

N72-25971

**SYSTEM SAFETY EDUCATION FOCUSED  
ON  
INDUSTRIAL ENGINEERING**

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**Presented at the  
NASA Government-Industry  
System Safety Conference**

**May 26-28, 1971**

No field of engineering enjoys closer relationship to public and political concern today than safety engineering; and probably no other engineering field is so ill prepared to exploit this relationship. Why? Because the demands on the safety engineer today require thorough understanding of systems analysis and systems engineering principles, human factors, and the safety implications of hardware design. Unfortunately, most safety engineers developed from other specialties and are primarily experienced in industrial safety. The rapidly expanding technology of today's world requires solution of potential safety hazards by recognizing the hazards and appropriately influencing the design of hardware to eliminate or reduce them.

Nowhere has the short supply of safety engineers, with the necessary background, been more sharply felt than in the Army Materiel Command. The primary mission of this command is the research and development, procurement, and supply of Army military hardware. The bulk of the system safety responsibility for this hardware rests with the Army Materiel Command Safety Office and similar offices at the subcommands (called commodity commands because of their commodity orientation). This safety organization has, until recently, been primarily concerned with industrial safety at production activities within the Army Materiel Command (AMC). There is increasing recognition by both the general public and development personnel that most accidents resulting in property damage, injury, and loss of life are caused by and/or compounded by hardware not designed for the human environment. The natural outcome of the recognition has been to place greater responsibility for hardware design on the AMC safety organization.

Having been staffed primarily by non-engineering safety personnel during World War II, AMC faced a critical shortage of the necessary skills. A large portion of its existing safety staff will be retiring in the next five years. AMC and especially Mr. Landon Feazell, the present Chief of the AMC Safety Office, recognized the impending safety personnel shortage and made provisions to improve the outlook.

Basically, the AMC requires the input of 20 to 30 engineers per year with thorough

knowledge of system safety and its related principles - personnel who can both influence design and revitalize the safety workforce, moving it into its proper realm of responsibility. To accomplish this would require hiring younger engineers with good safety engineering background or training. Unfortunately, this kind of engineer is difficult to find and even more difficult to hire. The best alternative was for AMC to train their own personnel and a training program was established to accomplish the following objectives.

1. Recruit into the AMC workforce young, qualified engineers with demonstrated capability.

2. Educate these engineers in the field of safety engineering. Also, educate them in the specifics of Army peculiar safety hazards incumbent with the development and handling of explosives, nuclear weapons, and the chemical/biological agents.

Since a good background in hardware design is essential to the functions of system safety, engineers with specialization in Mechanical, Electrical, Civil, Aeronautical, or Chemical engineering are desired. To obtain the very best engineering graduates AMC in conjunction with Texas A&M University, established a graduate level training program giving the student the opportunity to obtain a Master of Engineering Degree. To provide the necessary theoretical background, as well as the practical background, in hazardous materials requires two years of classroom study. The engineers upon graduation are placed in safety positions at all AMC activities. Since they are trained by the AMC Intern Training Center, the graduates have broad knowledge of AMC safety functions with no built in loyalties to specific commodity areas. They provide AMC with a highly capable, flexible, and mobile safety engineering expertise. A description of the curricula for the Safety Engineering Program follows.

## CURRICULA

This jointly sponsored Safety Engineering Program consists of twenty-four months of graduate level study divided into three sections: (1) the first six months of the program are taught by the USAMC Intern Training Center at the Red River Army Depot, Texarkana,

Texas; (2) the next 12 months are taught by Texas A&M University - with the first eight months taught at the Red River Army Depot Extension, while the last four months are taught on the main campus at College Station, Texas; and (3) the final six months are taught by the US Army Field Safety Agency at Charlestown, Indiana.

