INTERFACE

SOCIETY FOR TECHNOLOGY IN ANESTHESIA

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APRIL 1992 • VOLUME 3 • NO. 2

STA '92 Business Meeting

The meeting was called to order by N. Ty Smith. A motion to express great thanks to Jerry Calkins and his support staff for organizing STA '92 was passed unanimously with a vigorous round of applause. The minutes of the General Business Meeting of January 1991 were distributed and accepted.

The treasurer's report attesting to the finanacial stability of the society was given by A.W. Grogono. Jeff Feldman gave the newsletter report encouraging members to become involved in the newsletter either directly or via contributions and letters to the editor.

Allen Ream then reported that a review of the by-laws in preparation for the election had revealed numerous inconsistencies. He went on to propose changes designed to insure a continuity of leadership combined with opportunity for all members to become involved in the society. The revisions will be mailed to the STA members this spring for approval. The proposed changes include:

continued on page 23

INSIDE THIS ISSUE:

STA '92: *Design of the Workstation*

Jerry Calkins, STA '92 Program Chairman, extends welcoming remarks to the meeting attendees.

On January 30, over 200 engineers, physicians, industrial representatives, residents, graduate students, and other curious individuals, convened the Second Annual Meeting of STA in San Diego. The sole purpose: to design the ideal anesthesia workstation. From the outset, enthusiasm for undertaking the design project ran extremely high. Opening remarks by STA President, Ty Smith, and Program Director, Jerry Calkins, set the stage for the two and one-half day event.

Educational Panels and Poster Sessions

The first part of the meeting provided the participants with a background in data acquisition, data processing, information management and display, including human factors and human error. The Data Acquisition Panel, moderated by Steve Barker, had invited presentations discussing ***Hemodynamics and Cardiac Output*** by David Wong, ***Neurological Function*** by Betty Grundy, ***Respiratory Gases*** by David Westenskow, and ***Oxygen and Carbon Dioxide Transport*** by Steve Barker. The Data Processing Information/Management Panel was moderated by Frank Scamman with Joe Condurso (North American Dräger), David Weissburg (Ohmeda) and Christopher Westerteicher (Hewlett-Parkard) enlightening the audience about workstation design philosophies from the industrial perspective. The final panel, Data Display-Human Factors/Human Error moderated by David Gaba, had Matt Weinger presenting the ***Study of the Anesthesiologist's Use of Information Displays on the Ohmeda Machine***, David Woods discussing the ***Human Machine Interactions With Anesthesia Monitoring and Drug Delivery Systems***, Donald Norman enlightening the audience with his ***Science of Information Display***, and David Gaba presenting

> *"enthusiasm for undertaking the design project ran extremely high"*

Human Machine Interaction Problems Documented Through Realistic Simulation. (See p. 21 for a more complete discussion of these panels)

Each of the panel discussions v as followed by a series of scientific poster presentations, organized and moderated by Jim Philip. Each poster presenter gave a one-minute summary of the material being displayed. Once the oral presentations were complete, time was allocated for participants to view the posters and interact with the presenters (Abstracts of presentations can be found in the *Journal of Clinical Monitoring*, Vol. 8, No. 2, 1992).

continued on page 22

Equipment Must "Talk" to the User

Dr. Donald A. Norman, Professor of Cognitive Science at UCSD, presented the keynote lecture at STA '92 entitled "Don't Worry: It's only One Chance in a Million". In his lecture, Dr. Norman developed the premise that equipment must be designed to communicate more effectively with the user.

He began with an example of poor communication in medicine, the prescription. The prescription is structured to effectively transmit information from the physician to the pharmacist. However, it fails to communicate the information of interest to the patient. The patient needs information structured by time of day so that he or she will know which medications should be taken at breakfast, which at lunch, and so on. Figure 1 shows an alternate prescription layout which effectively communicates information to the pharmacist and the patient.

Medication	Breakfast	Lunch	Dinner	Bedtime
Amoxicillin	one	one		one
Digoxin	one			
Inderal	two		one	

Figure 1: An alternate prescription layout

Dr. Norman then pointed out that humans communicate with each other in subtle ways using gestures, facial expressions and body language. Machines, on the other hand, tend to communicate in less subtle ways, such as with loud noises and flashing lights. Humans communicate their intentions and inner processes (feelings), while most machines hide their underlying operation from the user. Every device has a purpose and method of operation which is well known to the designer of the device. The designer should strive to convey his or her mental model of the device to the user through the visible part of the device, its actions and its documentation.

Dr. Norman asked that we consider how our equipment "talks to us". A person would be considered rude if he treated us the way our monitors do. They don't signal their intentions and they don't gently inform us when a situation begins to deteriorate. Instead, they "scream" at us when things get really bad, even if we have already begun to make corrections. Maybe that's why clinicians are so angry about the current state of equipment in the operating room.

These points were illustrated with a case from the aviation industry. An airliner was flying under autopilot control when a gas tanks in one of the wings developed a leak. The airplane became unbalanced, and the autopilot began to use more and more rudder to keep the aircraft flying straight. Finally, the autopilot reached the limit of its output which caused it to immediately terminate and return control to the pilot. The airliner went into a spin and fell 6 miles before the pilot regained control. The problem here was that the autopilot never communicated that it was having increasing difficulty to the pilot. A human co-pilot would have noticed the subtle changes in the feel of the aircraft much earlier.

When Dr. Norman points out subtle flaws in a device, the designer sometimes responds that there is only "one chance in a million" that an error will occur. However, with the millions of operations that are performed each year, this may be too high a risk. Dr. Norman suggested that one way to reduce errors is to design equipment to communicate in richer and more subtle ways. ◆

—R. Loeb

EDITORIAL BOARD EXPANDS

Although *Interface* is not yet two years old, the newsletter continues to grow in scope and readership. In an effort to continue to provide interesting topics and consistent quality, the editorial board is expanding. Reynolds Saunders, MD, of Cedars-Sinai Medical Center, Los Angeles, CA has agreed to become the Associate Editor for *Interface*. Dr. Saunders has been an active participant in STA since its inception and has a longstanding interest in technology issues in anesthesia. His insights and enthusiasm are a welcome addition and will have a very positive impact on the newsletter.

