Further advancing the “Art of the possible”

Jack LEMLEY, ITA President 1983-1986

The ITA has shown remarkable foresight, as usual, in planning its 25th Anniversary Open Session to avoid crowded millennium agendas. We have always been a step ahead, it seems.
At the May 1992 Open Session, I also spoke on the Past, Present, and Future of Tunnelling in an address subtitled, Advancing the "Art of the Possible."I concluded that we have always been practical folk who, perhaps, have not looked too far ahead. With the approach of the year 2000, this seems a good opportunity to review and update those thoughts.

The thesis of that earlier address was that our profession was approaching a historical cusp because of changes:

• in the technology and economics of underground space, • in the nature of our workforce and how we manage our projects, and • in the political and economic climate.

Up to the present, technology and methods have interacted to produce the best possible solution for a particular project. To successfully advance, I feel, we in the tunnelling profession must move beyond this incremental, reactionary view of the “art of the possible.” We must reassess and redefine our culture. We must be proactive.

To update my assessment of our professional culture, I will briefly consider our industry’s past and present, then give my views on possible futures and their dependencies.

THE PAST

Tunnelling engineering has come a long way(dramatically so as the 20th century comes to an end. From cave dwellers to modern man, underground space has developed from a ready source of shelter and storage to(just to focus on tunnelling(specific, differentiated applications for mining, communications, water and sewer, hydroelectric, transportation, and a growing number of other areas. We have gone from the direct use of hand tools and the slightly more sophisticated wedging and fire-setting techniques to, as sources of metals and power improved, rock drills and air compressors and the use of explosive compounds and hydraulics, and, finally, to the high-technology, laser-guided tunnel boring machines in use today.

In the past, technology has driven the way we approached our work. We followed as much as lead. This was appropriate, perhaps, because, until our generation, tunnels were usually not a solution of choice but of necessity. A situation arose and we reacted-short term.

The history of the Channel Tunnel can be seen as a capsule view of our recent history. In the 1880s a channel tunnel was barely possible because of the development of steam and pneumatic technology. Politics, however, stopped those efforts and later ones. After the Second World War, however, technological advances and a changed political climate made a channel tunnel not only possible, but, I believe, inevitable. Today, the system provides a safe, rapid, comfortable, and virtually pollution-free communication link between England and the Continent.

Indicative of the future, the Channel Tunnel was a multi-national, transfrontier project. Five British and five French companies drove the tunnels and fitted out the rail system. British, French and other nationalities had to work together as a team with engineers and suppliers from around the world. French and British governments also had to cooperate. Legal systems and currencies had to blend.

It was a truly international project that made the best use of current methods and technology. As such, the long history of the Channel Tunnel rail transportation system represents the culmination of tunnellingís past and, I believe, contains seeds of possible futures.

THE PRESENT

The Channel Tunnel transportation system, at 50 km, is about 4 km shorter, portal-to-portal, than Japanís 54 km Seikan undersea tunnel, the only comparable tunnel. At 38 km, however, its undersea section is the worldís longest. Both surpassed the 19.8 km twin-tube Simplon tunnel, driven in the early years of the century, as the longest rail tunnel in the world. If a system of tunnels beneath the Straits of Gibraltar is undertaken, the proposed location of the tunnel(from Paloma Point in Spain to Malabata Point in Morocco (is about 52 km from portal to portal, nearly 28 km of this undersea. The work on Alpine tunnels now underway or projected, because of the diffi-

cult ground and great overburden and their location as a nexus of European rail and road traffic, will demand commensurate increases in technology and cooperation.

As our world becomes more crowded, more ecologically threatened, the development of tunnelling and underground space has now become as much a technology of choice as of necessity. This is not only because of increased technological possibilities but also because of the increased place of subsurface space in the consciousness of peoples and politicians. I like to think that our organization has had a major role in this. As our work with the UN indicates, we are still very much concerned with the totality of subsurface work as it affects and can assist humanity.

To move forward, the people in our professionófrom engineers to management, from TBM operators to the general workforce(must become even more proficient. Today tunnelling is an environment for thinking people(people who have great understanding not only of the nature of geophysical conditions and the overall engineering of the project but of the interrelated complex of human skills required to get the job done properly. Technologically, we require an understanding of the management of increasingly sophisticated equipment and techniques(of the efficient direction of computer-driven, laser-guided tunnel boring machines, of the logistics required to support men and operations at the end of a kilometers-long, meters-wide supply line, of sophisticated, interconnected material and scheduling programs, and of the myriad other specifically work-related tools available.

In bowing to new technology and better educated human resources, however, we must not lose sight of another human factor: practical experience. Our failures are rooted in people. We often rely too heavily on people who have good names, good licenses, and good degrees but who lack practical, hands-on underground experience.

As a classic example, John Hester belongs to this elite group of experienced hands. On the Channel Tunnel, he characterized himself as “one of the tunneling people, the guys at the sharp end of production”. For the six British TBMs, he turned around a program that went from almost a year behind to one that finished ahead of schedule, setting many records in the process.

We must continue to recognize men like John, hands-on professionals who came up through the ranks from TBM operators and supervisors to construction field executives. In a very real sense, they are the true innovators in our industry, the actual operators who make things work and bring this knowledge and organizational ability forward when they, in turn, become “management.”

THE FUTURE

Looking to the future, I believe the world of tunnelling and underground space has reached a turning point as we move into a new century(a new millennium. There are a number of reasons for this cultural shift, but I will develop just a few.