During the first two phases (first 18 months) all of the courses are graduate level and are presented in a university environment. A breakdown of the program of instruction by major topic area is shown below:

#### SYSTEM SAFETY RELATED COURSES (21 Credit Hours)

- \*Introduction to Safety Engineering
- System Safety Engineering
- System Safety Engineering in the Design of Equipment
- Safety Engineering in Facilities Design
- Safety Engineering in Transportation Systems
- System Safety Seminar
- Safety Engineering Research

\*Non Graduate Credit

These courses are designed to provide the students with specific background material which will allow him to serve as a system safety specialist on a design team. Discussion concentrates on the application, selection, and utilization of various system safety analytical approaches. Emphasis is also placed on the management of a system safety program, its relationship with other disciplines, and new developments and applications of system safety techniques.

#### SYSTEM SAFETY INTERFACE COURSES (22 Credit Hours)

- \*Statistical Methods in Reliability and Maintainability
- \*Weapon System Acquisition
- \*Engineering Application of Computers
- Theory of Human Factors Engineering
- Engineering of the Man-Machine Systems
- Evaluation and Control of the Occupational Environment

\*Non Graduate Credit

This set of courses is designed to provide the graduates with a working knowledge of Human Factors Engineering, Maintainability Engineering, Reliability, Industrial Hygiene, and the System Acquisition Process. All of these as you well know are very closely related and are important inputs when the total safety of the system is under consideration.

#### INDUSTRIAL ENGINEERING COURSES (30 Credit Hours)

- \*Introduction to Operations Research
- \*Mathematical Statistics
- \*Applied Mathematics
- \*Engineering Management
- \*Statistical Quality Control
- Analysis and Prediction
- Principles of Operations Analysis
- Advanced Quality Control

\*Non Graduate Credit

These courses serve three purposes. First of all they serve as pre-requisite type courses in order to bring all the different type engineering graduates to a common plane for the more advanced courses which follow. Secondly, the courses strengthen the student's mathematical abilities which are important in applying system safety and reliability analysis. Finally, since a Master's Degree is offered through the Industrial Engineering Department, certain "core" course are required by the Graduate College of Texas A&M University in order to award this degree.

The last phase of the program is conducted at the US Army Field Safety Agency and is designed to provide practical "hands on" type of training. The formal training includes both Army and AMC procedures, safety regulations, and related exercises in practical applications of safety principles. A portion of the program is devoted to "on-the-job" type training.

The major topics that are covered in this phase are:

#### FIELD SAFETY AGENCY TOPICS

- On-Job Orientation
- Munitions Safety
- Aviation Safety
- Industrial Safety

System Safety  
Radiological Safety  
Safety Management

As you can readily see from the curricula above, these engineers are being trained for much more than just "system safety engineering" as we have come to think of it during recent years. By taking the total engineering approach to system safety education, these graduates will have more capability in a much broader area of responsibility. A majority of the AMC installations at which these graduates will be assigned have no formal "system safety" organization. At many of these commands it will be a part of their duties to help initiate system safety activities. At still others the individuals may have to input system safety through such organizations as Research & Development, Quality Assurance, etc. After gaining invaluable experience on the job we feel these graduates will be capable of integrating into any system development team, and will be able to improve design through application of system safety engineering principles.

#### ENTRANCE REQUIREMENTS

The requirements for the engineering graduate input to this program are the same as the requirements for the other two intern programs (Production Design Engineering and Maintainability Engineering) which the USAMC Intern Training Center administers. Graduate engineers are recruited from universities across the nation, representing different engineering disciplines, from the upper one-third of their graduating class. With this academic ranking the students enter Federal Service as GS-7 Quality Students. After satisfactorily completing the first 12 months of the program they are promoted to GS-9 grades, and after successful completion of the 24-month program they are promoted to the grade of GS-11. At the end of the 24-month program each graduate assumes a three year continued service agreement with monetary repayment if they leave the Federal Government prior to the expiration of the three years.

#### FIRST CLASS

The first class of safety engineers began their study in June 1969. Their average undergraduate grade-point was 3.1 on a 4.0 system and they represented 15 different universities from across the United States. All 20 students received Master's Degree from Texas A&M University in August 1970 and have just this month completed the 24-month program and have been given permanent duty assignments at various AMC installations.

The second class has just completed the first 12 months of the program and the third class has been recruited and will report June 1 to begin training.