An international editorial board is also being developed. Naosuke Sugai, MD, PhD from the University of Tokyo will be the Far East editor and keep us informed about events and breakthroughs across the Pacific Ocean. John Zelcer, MD from Melbourne, Australia is very active in the Australian anesthesia activities and will serve as the Australian editor. Candidates for editorial positions to represent other parts of the world are currently being sought. Anyone interested, or who has a suitable nomination please contact the editor.

The editors are always interested in ideas for new topics, unsolicited contributions and individuals who might like to become involved. Please note that the Editor has a new address and ideas can also be sent to Dr. Saunders, the Associate Editor. The addresses are:

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PERSPECTIVES ON TECHNOLOGY

TOPIC: THE ANESTHESIA WORKSTATION

"Tools to reduce fatigue and stress, improve decision making and make the work environment more convenient...will be readily accepted..."

The Clinical Perspective

Jeffrey Feldman, MD
Assistant Professor of Anesthesiology
Yale University School of Medicine

Changes in the design of the anesthesia workstation over the last few years have been substantive. Instead of the bare bones gas machine of the mid 1980's piled high with individual monitors, manufacturers now offer highly integrated devices. The result is more uniform controls and a reduction in the number of displays. In short, the major advances of the last few years have utilized the breakthroughs in microelectronics to re-package the workstation.

These advances have laid the foundation for more exciting developments in the years to come. There are in fact many vexing problems that remain to be solved with regard to the anesthesia workstation. In light of increasing efforts to control the costs of healthcare, the cost of new advances will need to be balanced against their value - which may be difficult to assess. Furthermore, the traditional gas machine platform which remains the core of the workstation has a proven record of safety and reliability. Changes in this basic design will not offer much advantage unless an equal or improved level of safety and reliability is maintained.

Clumsy Automation

The term Clumsy Automation was coined by Earl Weiner, PhD, Professor of Management Science at the University of Miami, to describe the human factors problems identified during studies of airline cockpits. The same term can be applied to the anesthesia workstation—both as it was intended by Dr. Weiner and in the literal sense. The anesthetist must always be cautious not to step on, or trip over, wires and tubing strung across the workspace. Clutter due to cables running to the patient could be dramatically reduced by locating the monitor electronics on or adjacent to the operating room table. In that case only a single cable need run from the electronics to the display and that cable might ultimately be eliminated using telemetry. Other aspects of clumsy automation relate to inherent design flaws in the equipment that predispose to misuse and misinterpretation of the information (see Dr. Woods p. 21, Dr. Norman p. 21).

see next page

"An improperly designed third-party interface could, quite possibly, compromise the operation of an entire system."

The Industrial Perspective

Joseph A. Condurso
Director of Marketing
North American Dräger

Interface is not only the title of the STA Newsletter, but also one of the most important concepts driving advancement of the anesthesia workstation. From an industrial perspective the multi-vendor anesthesia workstation is the most common configuration found in today's operating room. Even the most sophisticated integrated anesthesia systems today (Modulus CD, or Narkomed 4, for example) may be configured with another vendor's hemodynamic monitor, or anesthesia data management system.

In the 80s, users of anesthesia equipment demanded less clutter, centralized alarms and integrated displays. Each manufacturer responded in their own way. Despite these advances, users continue to vocalize the need for integration. To satisfy the users' requirements will necessitate improved communication between the many devices which constitute the anesthesia workstation. Communication will facilitate the exchange of data, equipment status, and alarm conditions providing an interaction between these systems to improve operator control, reduce nuisance or false alarms and possibly facilitate predictive clinical intervention schemes or artificial intelligence.

To achieve these ambitious system requirements on a multi-vendor platform requires cautious steps and mutual cooperation between vendors. The industrial strategy must focus on the long-term benefits of providing a mechanism for communication and will prosper by meeting the needs of the customer.

At the recent Society for Technology in Anesthesia annual meeting, the participants were challenged to design the anesthesia workstation. Working groups developed specifications for the future anesthesia workstation. These innovative models are worthless, however, unless an effective means to interface components can be accomplished.

Vendor Cooperation Essential

Manufacturers of medical devices used in the operating room have no standard that they can follow to insure robust communication between devices. Some manufac-

see next page

The Clinical Perspective

continued from page 15

Another major problem with current workstation technology is signal processing. The availability of physiologic data is reduced due to problems with the patient-sensor interface and prevalence of signal artifact. Engineering advances that insure the quality of monitored information, such as analysis of signals with redundant information (ECG, SpO2), are clearly needed but have been slow in coming.

Alarms: The Boy Who Cried Wolf

An improved understanding of the role of human error in patient safety highlights the need for improved alarm technology. Although no machine can duplicate the decision making powers of a human, the human cannot maintain the same vigilance possible by a machine. Alarm technology should offer vigilance support, but, at present, fails in this function due to a lack of specificity and a high rate of false positive alarms. Even if the signal artifact problem is improved, reliance on traditional alarm technology, which is based upon static limits for monitored parameters, will perpetuate the limitations of alarms. Alarms must provide an early warning combined with decision support to help the clinician make an appropriate diagnosis.

Decision support is a much neglected area of workstation design. When an alarm is triggered, the clinician must go through a complicated decision process which includes assessing the accuracy of the alarm, developing a differential diagnosis, collecting information to make a specific diagnosis and instituting a management change. This process has many possibilities for potential error. Data may falsely be assumed to be accurate, important items in the differential diagnosis may be forgotten, vital information may be overlooked or difficult to obtain and inappropriate management may be instituted. Technology has the capability to aid the decision making process by making context sensitive reference information available at the bedside.

Is a New Workstation Worth the Effort?

There are a variety of factors that can justify new advances in workstation design. A reduced cost would be compelling but is not likely to happen. Improved reliability and reduced maintenance are also reasonable goals but the current technology is quite good in this regard. It is perhaps more likely that increasingly sophisticated workstations will be less reliable. This is an important consideration since patient safety and equipment reliability are interrelated. Just as small aircraft engines have remained simple and based upon old technology, some aspects of the workstation should not be altered too readily. Reliable delivery of oxygen is of paramount importance and current flowmeters serve that purpose. Electronic flowmeters offer the potential for centralizing controls but are not desirable if reliability is sacrificed.