First, as with engineering and construction in general, our industry is feeling the effects of globalization and consolidation. The Channel Tunnel, as mentioned, is a good example of globalization. Experienced personnel, technical support, and new equipment and supplies were drawn from world-wide sources. Although France and England supplied the bulk of this, resources, men, and equipment were drawn upon from the United States to Japan, from Canada, Germany, Italy, and many other nations to make this great project possible.

Like globalization, consolidation is required to reduce cost and gather the expertise necessary to bid and build major underground works. The United States construction industry has been in a period of consolidation for several decades. The European industry is under similar pressure to “downsize” and merge to improve competitiveness.

While recognizing this global emphasis on competitiveness, we must continue to build our industry on sound principals. This means good people using the best engineering and the best equipment. Certainly we must be competitive. But we must consider the long-term health of our industry in doing so.

Second, although we employ greatly improved technology and engineering techniques, we often do not use them as well as we should for reasons of poor communications, lack of training, and a tendency to manage in an older, hierarchical style. Mr. Kovari, from a country literally in the middle of European transportation, brought up this issue in his January 1998 *Tribune* editorial. “We can assert that the theoretical foundations of modern tunnelling lag behind practice. It is, therefore, a matter of urgency to eliminate fallacious theories, in particular those concerning the behavior of the ground and its interaction with the support systems. The complexity of tunnelling problems and the rapid growth of projects worldwide have led to the emergence of pseudo-scientific theories. These must be identified as such. Only rational approaches guarantee safety and economy in underground construction.”

Our ITA mission is “to encourage planning of the subsurface and to promote advances in the preparatory investigations for tunnels and in the design, construction and maintenance of tunnels by bringing together information thereon and by studying questions relating thereto.” There is an accelerated need to promote these aims. As Mr. Kovari stated, there is much misinformation within the profession. Better analysis, better geophysical and technical development, and better propagation of information for and about our industry is needed at all levels.

If the technology to be used does not match the siteís geology, then the work can be affected by orders of magni-

tude. From my consulting work, I can say that failure in underground work does not occur in small increments. On job after job, poor geotechnical investigation, inexperienced and poorly qualified people, and bad political and economic decisions do not produce petty problems. They produce major failures.

The key to a successful project does not lie strictly with a geologist, a tunnelling engineer, or a construction foreman, but with the full complement of all the personnel who must effectively use the materials and technology that must be brought together and combined in a coherent fashion. A successful project can only be realized through broadening the experience base of our industry through all disciplines concerned. Geotechnical and geomechanical technology must blend seamlessly with mechanical, civil, electrical, electronic engineering and related disciplines as well as with the integration of labor management skills into the process of project logistics. The project must always be considered as a whole, with each aspect-human and machine - fully-appreciated and properly integrated into the overall plan.

Third, we must reassess management's role. It is different today because the workforce is different. Today, the old hierarchical, top-down system has been replaced by what I like to think of as a "web of workers"-an interrelated, interconnected, interdependent team who are able to work together because they communicate and are, in turn, informed about project goals and progress. They think about what they are doing(and they are empowered to make critical work-related decisions. Management structure is no longer vertical; instead, the image of the network should replace the image of the pyramid.

To be empowered, a worker must have both the motivation and the ability to produce high quality goods and services. Managers cannot simply "grant permission" for other team members to "be empowered." As a part of the team, management must actively create and nurture the conditions for empowerment.

This means that today's team leaders must be trained in management as well as in the technical disciplines related to engineering/construction. Human relations decisionsóand concomitant decisions in related areas such as public relations, media management, contracts, risk management, finance, and many othersócan make or break a project. This means that a diploma in management may well be a future requirement. It is, in fact, an implied requirement today.

The Channel Tunnel project could not have been achieved without trained, well-managed, empowered teams. Teamwork is one of those termsólike TQC, value engineering, or partneringóthat comes easily to mind these days. It is anything but easy to achieve, however, as our friends in the manufacturing disciplines will attest.

Communicating, thinking workers are also safer, more productive workers. Quality and Safety programs, while helping to ensure a safer, more productive workforce, should also be treated as major communication links. If done properly, they reinforce the teamwork so essential in the modern workplace.

Finally, we have not promoted our industry in a focused, conscious manner (we have not managed the image of our profession very well. The public must recognize what we do for what it is: a cost-effective, ecologically sound solution to the growing needs of our increasingly crowded, complex planet. There is a growing burden on our profession to preserve our credit with the public. Accepting this mission will become increasingly important.

I believe that it is an absolute necessity to use every means to ensure that the public image of our work is presented as positively as possible and that this image matches reality in doing so. This is particularly true of transportation projects because they are highly visible, affect a wide and varied public, and are, necessarily, "good copy" for the press.

This means the early creation and continued maintenance of a proactive communications environment. Such an environment must include media and government relations, marketing and publication communications, employee communications and organizational relationships such as quality and safety, and job-oriented economic, political, and legislative analysis, to name just a few.

The ITA's role in this must be more fully considered.

CONCLUSION

Tunnels connect. And as tunnels grow longer and more complex, they demand that we not only accept our mission statement but move it forward.

The engineering and technology exist. So does the desire to employ this old resource made new by the improved capabilities of our profession and the good offices of the ITA. As tunnelling becomes less expensive, safer, and more capable and predictable, it is becoming a technology of choice. The world community is increasingly seeing underground construction as the economic and ecologically sound answer to competition for surface and air rights, particularly in dense urban environments. We must actively promote this view.

As a communication medium, tunnels are a technology that can lend reality to the new openness and interaction we are experiencing after the Cold War decades. I believe that the ITA, as witnessed over its first 25 years, is the organization to give shape to these future needs.