational training + job briefing
Consolidation	2 days job-related practice
Continuing education	whenever process or job changes
Group - 8 Professional occupational hygienists	
Introductory	6 month field familiarization
Consolidation	2 year MS (+ practice)
Continuing Education	revalidate every 5 years

Exhibit 5 (continued)

Group - 9 Occupational hygiene technicians	
Introductory Consolidation Continuing education	6 month field familiarization 3 months theory & practice 1 week development course every 2 years
Group - 10 Other health & safety professionals	
Introductory Consolidation Continuing Education	2 week general course to standards required by profession recent trends & at job change
Group - 11 Administrative & technical support staff	
Introductory Consolidation Continuing education	1 week general course appropriate to needs recent trends & at job change
Group - 12 Inspectoral	
Introductory Consolidation Continuing Education	1 month legal & general to professional standards or 1 year in first 5 years 1 month every 3 years
Group - 13 Educational	
Introductory Consolidation Continuing education	2 week general course training of trainers course after practical experience 2 weeks every 3 years or sabbatical in industry
Group - 14 Health & Safety related professional staff	
Introductory Consolidation Continuing Education	in professional education 2 week general course + specialized courses recent trends
Group - 15 Political & media	
Introductory Consolidation Continuing education	national: 1 hour per year local: 1 hour twice per year national occupational health and safety day or week short courses/seminars/ briefings on current topics

Educational Needs of the Profession

Review of recent events in Britain and the European community highlights the essential need to gain public recognition of industrial hygiene as a professional field. In Britain, new legislation on the control of substances hazardous to health, rushed through to meet a deadline for a European Directive, provided an opportunity to introduce professional standards into legislation. We were not able to participate as there was no place for representation of a profession in the tripartite (government, employers, and unions) process of legislative drafting. However, although only a few in number, we gained some unofficial recognition, and now participate in discussions on how to introduce professional standards into compliance procedures.

A further opportunity to gain recognition was presented in the program for official recognition of core professions which may practice, without restriction, throughout the member states of the European community. In view of the very small numbers of professional industrial hygienists, this was not attempted. However, membership of one of the major professional institutions (medical, scientific, or engineering) offers this privilege.

On the drafting of relevant European Directives themselves, the profession has had little input. Texts were first prepared in offices of the Commission with little consultancy, and then reviewed by national delegations with little industrial hygiene representation. Discussion documents appeared with little time for comment and often provided outdated texts which were largely concerned with details of requirements rather than the principal structures themselves. (Some Directives were adopted even before the deadlines for submitting comments.)

Although this experience is not directly appropriate to the United States, similar key professional matters arise here. For example, will a CIH be permitted to practice industrial hygiene throughout the United States? If so, who else will? How do, or will, state licensing requirements (at present limited to asbestos and lead) impact the work of the professional?

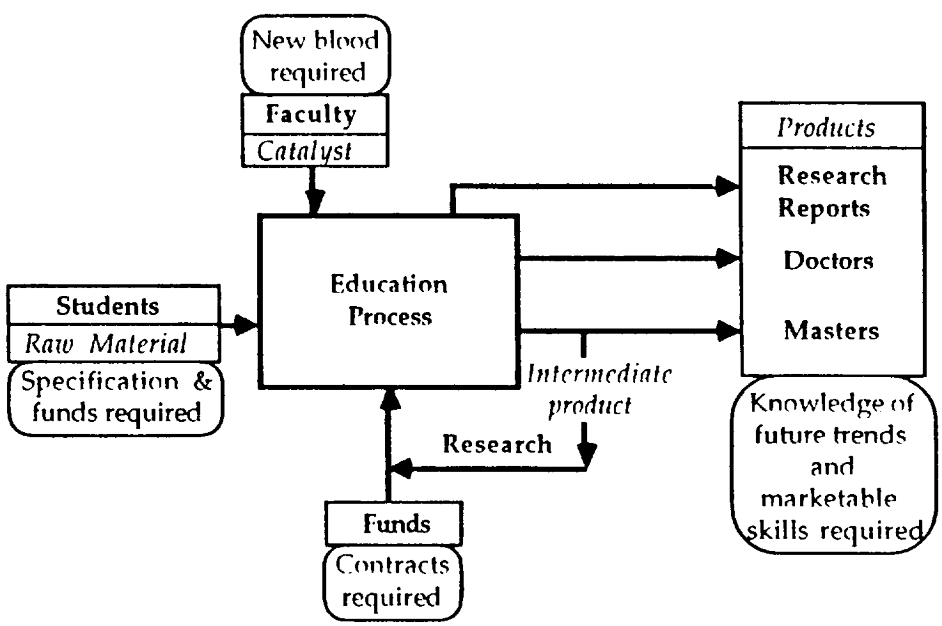
In the context of my subject, it is useful to consider professional education, per se, and I draw on the writing of Edgar Schein[14] who identifies three basic components of a professional education:

1. An underlying discipline or basic science component upon which the practice rests or from which it is developed.
2. An applied science or "engineering" component from which many of the day-to-day diagnostic procedures and problems-solutions are derived.
3. A skills and attitudinal component that concerns the actual performance of services to the client, using the underlying basic and applied knowledge.

The term "client" is here taken to include the employer where appropriate. It provides a reminder that the professional's first responsibility is to his/her profession -- even when he/she is the employee of some other person or organization. While Schein considers that these divisions constitute a hierarchy of application, justification, and status, they are also a useful tool to analyze essential components of education for the professional, and have been discussed elsewhere.[1]

Education is essentially a production process, and can be illustrated by analogy with a chemical engineering process (Exhibit 6).

Exhibit 6. Education Production Flow Chart

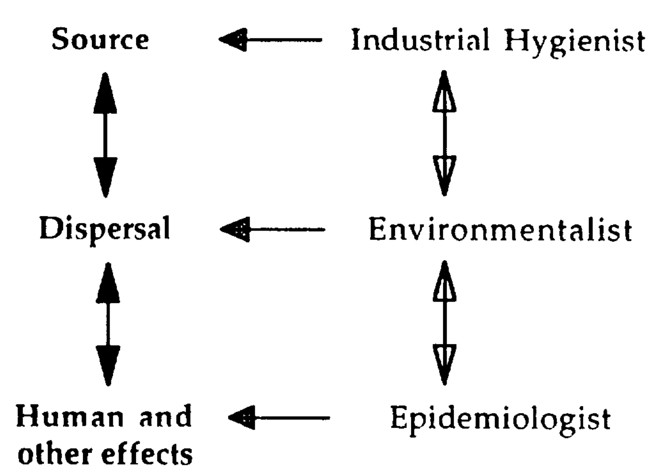


In recent years our profession has attracted students with principal interest in analysis, and the education they have received has enhanced their ability. In line with the flow chart shown in Exhibit 6 we should now be looking for students with a principal interest in synthesis to build on the profession's analytical knowledge. For this reason we should make careers in industrial hygiene attractive to those with engineering interests, and our courses should enable them to develop their abilities to synthesize systems of control. Although some now enter our profession with baccalaureates in industrial hygiene, I believe it preferable that the first degree should be in some traditional, rigorous subject -- preferably with technology/engineering as its core.

Our catalyst, the faculty, also needs consideration. Career attractiveness of teaching needs upgrading. Far too much time is spent by academics on writing research fund applications, and successful careers are too dependent on the weight of paper published. This does not make for committed responsibility to teaching or encourage good teaching practice. And why are only 19 percent of academic industrial hygienists certified professionals? These are rhetorical questions that need consideration and answers if our human products are to be of the quality required by the world marketplace.