One would like to show that an advanced anesthesia workstation improves patient outcome. Although a laudable goal, improved outcome as a result of a technological advance is difficult to prove. (See Interface Vol. 2 No. 3). An improved anesthesia workstation will likely be justified on the basis of human factors considerations. Tools to reduce fatigue and stress, improve decision making and make the work environment more convenient are desirable and will be readily accepted by the user. Just as tools like portable telephones create their own market because they make our life easier, so it will be with advances in the anesthesia workstation. ◈

The Industrial Perspective

continued from page 15

turers had the foresight to see the need for communications and developed protocols in the mid 80s, which remain robust and adaptive to the interfacing needs of the 90s. These companies have a great deal of experience in resolving compatibility problems that will unquestionably occur when trying to interface a variety of devices from a variety of manufacturers which have undergone many software revisions.

An improperly designed third-party interface could, quite possibly, compromise the operation of an entire system. Caution is advised when purchasing devices from many vendors in the absence of a communication standard which insures trouble-free operation. One way to approach this problem is for the many companies involved to formulate agreements which insure technical cooperation through the engineering process. These agreements must allow for validation of the interface performance and provide a venue for companies to inform each other in advance of software changes which affect the communication link. Since software revisions vary with each location, on-site test procedures of inter-device communications are useful to insure trouble-free operation. The engineering effort is not trivial and the cost substantial. All of the above is possible but can only be accomplished through mutual cooperation.

A multi-vendor anesthesia workstation must be designed to support bi-directional communication between interfaced devices. The communication standard should minimize the number of cables (preferably only one) and insure that all data is available from each device. The goal is to support alarm management, data management and integrated display. Serial communication utilizing an RS-232 serial protocol continues to be a cost effective, practical approach. Local area network technology is maturing rapidly and has already begin to find useful application in the operating room.

If the anesthesia workstation was always configured in total from a single vendor, the communication difficulties would be more straightfoward. The multi-vendor anesthesia workstation will be a reality for a long time to come. Long term success can only be achieved by addressing and anticipating the needs of the marketplace, and recognizing that Patient Data Management and Communications are one of the primary challenges of the 90s. An "Open Architecture" designed into the equipment and based upon continued cooperation between vendors is essential to meeting these challenges. ◈

STA EVENTS AT ASA '92 PLANNED

In keeping with what is now a tradition, STA will sponsor two events at the Annual Meeting of the American Society of Anesthesiologists in New Orleans this October. The STA dinner will be held Sunday evening, October 18, and will feature John K. Lauber, Ph.D. a member of the National Transportation Safety Board as the dinner speaker. Dr. Lauber has extensive experience in accident investigation for the US government and is well aquainted with issues related to technology and human safety.

The STA breakfast panel takes place Wednesday, October 21, 1992 at 7:30 a.m. and promises to satisfy both intellectual and physical apetites. The panel has been arranged by, and will be moderated by, Alan W. Grogono, MD, Chairman, and Merryl and Sam Israel, Professors of Anesthesiology, Tulane University School of Medicine. The speakers and their topics are:

Anesthesia Delivery: How Far, How Near
R.T. Chilcoat, M.Sc.,Ph.D.
Section Director
Health Care Research and Development
BOC Group Technical Center, Murray Hill

The Facility: Essential Requirements and Impossible Features
Jeffrey B. Cooper, Ph.D.
Director of Anesthesia Technology
Department of Anesthesia
Massachusetts General Hospital, Boston

Monitoring: Problems and Solutions
Irene Osborn, M.D.
Assistant Professor
Department of Anesthesiology
Albert Einstein College of Medicine, NYC

What Won't Work Where: MRI, Radiotherapy, Hyperbaric Oxygen, ESWL, CAT
Dwayne R. Westenskow, Ph.D.
Professor, Department of Anesthesiology
Utah University Medical Center, Salt Lake City

Do We Need to See the Patient: Can We Do it All by Instruments?
Professor Dr. B. Smalhout, M.D., Ph.D
Chairman, Institute of Anesthesiology
University Hospital
Utrecht, Holland

Look for information about attending these events in this newsletter and the ASA registration packet. ◆

STA '93—A Special Year

"Human Performance and Anesthesia Technology"
STA Third Annual Meeting
February 17–19, 1993
Sheraton New Orleans Hotel
New Orleans, Louisiana
Held in conjunction with the Seventh International Symposium for Computing in Anesthesia and Intensive Care (ISCAIC 7)
Join us! Be a part of STA '93 *and* Mardi Gras!
Also, *"Mardi Gras Anesthesia Update,"* February 20–22, 1993

UPCOMING EVENTS

World Congress of Anesthesiologists

Tenth meeting of the WCA to be held in The Hague, The Netherlands, June 12-19, 1992. Contact the American Society of Anesthesiologists for information.

ESCTAIC

The European Society for Computers and Technology in Anesthesia and Intensive Care will hold its third annual meeting once again at beautiful Goldegg Castle, Salzburg, Austria from October 7 to 10, 1992. For information contact: Dr. Leo Moser, Anaesthesiologie, P.O. Box 30, A5014 Salzburg, Austria.

Annual Meeting of the American Society of Anesthesiologists

To be held October 17 through 21 in New Orleans, Louisiana. Contact: American Society of Anesthesiologists, 515 Busse Highway, Park Ridge, IL 60068-3189, (708) 825-5586.

Computers in Anesthesia XIII

To be held October 21 through 24 at the Bourbon Orleans Hotel, New Orleans, LA. Contact: Ann Y. Loffi, T-4126 MCN, Vanderbilt Univ. Medical Center, Nashville, TN 37232-2125.

STA '93

To be held in conjunction with the Seventh International Symposium on Computers in Anesthesia and Intensive Care (ISCAIC 7) in New Orleans, LA at the Sheraton New Orleans Hotel. The meeting theme is "Human Performance and Anesthesia Technology." This is Mardi Gras time and promises to be exciting and fun. Deadline for abstracts, September 1, 1992. Contact: Jerry Wilhoit, CAE, Executive Director, Society for Technology in Anesthesia, 11512 Allecingie Parkway, Richmond, VA 23235.

Evolution of the Anesthesia Machine

Clayton Petty, MD
Clinical Professor of Anesthesiology
University of Utah, Salt Lake City, Utah

"Accidents in anesthesia have been the impetus to finding solutions to machine deficiencies."