#### CONCLUSION

Since one of the objectives of this conference is "applications" and "transfer of information" it should be pointed out that while the program described in this paper is a specific program for AMC, a similar program is available on an individual basis at Texas A&M. Here the individual would choose his own degree program and would usually require 12 months to attain a Master's Degree in Industrial Engineering, assuming he has a Bachelor's Degree in any field of engineering. Individual students are encouraged to adapt the techniques and philosophy of "system safety" to "product safety" as it is commonly referred to by private and consumer industry. Indeed, it has been said that one of the more important spin-offs from the aerospace technology may be the system safety concept and its application to product safety.

The USAMC-Texas A&M program in Safety Engineering is an effective method for educating and training engineers in the unique and demanding technology of system safety engineering. As these graduates progress through AMC assuming positions of responsibility, they will make their presence felt and will have a tremendous impact on not only AMC, but the US Army as well, the principal customer of AMC commodities. Improved safety performance, monetary reward from reduced costs, and upgrading the overall capabilities of the AMC safety workforce are the expected results from this program.

The first class of the "System Safety" course at The George Washington University was held in March 1969. This two-week, non-credit course was offered twice in 1969, three times in 1970, and it is scheduled at least four times in 1971. So the course is in an expanding mode.

The course was initiated with the support and guidance of the Electronics Industries Association G-48 "System Safety Committee," chaired by George Mumma of the Martin Marietta Corporation. Mr. Mumma also serves as a guest lecturer in the course. Numerous notables in the field of system safety contribute as guest lecturers in the course including the Chairman of this Conference, Phil Bolger, and Jerry Lederer, NASA Director of Safety. In addition to Messrs. Bolger and Lederer, the following men listed in the program for this Conference have served as lecturers in this course: C. O. (Chuck) Miller, Dr. Carl C. Clark, Haggai (Guy) Cohen, and Dr. Raymond M. Wilmotte.

## COURSE RATIONALE

### Course Scope

At GWU, system safety covers the total spectrum of risk management. While starting with the dynamic system element (vehicle, machine, or process), the course examines the influence on system safety of attitudes and motivations of design, production, test and operations personnel, employee/management rapport, the relation of industrial and labor associations among themselves and with the Government, human factors in supervision, the interfaces of industrial and public safety with design and operations, the interest and attitudes of top management, the effects of the legal system on accident investigations and exchange of information, the certification of critical operating personnel, political considerations, public sentiment and many other non-technical but vital influences on the attainment of an acceptable level of risk control.

Not only does the course cover a wide range of subject matter. It is designed to introduce the principles, requirements, techniques, and limitations of system safety to those charged with hazard or risk control in the

following fields: urban planning, environmental control, mass transit, automotive safety, hospital administration, accident investigation, insurance underwriting and campus safety.

Three Titles - The GWU course is not as directly related to the military services as other system safety courses offered throughout the country. Both the University of Southern California course and the one presented by the University of Washington are sponsored by the United States Air Force. The course taught at Texas A&M University is under the direction of the United States Army Material Command. Nonetheless, students from all the military services have been and continue to be enrolled in the GWU course.

Carrying out the theme of this Conference-- "to expand the application of system safety principles into the general and consumer industries"--GWU advertises its course under three titles. The purpose of multiple titles is not to confuse anyone but rather, to hopefully match impedances with other industries beside aerospace.

Obviously, the course is advertised as a "System Safety" course because this term is commonly understood in the aerospace industry, the military establishment, and in NASA.

Attempting to communicate with a completely foreign segment of the economy, GWU offers the course as one in "Hazard Control." Those who would understand this term much easier than they would the term, "system safety," include insurance underwriters, hospital administrators, or perhaps those associated with the mining industry.

Still another portion of industry is introduced to the course under the title, "Risk Management." This group could include urban planners, campus safety managers, and even professional football team owners!

ASSE Sponsorship - The breadth of scope, titles and application described above was a prime factor in the decision of the American Society of Safety Engineers, representing approximately 10,000 safety professionals, in January 1971 to co-sponsor the GWU course. This action by ASSE was unique as it marked the first and only official endorsement of any university educational activity by that organization.