I see the future position of the industrial hygienist with respect to fellow professionals as illustrated in Exhibit 7:

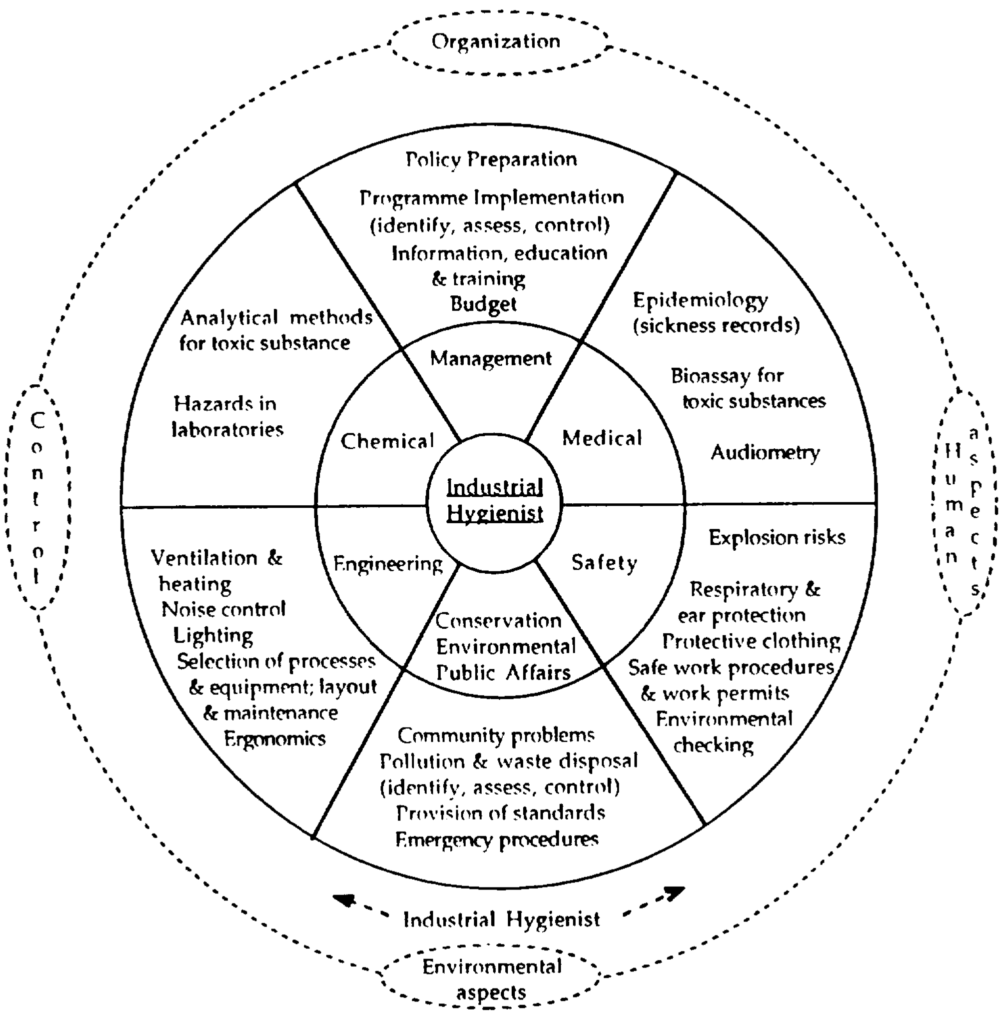
Exhibit 7. Future Relations With Fellow Professionals



This emphasizes the role of the industrial hygienist as the leader in course control rather than in "end-of-pipe" technology. He/she should be particularly skilled in such fields as toxic use reduction and specification of emission standards. This is already recognized in the field of noise where specification of noise levels for equipment purchase is routine, but needs urgently to be applied to permissible levels for release of air contaminants from equipment (e.g., grinders) or processes (e.g., welding). These would be comparable with specification of sound power level from mechanical equipment.

I believe the profession has been remiss in concentrating on the development of scientific skills at the cost of skills in human relations. Many students embark on their careers in industrial hygiene with no clear understanding of the organization of work or ability to communicate their knowledge to decision makers. The extent of the need to communicate is apparent from Exhibit 8, which puts the industrial hygienist at the center of the universe:

Exhibit 8. Industrial Hygienist's Contacts



The industrial hygienist must be able to communicate with, and persuade when necessary, all of these members of the organization in the languages of their own professions and specialties.