In the first public demonstration of general anesthesia on October 14, 1846, Morton used a gas inhaler made by a Boston instrument maker. The inhaler had an inspiratory port, an expiratory port, and a sponge in the central container. One-way valves prevented rebreathing. Morton ultimately abandoned the inhaler and began dripping ether. Despite its flaws, the inhaler was similar to the modern anesthesia machine including unidirectional flow, increased surface area to facilitate vaporization and space to hold the liquid anesthetic.

Early Technology

Many ingenious ideas to administer general anesthesia have been tried since Morton and many failed due to a poor understanding of vaporization and the uptake and distribution of anesthetics. John Clover designed a successful device in England around 1860. His apparatus was portable and often taken even into the home. The device consisted of a large concertina bag (like an accordian) with one-way valves at both ends. The bag filled with room air when expanded, and, when compressed, the air was expelled through the other valve, passing thru a vaporizing chamber containing liquid chlorform. The air/chloroform mixture then passed into a 7.4 liter collecting bag. Dr. Clover calculated the amount of vapor produced by each milliter of liquid chloroform and the volume of the collecting bag so as to administer four percent chloroform via a face mask. The face mask had a spring loaded expiratory valve, a means to introduce room air during inspiration, and an inflatable rim to provide a tight fit.

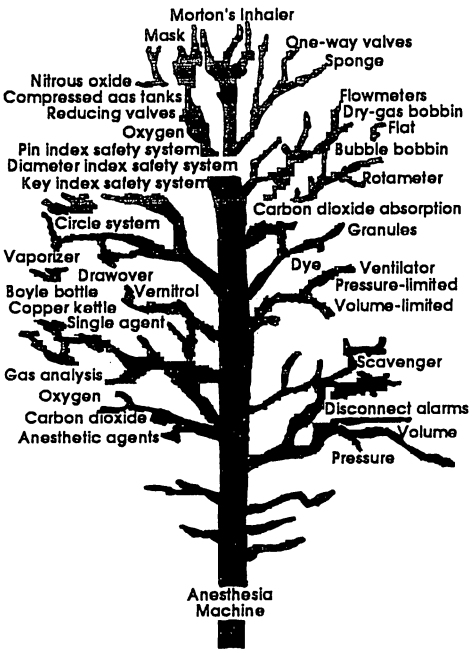


Figure 1: Machine Genealogy

Additions to the anesthesia machine were introduced slowly. Before compressed gases could be piped to the anesthesia machine, tanks were required that could withstand 2000 psig. To use the tanks required valves, a yoke to hold the tank, and a regulator valve to reduce the tank pressure to 40-70 psig. The first reducing valves had a spring which controlled the brass diaphragm of a side drum. Flanges were built into the valve body to help reduce freezing as the gas expanded. Compressed gas tanks were developed for nitrous oxide and oxygen as early as 1868 but oxygen was not readily accepted into the practice of anesthesia until after 1888.

Dr. Jackson introduced an anesthesia machine in 1915 which made closed circuit anesthesia possible because carbon dioxide was absorbed from expired gas by an aqueous solution of sodium hydroxide and calcium hydrate. This was nine years before Waters introduced dry granules for absorption of carbon dioxide in the to-and-fro system. An electric motor circulated the anesthetic mixture (forerunner of the Revell circulator). Gas mixtures passed thru a bottle containing oil of bitter orange peel to make the smell of the anesthetic more accepted to the patient (Does this remind you of fruit flavoring in pediatric anesthesia today?) Ether and chloroform were injected into the circuit via air locks. The machine also had a reservoir bag, compressed gas cylinders of nitrous oxide and oxygen, and a special jar containing sulfuric acid which extracted water vapor from the inhaled gas mixture. Despite the innovations in this machine, it ultimately became a laboratory curiosity.

Rebreathing of expired gas is desirable in that anesthetic vapor is conserved, but carbon dioxide posed a major problem until the introduction of soda lime granules in 1924 by Waters. Early practitioners relied on the temperature of the cannister to indicate when the granules needed changing. Years of study were required to optimize the size and hardness of the granules, and the cannister size. Use of indicator dyes eliminated the need to monitor canister temperature and ethyl violet has emerged as the most reliable dye.

Patient Safety Spurred Design Changes

Accidents in anesthesia have been the impetus to finding solutions to machine deficiencies. Flowmeters were initially designed to allow one flowmeter control valve for high flow oxygen (1 L/min to 15 L/min) and one valve for low flow oxygen (0-1 L/min). Similiar flowmeters were incorporated for nitrous oxide. Patients were given

hypoxic mixtures when the anesthesia provider accidentally set the low-flow oxygen flowmeter rather than the high-flow oxygen flowmeter to balance a nitrous oxide flow of 4 L/min. Analysis of this problem and other causes of hypoxic problems resulted in the introduction of a single-control flowmeter valve. An in-circuit oxygen analyzer, hypoxic guard system, and an oxygen failure protection device also were designed to prevent delivery of an hypoxic mixture. It is interesting to note resistance shown by anesthesia providers to the introduction of oxygen analyzers. Many felt the device was unnecessary since all anesthesia providers were of course quite vigilant. Pressure from the anesthesia literature, standards, organizations and finally, laws in some states, has mandated use of the oxygen analyzer.

The introduction of ventilators in the operating room highlighted new design problems. The previously untroublesome pop-off valve could now cause a loss of tidal volume if left partially open after connecting the ventilator. After ventilators became a standard part of the anesthesia machine, engineers designed a switch to isolate the pop-off valve from the breathing circuit during mechanical ventilation.

Recent studies have shown that one of the most frequent problems in anesthesia is an unrecognized disconnect. Disconnects can occur at many points in the circuit and it is sometimes difficult for the anesthesia provider to detect certain incomplete disconnects which can lead to decreased ventilation. A pressure sensor was first introduced to the breathing circuit as a disconnect alarm. Later a tidal volume monitor was placed in the circuit which could alarm if a certain volume over a preset time was not measured. Today both pressure and volume disconnect alarms are recommended for anesthesia machines as an aid to detecting breathing circuit disconnects.

