

## Kalman Kovári Pro and Contra NATM

### Pro y contra el NATM

*In this short contribution reference is made to the remarks (Gallerie No. 45, 1995) given to the earlier published paper: "On the Existence of the NATM: Erroneous Concepts behind the New Austrian Tunnelling Method", Gallerie No. 44, 1994*

*En ésta pequeña contribución se hace alusión a las observaciones hechas (Gallerie N. 45 - 1995) al artículo publicado precedentemente en la Revista Gallerie N. 44, 1994 titulado: "On the Existence of the NATM: Erroneous Concepts behind the New Austrian Tunnelling Method". (Sobre la Existencia del Método NATM: Conceptos erróneos del Nuevo Método Austriaco de Excavación de Túneles).*

Commenting on my paper Prof. Lunardi expresses perfect agreement with my criticism on NATM and suggests that we pause for reflection. He correctly points out that tunnelling has made a great progress in recent decades necessitating a critical review of its theoretical foundations. We may add that such reflections are the more important as tunnelling has not only progressed but also undergone a tremendous growth in size, complexity and subtlety at the same time.

In the eyes of its founders NATM is frequently referred to as a "structure of thoughts". As such it has formulated a number of basic principles for tunnelling and has been disseminating them in thousands of printed pages over the last three decades. In my lecture in Salzburg I have conclusively proved that NATM from a scientific and technological point of view has to be rejected. One of the main reasons is that it eludes definition. This fact is admitted by Müller, who wrote (1978): "Practically everyone who applies this method of construction has a different conception of it in his mind". Mr. Marzola must have been aware of this particular difficulty of NATM when he starts his comments on my paper with: "The NATM is, in my opinion, ..." confirming that NATM remains a matter of personal opinions.

Mr. Marzola goes on to describe his "fascination by the theories" which Müller at "the end of the sixties" has explained to him and continues: "I remember the enthusiasm with which, after having digested the concepts, I went on preaching, like a new apostle, this new "philosophy" of approach to designing and tunnelling". This reminiscence reveals common features of NATM papers: Argumentation with feelings of conviction and reference to father figures as authorities.

Principles and concepts which in the sixties might have been useful from a purely pragmatic point of view may be completely obsolete nowadays. NATM started with the announcement of principles and rules in ambiguous formulations without justifying for them. The early dogmatic thinking could not develop into a critical one, causing NATM to become pseudotunnelling. The founders and followers of NATM have never worried about defining the technical terms they use and giving justification for their announced "rules" in terms of scientific principles. NATM's "structure of thoughts" became a catalogue of principles often formulated in the art of oracles offering many contradictory ways of interpretations. In many instances a statement sounds impressive but it says nothing.

As an example consider the following comments of Dr. Danella and Dr. Uguccioni on my paper. "The Austrian method provides the engineer with the possibility of exploiting the characteristics of the rock mass without having to resort to linings when they

are not necessary".

This assertion contains two statements which are connected by a condition:

- NATM provides the possibility of exploiting the characteristics of the rock mass and
- NATM can do this without having to resort to linings when they are not necessary.

The first statement repeats one of the central claims of NATM being alone capable to make the ground to a structurally supporting component. In my paper I have explained that this claim is false because tunnelling without the structural action of the ground is simply inconceivable.

The second statement saying that NATM does not need linings if they are not necessary is a triviality. Imagine a structural engineer praising his allegedly new "Concrete philosophy": "It provides the engineer with the possibility of exploiting the characteristics of the concrete without having to resort to steel reinforcement when it is not necessary".

Let us now consider the following assertion of Dr. Danella and Dr. Uguccioni defending NATM against criticism: "Although the principles indicated by NATM are not new, they are not in disagreement with those expressed previously". This view is untrue. NATM has introduced a number of principles which have never been formulated before and which are either basically false or trivial. Take as an example the official definition of NATM. According to this ground rings must be activated in order to obtain a load bearing capacity of the rock. The rings can apparently take the form even of "onion-skin-shell" structures in the rock mass.

Another fallacy, which has never been mentioned before, concerns "the main concept of the NATM which is based on Pacher's ground response curve" (Müller). There is no evidence theoretically or empirically for the existence of the ground response curve with the shape postulated by Pacher. The corresponding claim of Rabcewicz being able to minimize the rock pressure and the lining thickness is therefore also unfounded.