Curriculum

An outline of subject content needed for professional work is shown in Exhibit 9:

Exhibit 9

Academic Subjects

Applied physiology
Epidemiology
Occupational toxicology
Statistical methods

Central to Occupational Hygiene

Identification
- information sources
- recognition practice

Evaluation
- sampling & analysis
- biological indices

Interpretation
- assessment
- hazard & risk

Control
- process
- environment
- work practice

Hazardous Agents	
Chemical	Explosion Fire Toxicity Corrosivity Reactivity
Physical	Noise & vibration Radiation - ionizing - non-ionizing EMF/ELF Thermal - stress - comfort Lighting
Micro-biological	Bacteria Fungi Viruses Protozoa & their products

Field visits - field studies - laboratory studies
Modelling - process/environmental/biological
Information - data search, processing, recording, reporting

Administrative Subjects

Communication
Education & training
Environmental issues
Ergonomics & safety
Legal aspects
Management Practices
Principles of public health
Regulatory aspects

The extent of the education curriculum illustrated in Exhibit 9 indicates the problem of identifying the necessary depth of study in each facet, and matching this to the ability of the educational system to provide for this in two academic years at the masters level. It is evident that the profession should define the minimum knowledge required in essential core subjects and identify those facets that can be considered appropriate to specialized education and training. Acquisition of a masters degree in industrial hygiene cannot be considered the end of education. There should be a formal requirement for a period of apprenticeship or internship undertaken under the direct supervision of an academician.

At the Harvard School of Public Health, the new 20-credit intern course taken in the second year of the master's course is proving popular with students and judged beneficial by the faculty. For students, this should be only a start towards gaining competency in general practice, or experience needed to go forward to doctoral studies.

Continuing education is already recognized as a necessary requirement for sustaining professional qualification, and its increasing importance is indicated by the steady growth in number and quality of the professional development courses offered at annual conferences. Beyond the basic education required at the master's degree level for general practice of industrial hygiene, attention should be given to requirements for more advanced education to the doctoral level. To encourage discussion, some ideas on current research needs, which must form a platform for doctoral studies, are shown in Exhibit 10:

Exhibit 10. Immediate Research Needs on Hazardous Substances

Stage	Needed Research	To Study
Human	Pharmacokinetic modelling	Exposure to organ dose and BEI
Environment	Releases from sources	Release to exposure
Process	Toxics use reduction	Design to minimize presence of hazardous substances
Plant	Engineering design	Quantification of leakage Design to minimize release to environment

In the future, I believe the three development tracks summarized in Exhibit 11 will be recognized:

Exhibit 11. Three Development Tracks Beyond the Master's Degree

Development Track	Example of Further Training or Education
Management	MBA
Subject specialist	3 month to 1 year courses after Master's Degree
Research and advanced teaching	Doctoral studies

In conclusion, attention should be given to distinguishing between that fundamental knowledge which will be applied throughout a person's career and transient material representing "flavor of the month." Both are required; the first principally in education and the second principally in training. The dilemma facing the educator is to identify which apparent transient will become a permanent feature of professional activity in the medium and long term. A close watch must be kept on reviews of current practice and on predictions of future trends.[15,16] Development of techniques to maintain current awareness is an essential need for practitioners, and the current rapid development of information science is creating obsolescence in academic communities. The profession as a whole should be considering how it can best support educational organizations in teaching students cutting-edge information technology, even by such simple steps as putting journal contents on CD ROM and creating an electronic and updated version of the AIHA Guide to Technical Information Sources.[17] Today, what matters is not what you know nor who you know, but where you can find needed information quickly.

A final question that may help concentrate our thoughts on education for the future is, "How would Socrates have coped with multi-choice questions?" Or would he have been their author?

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