Computer chip technology has had a major impact on the development of the anesthesia workstation. Both the volume and pressure disconnect alarms have been made feasible because of the incorporation of microchip technology. The first built-in ventilator on a commercially made machine in the USA was powered by the Venturi principle which limited its capabilities. Computer control of electrically driven ventilators allowed much more versatility and has replaced the older ventilators. Oscillometric blood pressure measurements were possible in the early 1900's, but computer chips allowed the principle to be incorporated into the non-invasive blood pressure devices. The ability to measure carbon dioxide, halogenated agents, and nitrous oxide by infrared light was possible in the early 1960's but again miniaturization brought the technique to the operating room. Pulse oximetry instruments were developed in the late 1940's but were very bulky and impractical in the clinical setting. The computer chip allowed the instrument to be reduced in size while still capable of analyzing the immense amount of data required for calculating hemoglobin saturation.

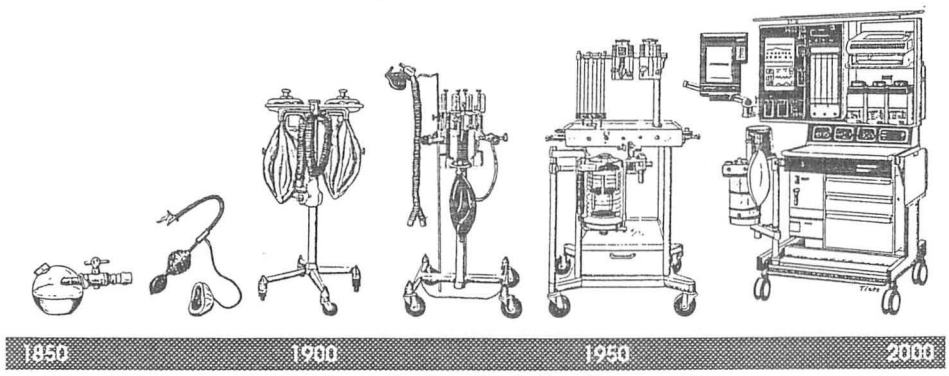


Figure 2: Anesthesia Timeline

Anesthesia Machine Standards

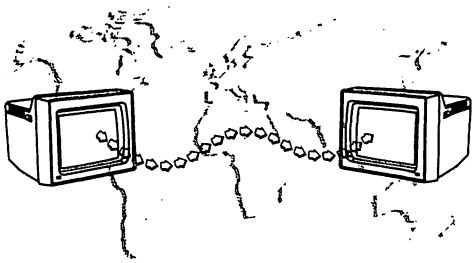
The first standards adopted for the manufacture of anesthesia machines were the pin index safety system and color coding applied to medical gases contained in tanks. The diameter index safety system and the key index safety system for connection of gas lines from the hospital to the anesthesia machine evolved from the principles established by the pin index safety system.

Establishment of the ANSI Z-79 Committee brought together manufacturer, anesthesia providers, engineers, hospital representatives, and other interested parties to make recommendations of standards for anesthesia machines. The committee was ultimately transferred to the American Society of Testing and Materials (ASTM). An International Standards Organization (ISO) also sets machine standards but the ASTM standards have always exceeded those of the ISO. Unfortunately the standards set by the ASTM are not mandatory. A manufacturer can sell a sub-standard machine and the anesthesia provider is allowed to use it. The only sources of enforcement are the "common law" standards, peer pressure, threat of litigation, and laws in two or three states. Not all anesthesia machines in the USA meet the standards of the ASTM. As medicine, in particular anesthesia, adopts standards of practice, they will influence upgrade of all anesthesia machines not in compliance with standards. Figure one uses a geneology tree to depict the impact of standards activities on the development of the anesthesia machine.

The anesthesia machine is slowly evolving into the concept of the Anesthesia Workstation. This evolution began years ago when someone attached the first shelf to an anesthesia machine. First the ECG machine was placed on the shelf and then other measuring instruments found a home. At present, the core of the anesthesia workstation concept remains the traditional anesthesia machine. When one considers the development of the computerized anesthetic record and the growing acceptance of intravenous anesthesia, it is likely that the anesthesia workstation of the future will be quite different from the concepts of today. ◆

SIGnatures

Notes from the STA Special Interest Group



The STA activity continues to increase on the CompuServe MedSIG Subspecialty forum. New additions to the library files may be of interest to the STA membership. Alastair Lack (UK) has posted the start of an international electronic mail directory for individuals with technology interests. The file containing this directory is entitled "WSTA.TXT" and is available for downloading. If you are interested in adding your name to the directory please send E-mail to Alastair Lack at CompuServe ID 100012,2245 and he will include your name in the next edition.

Two files of special interest to STA members are "9110M.ASC" and "9101M.ASC" which are the minutes of the STA Board Meeting and Business meeting held during the annual meeting in January.

Software for Using CompuServe

For those individuals who use CompuServe regularly and would like to manage on-line costs more effectively, software is available to help. TAPCIS is now available to STA members at a special price. This program automates the process of logging onto CompuServe, getting mail, and visiting forums such as the STA area of the MedSIG. Using TAPCIS one can read mail and messages off-line and reply to them off-line. TAPCIS will log on again and post the replies. This automation reduces on-line charges significantly compared to reading and replying to messages while one is on line. The savings can be particularly significant for those who are calling from overseas. TAPCIS includes everything you need to connect to CompuServe. "Support Group," the group that sells TAPCIS, is offering TAPCIS at a special price of $59 to members of the Society of Technology in Anesthesia. (The regular price is $79.) TAPCIS includes a 90 day full money back guarantee and toll free support in the USA. You can order TAPCIS by calling 1-800-872-4768 (in the USA) or 1-301-387-4500 or by sending a CompuServe Mail message to 74020,10. Mention your membership in the "Society for Technology in Anesthesia" and use account number #104061 to get the special pricing.

TAPCIS is not available for the Macintosh but similar software is available such as the CompuServe Navigator and CompuServe Information Manager for MAC. Additional information on these MAC products may be found on CompuServe by typing GO NAVIGATOR<cr> or GO CIM<cr> at any "!" prompt.

Options for CompuServe Charges

CompuServe has instituted a new option for billing. One can now pay a flat rate of $7.95 per month and receive unlimited connect time while using many of the features of CompuServe. (Communications surcharges for using other than the CompuServe network in the USA still apply.) The flat-rate services include news, weather, sports, some on-line encyclopedias, the electronic shopping service, some of the games, travel (including the EAAsySabre airlines reservations system), and so on. Charges for mail are more complicated under the flat rate system than under the pay-as-you-go system. Each month, a flat-rate subscriber receives an allowance of $9.00 for mail charges. This allowance covers the equivalent of 60 three-page messages per month with no additional charge and applies to both ASCII and binary messages. After you use up your $9.00 allowance, you will be billed for any additional charges. Any remaining message allowance expires at the end of each month. (Note: Each 2,500 characters is about one double-spaced page.)