We come now to the remark of Dr. Danella and Dr. Uguccioni stating that: "the Austrian method, based on relatively simple procedures, does not require particularly difficult design or highly skilled firms for its application. Thanks to the straightforward method indicated by NATM many firms could be perfectly capable of carrying out tunnelling operations, which leads to greater competition and lower prices". Here we are concerned with the frequently repeated assertions that NATM is more of an operational tunnelling method than a theoretical methodology (Marzola). However, we must add for clarity that "Shotcrete Supported Tunnelling" (de Mello) — in German "Spritzbetonbauweise" — must not be confused with NATM.

NATM, molte ditte potrebbero essere perfettamente in grado di eseguire operazioni di scavo di gallerie, il che porta ad una maggior concorrenza e a prezzi più bassi". Qui abbiamo a che fare con le asserzioni, spesso ripetute, che il NATM è più un sistema operativo per lo scavo di gallerie che non una metodologia teorica (Marzola). Tuttavia, dobbiamo aggiungere per chiarezza che il "Shotcrete Supported Tunnelling" (costruzione di gallerie con l'aiuto di shotcrete) (de Mello) — nella "Spritzbetonbau-weise" tedesca — non deve essere confuso con il NATM.

Dal momento del suo ingresso nella letteratura sulla costruzione di gallerie nel 1963, il NATM ha sempre mostrato due facce: una scientifica ("Struttura di pensieri") e l'altra operativa. Questa ambiguità concettuale aiuta fortemente il NATM a immunizzarsi contro le critiche. Quando considerano il NATM in modo critico, le persone della mentalità scientifica spesso ritengono che i suoi meriti consistano nelle istruzioni operative e gli ingegneri nell'esercizio della loro professione spesso suppongono che il NATM sia una "struttura di pensieri". In realtà, considerando il NATM come un "metodo operativo per la costruzione di gallerie", si può facilmente dimostrare che i "principi del NATM non soltanto non sono di alcun aiuto durante la costruzione di gallerie, ma sono anche causa di confusione. Prendiamo per esempio il principio N. 14 del NATM: "Chiudere il rivestimento ad anello (salvo nel caso in cui la roccia lo produca)". Questo principio ci dice sempli-

cemente: "Inserite un arco rovescio se le condizioni della roccia lo richiedono". A parte questa banalità, vi è anche un difetto formale nel suddetto principio N. 14. Esso suggerisce erroneamente che la stessa massa rocciosa sarebbe in grado di chiudere un rivestimento aperto di calcestruzzo formando un anello. La parola "anello" è quindi usata prima correttamente e poi, fra parentesi, in modo errato. Tale "abuso di parole" (Locke) è spesso riscontrato negli scritti sul NATM. Una volta accettate tali formulazioni, si potrebbe continuare e dare altre istruzioni, del tipo di questa: "Stabilizzare la massa rocciosa mediante ancoraggi (salvo nel caso in cui la roccia stessa produca la propria stabilizzazione)". Consideriamo il principio NATM N. 6, con la sua formulazione oracolare: "Costruire il rivestimento non troppo presto e non troppo tardi, e in modo non troppo rigido e non troppo flessibile", che non richiede ulteriori commenti. Il principio NATM N. 16 ci istruisce: "Quando è possibile, eseguire lo scavo su tutto il fronte, poiché lo scavo in successione danneggia il terreno". Dalla letteratura appare chiaro che lo scavo su tutto il fronte è applicato molto raramente dai sostenitori del NATM. Di conseguenza, il NATM è spesso definito come "metodo sequenziale di scavo di gallerie" (Eisenstein). Questo è un buon esempio di come il NATM possa essere definito arbitrariamente. Il NATM come metodo operativo per lo scavo di gallerie non è in grado di sopravvivere a un esame critico.