The following is included in your monthly allowance:

✔Send Mail (per message per recipient):
- first 7500 characters $ .15
- additional 2500 characters $ .05

✔Receipt Requested $ .15

✔Receive Internet Messages (i.e., messages from outside the CompuServe mail network, i.e., bitnet, edunet, etc.):
- first 7500 characters $ .15
- additional 2500 characters $ .05

✔Receive messages from other CompuServe subscribers: no charge

✔Surcharged messages, such as Congressgrams, fax, telex, and postal are not included in the $9.00 monthly allowance.

Further details may be found by typing GO BIL-72<cr> and GO MAILCH<cr> at any "!" prompt.

Some of us have expressed concern about the new flat-rate pricing system. The alternative is paying $12.80 an hour at 2400 baud on the pay-as-you go system. The price of $12.80 an hour is about $0.21 per minute. There you can send and receive both CompuServe and Internet messages without surcharge (except for multiple recipients and return receipts). A 7500-character message would take about 31 seconds to transmit if you had no set-up and "overhead" time. This would theoretically cost you about $0.10 on the "pay-as-you-go" system and $0.15 on the flat-rate system. For multiple recipients the surcharge would vary depending upon the length of the message. From CompuServe's standpoint, a totally unlimited mail system would allow businesses to exchange data nationwide, 24 hours a day, every day of the month, by paying $7.95 for each account! In an effort to avoid such extreme usage, CompuServe has initiated a pricing structure to attempt to cover its expenses. Unfortunately for us, the flat-rate mail pricing structure is confusing, and it is hard to know which option might be best for an individual. The choice depends not only on mail usage habits but also what other services one might use under the flat-rate plan.

CompuServe has been responsive to user comments in the past. This author would hope that the charge for receiving Internet mail would be either eliminated or significantly reduced (eg. $.01 per message) since the Internet network is basically educational in its mission! Also a simpler mail charging system would be easier to understand. Users are urged to leave comments for CompuServe by typing GO FEEDBACK<cr> at any "!" prompt. Feedback is free (except for external network charges) for ALL pricing plans! ◆

—F. Block

STA '92 Educational Panels

Panel discussion sessions brought together experts from diverse fields to provide insights into the many aspects of redesigning the workstation.

Human Factors in Anesthesia Workstation Design

Human factors aspects of anesthesia workstation design were discussed by four panelists who offered complementary views of the importance of redesigning the environment to better support the anesthesiologist's work during surgical patient care.

Matthew Weinger, Assistant Professor of Anesthesiology at the University of California, San Diego discussed basic principles of display and control design relevant to the anesthesia workstation. His presentation included a novel set of iconographic prototype displays for key organ systems. One display showed a beating heart complete with pulmonary artery catheter. Blood flowed through the heart at a rate consistent with cardiac output, and it changed color as appropriate to the oxygen saturation. Digital displays located at anatomically appropriate points provided exact values of intramyocardial and peripheral pressures and resistances.

> ***"...we can take students into the OR, and every bad thing about human factors and design that we have taught them can be demonstrated."***
>
> **—D. Norman**

David Woods, PhD, Director of the Cognitive Systems Engineering Laboratory at Ohio State University, discussed elements which distinguish well designed systems from "clumsy automation" (a term used by Dr. Earl Weiner to describe flight control systems in aviation that are difficult to use). Besides discussing parallels in workstation design between anesthesiology, aviation and spaceflight, Dr. Woods described in detail his group's analysis of problems they have documented in the use of intravenous infusion controller devices. Their analysis identified multiple ways in which the operation of the device was opaque to the user, and did not conform to expectations. He also presented a diagram of his group's functional redesign of the device to make its operation safer and more accessible to the anesthetist.

Donald Norman, PhD, Chairman, Department of Cognitive Science, University of California, San Diego, delivered a fascinating presentation of the view of a professional cognitive scientist and human factors expert on the operating room environment. Dr. Norman suggested that the OR was "heaven" for the professor of cognitive science because "...we can take students into the OR, and every bad thing about human factors and design that we have taught them can be demonstrated." In his presentation, Dr. Norman emphasized the importance of simplifying the OR environment, and achieving standardization of components, their communications protocols, and their physical packaging.

Panel organizer, David Gaba, M.D., Assistant Professor of Anesthesia, Stanford University, described principles of "behavioral design" aimed at producing equipment which is in harmony with human requirements for a specific task domain. Specifically, he emphasized continual testing in the course of equipment design, and he presented videotapes of human/machine interaction problems encountered by anesthesiologists during simulated crises utilizing an anesthesia simulator system. Gaba proposed that testing of prototypes and of actual equipment in a realistic simulator setting would allow problems in equipment design to be identified and changed before the manufacturer commits to the design.

Together, the panelists provided an important challenge to the teams designing anesthesia workstations: To design a flexible device that presents data to the anesthesiologist when it is needed, in a manner that is easy to assimilate, and allows for easy control of the workstation.

—D. Gaba

Data Processing and Management Panel

The first speaker was David Weissburg, MS, from Ohmeda in Madison, Wisconsin, describing the Arkive Anesthesia Data System developed by Diatek. This system manages patient data collected during the pre-anesthesia visit, the intra-operative period, and post-anesthesia recovery. This data is not only archived but also processed for drug use, billing, quality assurance, and research purposes. The various locations are integrated by an Ethernet based local area network. In the operating room, the Arkive is capable of interfacing with over 90 different monitoring devices. The user interacts with the system via a touch-screen which can easily be positioned near the patient. Data is gathered every 2 seconds, processed by an artifact rejection algorithm, and stored to disk every minute. It is possible to recall past anesthetic records for analysis which is particularly valuable if the patient returns to the operating room. Additionally, data can be exchanged with the hospital mainframe for billing and demographic purposes. He stressed that Ohmeda maintains an open architecture to the system and welcomes new initiatives for interfacing.

The next speaker was Joseph Condurso, MS, from North American Dräger (NAD), Telford, PA, describing (NAD's) commitment to Data Management. NAD has created a new division, NAD Information Systems. Its charter is to develop data management products for hospitals and assist them in custom installation and consultation. The O.R. Data Manager recovers physiologic data from Narkomed systems and the Vitalert cardiovascular monitors. The data is stored on a disk and an anesthesia record can be printed in the operating room or remotely in the

continued on page 23

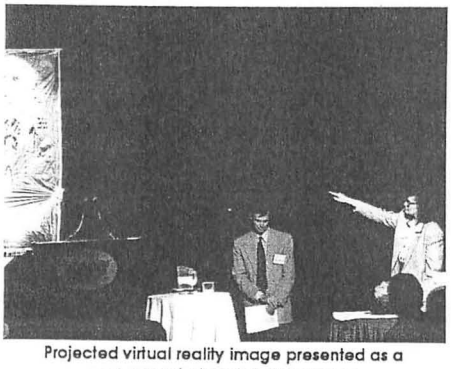
Design of the Workstation

continued from cover

Design Teams: Friendly Competition

At the beginning of the meeting, the participants were divided into 16 teams, each team charged with designing the ideal anesthesia workstation.

On Friday afternoon, the design sessions began with an Experts' Corner. Twenty-five experts representing a wide variety of topics were available for consultation by Design Team members. Upon conclusion of the Experts' Corner, the teams were given 12 hours to complete the design. Each team established objectives, design criteria



Projected virtual reality image presented as a component of workstation design

and planned their final presentation to the assembled critics. Sixteen unique designs were devised and each team received a prize. In the opinion of the judges, there was no best design; the debate will likely rage for years as to who really was number one.

Upon completion of the design presentations, the Great Debate in-

Panel of judges present awards to design team leaders. From left: Gerri Icuzaua, Heidi Lenz, and Connie Calkins

volving controversies and technology commenced. The debaters included Drs. Block, Ream, Saunders, and Philip. Because of the prowess and the astuteness of the debaters, each provided both pro and con positions on the issue under consideration entitled, ***Now That We Have Designed IT, DO WE NEED IT?*** The audience was left to draw their own conclusions.

All Work and No Play ...

Numerous social events, including receptions, luncheons, and dinners, were held during the course of the meeting. One dinner speaker was Philip T. Robinson, DVM, who gave an enlightening presentation about ***Anesthesia at the Zoo.*** An interesting aspect of his presentation is that much of the technology used for anesthesia at the zoo is designed to protect the anesthetist from the patient rather than the other way around! The STA distinguished lecturer for this year was Donald Norman who is the author of the bestselling book entitled ***The Design of Everyday Things.*** Dr. Norman presented his topic entitled ***Don't Worry: It's Only One Chance in a Million.*** (See "Equipment" p. 14)

During STA '92, spouses also had an exciting time. In addition to all of the social events, they were entertained by a guest speaker discussing the history of San Diego. They also participated in numerous coffees and teas. The hotel is located near excellent shopping and other activities, including the zoo and numerous art museums. The weekend also had the additional attraction of trials for the America's Cup sailing competition.

For those individuals who would like a permanent record of events, the entire program will be available on VHS videotape within the next few months. Proffer Productions in Kansas City with the assistance of Robert Mogue are in process of editing and production of tapes. It also appears that the summaries of the 16 workstation designs will be published and available for purchase later this year.

All who participated felt the meeting was a tremendous success and are looking forward to the Third Annual Meeting - STA '93, which will be held in New Orleans next February. ◆

Please Note the New National Office Address

The Phenix Corporation has now taken over as the new managing organization for STA. If you have any questions or concerns, please contact:

Jerry Wilhoit, CAE
STA Executive Director
11512 Allecingie Parkway
Richmond, VA 23235
(804)379-5513
(804)379-1386 FAX

STA Professionally Managed by
The Phenix Corporation
AN ASSOCIATION AND CONVENTION MANAGEMENT COMPANY

STA '93

Abstract Deadline
September 1, 1992
Contact the National Office at (804)379-5513 for details

Business Meeting

continued from cover

Proposal 1: Officers are currently elected for 3-year concurrent terms. The BOD (board of directors) has endorsed a change, namely that the President and Vice-President be replaced by a President, President-Elect, and Immediate Past President. The President would be elected annually and progress through the offices with a 1-year term in each. The BOD expressed appreciation to NTS for a difficult job. This proposal was passed unanimously.

Proposal 2: The BOD would have 2 components, the voting members - President, President-Elect, Secretary, Treasurer, and 3 members at large - and 3 non-voting, ex-officio members - Immediate Past President, Newsletter editor, and Chairmen of the committees. Two members of the present BOD would retire next year and 2 the following year. This proposal was passed unanimously.

Proposal 3: There is a requirement that mail ballots be unanimous. The proposal was that $^2/_3$ of those responding should be sufficient, unless the By-laws specify a lower percentage. The discussion of this proposal centered on whether a quorum of the membership should be required. It was noted that the present By-laws do not address a quorum and that mail notice is required of annual meetings. Approval was ultimately finalized for the proposal as written.

Nominations from the nominating committee to fill the currently expired term of one member of the BOD were then presented by Allen Ream. Dr. Gravenstein, who had agreed to have his term expire, was thanked for his excellent service to the society and Ira Rampil and Steve Barker were nominated. There were no further nominations from the floor. Steve Barker was then elected to the board.

Committee reports were then given by Alan Grogono (Education) and Julian Goldman (Membership). (Note: Please see the article on the BOD meeting) Jim Philip and Wes Frazier presented a report on the task force on testing and certification for technicians and technologists. Progress is being made and there is a desire to collaborate from the American Society of Anesthesia Technicians and Technologists.

David Edsall gave a report from the committee on the National Anesthetic Database. The goal is that by STA 93 a "white paper" on the vision could be presented. Anyone willing to call an 800 bulletin board number and comment at least monthly is a member of the committee investigating this question. Currently there are 18 members.

Jeff Feldman reported about the activities of the committee on equipment, testing and specifications. Along with other committee members Al Perrino and John Howse, efforts are underway to build a liaison with ECRI to facilitate the evaluation of equipment particularly where STA members can be a resource.