Per illustrare la confusione generale a proposito del

NATM come "metodo operativo per lo scavo di gallerie", confrontiamo il parere del Dott. Danella e del Dott. Uguccioni, sopra esposto, secondo il quale "il NATM non richiede una progettazione particolarmente difficile o ditte altamente specializzate", con quanto dichiarato da Müller (1979): "Lo scavo di gallerie", con l'uso del NATM richiede, rispetto allo scavo di gallerie tradizionale, una squadra nella quale tutti i membri, dall'operatore per l'applicazione del calcestruzzo fino al direttore generale, devono imparare a lavorare insieme per un periodo di anni, come i membri di una squadra di calcio". Questa è ancora l'opinione predominante fra i sostenitori del NATM, e non quella espressa dal Dott. Danella e dal Dott. Uguccioni. Per dimostrare ciò, consideriamo la recente affermazione di P. Haselsteiner (\*), secondo la quale "il NATM richiede capisquadra adeguatamente qualificati e ingegneri consulenti. Ma questi sono rari. Non più di un migliaio di operai, una dozzina di ingegneri consulenti e mezza dozzina di ditte costruttrici conoscono a fondo il NATM".

Quest'affermazione ci fa venire in mente l'applicazione del NATM come strumento di commercializzazione di quella dozzina di ingegneri consulenti e di quella mezza dozzina di ditte costruttrici.

Lo scavo di gallerie come una delle discipline dell'ingegneria richiede maggiore responsabilità intellettuale e coerenza di pensiero di quanto non ci dimostrino le attività di commercializzazione con l'uso del NATM. ●●

(\*) a3 BAU Das österreichische Baumagazin, edizione 12, 1994, p. 88.

Since its introduction into tunnelling literature in 1963 NATM has always been showing two faces: a scientific one ("structure of thoughts") and an operational one. This conceptual ambiguity greatly helps NATM to immunise itself against criticism. When critically looking at NATM scientifically minded people often believe that its merits lie in its operational instructions and practising engineers often suppose NATM to be a "structure of thoughts". In fact, considering NATM as a "operational tunnelling method" one can easily prove that "NATM principles" are not only of no help in practical tunnelling but they also cause confusion. Take, for example, the NATM principle No 14: "Close the lining to a ring (except for the case the rock causes it)". This principle simply tells us: "Place an invert if the rock conditions necessitate it". Apart from this triviality there is also a formal defect in the above principle No 14. It suggests erroneously that the rock mass itself would be capable of closing an open concrete lining to a ring. Thus the word "ring" is first used correctly, afterwards — in parentheses — in an incorrect sense. Such "abuse of words" (Locke) is frequently encountered in NATM papers. Once such formulations

are accepted, one could go on to give other instructions like this: "Stabilise the rock mass by anchors (except for the case the rock itself causes its own stabilization)". Consider NATM principle No 6 with its oracle-like formulation: "Construct the lining not too early or too late, and not too rigid or too flexible" requiring no further comment. The NATM principle No 16 instructs us: Whenever possible perform full-face excavation, sequential tunnelling damages the ground". From the literature it is clear that full-face excavation is very rarely applied by the supporters of NATM. Therefore, NATM is often characterised as a "sequential tunnelling method" (Eisenstein). This is a good example of how arbitrary NATM can be characterised. NATM as an operational tunnelling method is not capable of surviving critical scrutiny.

To illustrate the general confusion concerning NATM as an "operational tunnelling method" let us confront the above-formulated view of Dr. Danella and Dr. Uguccioni, according to which "NATM does not require particularly difficult design of highly skilled firms" with a statement of Müller (1979): "Tunnelling using the New Austrian Tunnelling Method re-

quires, in comparison with conventional tunnelling, a team, in which all its members, from the shotcreting operator up to the managing director, will have to learn to work together over a period of years, like the members of a football team".

This is still the generally prevailing view among NATM supporters and not the one expressed by Dr. Danella and Dr. Uguccioni. To demonstrate this consider the recent statement by P. Haselsteiner (\*) saying that "NATM requires adequately qualified foremen and consulting engineers. But they are rare. Not more than one thousand workmen, a dozen consulting engineers and half a dozen construction companies can master NATM". This statement reminds us of NATM's application as a marketing instrument of these dozen consulting engineers and the half dozen construction companies. Tunnelling as one of the disciplines of engineering requires greater intellectual responsibility and coherence of thoughts than the marketing efforts with NATM demonstrate us. ●●

(\*) a3 BAU, Das Österreichische Baumagazin, edition 12, 1994, p. 88.