John Zelcer invited everyone to the ISCAIC meeting in 1996 in Australia to be held April 8th or 9th. The WCA will meet in Sydney in April 1996 and the ISCAIC will follow in Melbourne.

Official thanks was expressed to Bob Mogue and the audio-visual staff for their excellent support at the meeting. A round of applause followed and the meeting was closed. ◆

—F. Block

Videotapes Available from STA '92

The 1992 STA Annual Meeting brought together some of the brightest minds in the business on the synergy between anesthesia and technology. The meeting presentations will soon be available on VHS videotapes. Topics and speakers include:

DATA ACQUISITION

David H. Wong, PharmD, MD, *"Hemodynamics and Cardiac Output,"* Betty L. Grundy, MD, *"Neurological Functions,"* Dwayne Westenskow, PhD, MD, *"Respiratory Gases,"* Steve J. Barker, PhD, MD, *"Oxygen and Carbon Dioxide Transport"*

DATA PROCESSING/INFORMATION MANAGEMENT

David Weissburg, MSIE, Ohmeda, Christopher Westerteicher, Hewlett-Packard, Joseph Condurso, North American Dräger

DATA DISPLAY...HUMAN FACTORS/HUMAN ERROR

Matthew Weinger, MD, Study of the anesthesiologist's use of information displays on the Ohmeda Modulus CD Anesthesia Machine, David Gaba, MD, Human-machine interaction problems documented through realistic simulation

These presentations and more will be made available soon at reasonable cost. For more information, please fax your name, address, and phone number to (816)474-5655. When the programs are ready for duplication, we will contact you with more information.

Data Processing

continued from page 21

Recovery Room. Efforts are underway to network operating rooms using Ethernet and to create a database of multiple cases for data integration and data management. Future efforts include networking to hospital mainframes.

The last speaker was Christoph Westerteicher, MS, from Hewlett-Packard. He described the HP philosophy of open systems architecture using the Merlin cardiovascular monitor as an example. HP has developed interfaces for many medical monitoring instruments which allows their respective data to be brought into the Merlin's database. He expressed HP's commitment to working with manufacturers and users to make a very flexible system. He also detailed the operation of the Open Systems Interconnect (OSI), a data-exchanging protocol which consists of 6 layers with hardware at the base extending up to applications at the top.

Questions at the end of the session were quite varied. For Mr. Weissburg, Q: "How do you keep the touch screen on the Arkive clean?" A: "Any standard hospital disinfectant, even Windex." Q: "Where did you get your anesthesia death rate figure of 1:300,000?" A: "The British literature." Q: Why does the Arkive cost so much?" A: "We need to amortize our development efforts." Q: "Why do Hewlett-Packard monitors not communicate with NAD products?" A: "NAD will license to HP the Vitalink protocol and NAD will program our systems to accept HP's protocol if it is provided to us." For Mr. Westerteicher, Q: "Do you think an industry standard for a basic user interface would offer the same benefits that they have for communications?" A: "Yes, the industry badly needs a standard interface. The MIB would provide such a standard but no one seems to want to implement it yet in its immature form." For the panel at large, Q: "Should anesthesia databases reflecting true physiological variations be used to educate non-anesthesia individuals that patients are not 'trains' that can be driven down parallel tracks?" A: "Yes, such data would be very valuable in that not all changes are the responsibility of the anesthetist." ◆

—F. Scamman

BOARD OF DIRECTORS MEET AT ANNUAL MEETING

The STA Board of Directors met on January 29, 1992, the day before STA '92 began. Dr. Grogono gave the treasurer's report noting the Annual Meeting budget is on target and the society as a whole, is in good financial condition.

STA Board convenes for a full day meeting prior to STA '92

In order to help with increasing STA exposure, the board discussed methods to reach the ASA membership. A decision was made to approach the APSF to consider distributing a one- or two-page flier about STA in one of the APSF mailings. Videotapes of the 1992 STA meeting will also be made available.

By-laws to Change

Allen Ream reported that extensive review of the by-laws indicated inconsistencies and contradictions. He distributed a proposed draft revision of the By-laws to be voted upon at the STA business meeting and distributed to the membership. The changes are discussed on page 23.

Allen Ream then gave the Nominating Committee report regarding election of a new board member. Since all board members have begun terms simultaneously but only one was to be replaced, J.S. Gravenstein agreed to have his term end now and asked that he not stand for re-election. The Board voted unanimously to recognize Dr. Gravenstein for his outstanding service. The Nominating Committee nominated Ira Rampil, Steven Barker, and Paul Barash to replace Dr. Gravenstein on the Board of Directors. Paul Barash asked not to be considered and this request was accepted.

Jan Ehrenwerth reported on the work of the development committee which was very successful in arranging corporate sponsors for the annual meeting. A total of 20 sponsors were obtained which helped defray a major portion of the meeting cost.

STA '93

Alan Grogono discussed the future plans of the Education Committee. The STA sponsored dinner at the 1992 ASA meeting will be held on October 18. The speaker will be John Lauber from the National Transportation Safety Board. His background is in research psychology and he will speak on airplane accidents and the implications for anesthesia. The STA breakfast panel will address the problem of anesthesia in remote locations. Plans for STA 93 were also discussed. This will be held in New Orleans, from Wednesday, February 17—Friday, February 19, 1993, right before Mardi Gras. The major theme will be Human Factors. The STA Board of Directors will meet on Tuesday, February 16.

Julian Goldman presented the Membership Committee report. STA now has 504 members. The possibility of an Associate Membership category, intended for anesthesia technicians and technologists, was discussed but not resolved. Another proposal was a "membership disk" for MAC or PC computers. This might include the membership list, a database program, perhaps communications programs, and other information. The STA membership brochure is also being redesigned.

New Management Group Selected

Jerry Wilhoit, a representative from The Phenix Corporation of Richmond, Virginia, visited the board meeting to discuss the management services offered by his company. After some discussion, The Phenix Corporation was selected as the new managing organization for STA, subject to contractual approval. The Board expressed its appreciation to Gerri Kuzava and the International Convention Services organization for their help in getting STA off the ground.

The meeting was adjourned.

Note: Copies of the official minutes of the board of directors meeting are available in the subspecialty library of the MEDSIG. (See SIGnatures p. 20)

—F. Block

Plan now to attend STA '93, February 17–19, 1993

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