

Report on Euromech 259 : "BIO-MECHANICAL TRANSPORT PROCESSES"

IESC Cargèse, Corsica, France, October 9 - 13, 1989,

The aim of this Colloquium was to discuss problems of bio-mechanical transport processes in the cardiovascular system, to facilitate an understanding of the underlying mechanisms, and ultimately to lead to a cross-fertilization of ideas and the development of new approaches.

Altogether 52 scientists participated from 13 countries : Belgium (4), France (14), West-Germany (8), East-Germany (1), Greece (1), Netherlands (5), Norway (1), Portugal (2), Turkey (1), U.K. (12), USA (1), Soviet Union (1), Japan (1) ( the list of participants is enclosed). These participants were selected by the Scientific and Organizing Committee after receiving the suggestions of the Euromech Correspondents and the requests of candidates which followed the publication of an announcement in Journal of : "Association Universitaire de Mécanique" (France). Considering that the progress in the field of "Bio-mechanical transport processes" was done thanks to interdisciplinary researches we decided to choose scientists from different fields: engineers, surgeons, physicians, physicists, mathematicians. Unfortunately we were obliged to refused many participants ( more than hundred fifty persons are interested in this field ). Some participants who were unable to participate were replaced by the others after decision of the Committee.

The contributions reflected interdisciplinary researches implying bioengineering, physiology, medicine and mechanics and were related to following topics: transport phenomena, heart thermo-biophysical properties, flow in blood vessels, microcirculation, blood-wall interactions, instrumentation and hemodynamic investigations.

A Preliminary Program was established in June 1989 and sent to all participants and to Euromech Committee and the final one in September 1989 ( enclosed). Participants were asked to provide a summary of the work that they wished to report and a booklet of abstracts was edited in September 1989 ( enclosed).

In relation to its importance the contributions related to mass transport properties was under-represented at the Colloquium. Some of them treated the development of atherosclerosis and the permeability properties of myocardial tissue. These took into account the poro-elastic characteristics of the tissues and established a porous matrix model. There was, furthermore, both an experimental and a theoretical study of heat shunting in the myocardium which predicted that the shunting of oxygen in the myocardium is negligible. In a related study a model considered the influence of intra-coronary blood volume on the mechanics of a spongy left ventricular wall which permitted torsion about the axis of symmetry. Also, in the area of mass transport, a model was proposed which predicted the clearance of a range of solutes at an ultrafiltration membrane from a clearance measurement without ultrafiltration and the membrane specification.

Flow in blood vessels, lung airways and models were discussed in detail. Many papers dealt with the problem of analytical ( in one case ) and mainly numerical solutions techniques for blood flow analyses in straight and bent pipes and in bifurcations, and experimental validation of the methods in normal and atherosclerotic plaques. Concerning carotid artery blood flow it was shown how finite-element solutions of the Navier-Stokes equations can be used to numerically

simulate all details of the three-dimensional flow in the carotid artery bifurcation in close agreement with experiments. Because of the complex structure of the secondary flow bifurcations, the numerical analysis of the reduced two-dimensional problem of bifurcated ducts was found to be most useful for a better understanding of the development of the flow, the generation of separated regions and velocity, pressure and shear stress distributions. Since contact between the various research groups is not well established, it is found that the bifurcation problem was attacked by different research centers considering: numerical analysis of flow in a T-junction, numerical and experimental study of flow in a 90° bent pipe with circular cross-section or numerical solutions of the Euler- and Navier-Stokes equations for flows in vessels with moving boundaries. The question of the physiological relevance of numerical investigations and their physical reliability was also raised. It was emphasized, that continuously increasing computational power and rapid improvement of integration techniques justify the hope, that analysis of physiological and pathological problems will benefit substantially from this development. The discussion closed with conclusions, that a stronger interlinking of all disciplines involved of physiologists, engineers, mathematicians, and computer scientists is a necessary if not indispensable goal for future work to be successful.

The general topic of microcirculation was highlighted by the emerging trend to investigate the multiphase nature of blood when traversing the various kinds of microcirculations in the body: skeletal muscle, cerebral capillaries, hemochorial placenta. Velocity profiles of erythrocytes and their influence on the partitioning of platelets in arterioles, methodological work on red cell mechanics and a chemomechanical model of the RBC-membrane as a multi-fluid-sheet system with elastoviscous properties represent some aspects of this important topic. A general approach considering a synergetic interpretation of red cell motion as "rectified flow" will permit eventually to develop and replace the conventional mechanical model of blood flow.

Blood wall interactions may concern several types of interfaces: physiological, pathological and artificial. These interactions are governed by physical and chemical properties of the wall as by its mechanical and morphological properties. New methodological approaches (experimental, numerical, clinical) are necessary to carry out such descriptions. Numerical approaches offer the possibility to determine deformability and stability of the wall and different flow characteristics from a set of parameters and of hypotheses. In vivo approaches, whether they are experimental or clinical, seem to be the best way to study blood flow and blood wall interactions. Fluorescent markers, such as acridine red or radiolabelled cells and radiolabelled proteins are useful tools to study the velocity patterns and blood cell adhesion and protein adsorption onto the wall.

Hemodynamic measurements more rigorous and more accurately than ever were done thanks to the development of improved instrumentation. For example the following new techniques were presented: a miniature PC controlled laser-Doppler velocity- and concentration meter which can measure velocities and concentrations of blood cells up to physiological values and a simpler version of an intraoperative ultrasound flowmeter with better performances.

It must be stated that this colloquium, assembling a group of active and eminent scientists from theoretical, experimental and clinical disciplines of various countries, provided an excellent forum for discussion and permitted a mutual beneficial exchange of information opening the bases of new scientific collaboration. To this extent, in our opinion this colloquium was highly

successful and a rewarding experience for all participants.

On behalf of all participants we would like to express our gratitude to the Euromech Committee for approving this Colloquium and to all our financial sponsors.

It is our belief of all of us that in two - four years the new ideas discussed and the collaboration established will be realized in much larger extent and a new colloquium or a conference ( to be decided later ) in this field will follow.

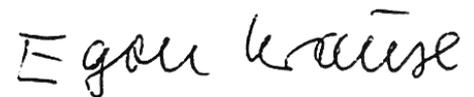
November 22, 1989



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# ADVANCED RESEARCH WORKSHOP

Scientific Affairs Division - NATO - B-1110 Brussels Belgium - Telephone 02/2410040 - Telex 23-867 (NATOHQ)

## FINANCIAL REPORT

(to be sent within 120 days of the meeting)

### REMARKS FOR COMPLETION OF THE REPORT

- The director is reminded that grant closure cannot take place until this report, together with the general report and scientific summary (green and white forms) are accepted by NATO.
- The director is also reminded to keep for three years all vouchers, bills etc., as stated in the award letter, since a number of accounts will be subject to detailed auditing (all expenditure items except 5(f)).
- Please note that the names of all the participants receiving funds should be given in the annexed tables irrespective of the source of the financial support given and independently of the separate lists of participants with full addresses to be provided as part of the general report (green form).

#### 1. Advanced Research Workshop

Title: "BIO-MECHANICAL TRANSPORT PROCESSES"

Location:  
(site and country)

Dates: October 9 - 13, 1989  
Number of working days: 5 ( five )

Institut d'Etudes Scientifiques de Cargèse  
F-20130 Cargèse ( Corsica ), France

#### 2. Director:

(name, position, official address, telephone no., telex no.)

Professor Florentina MOSORA, Université de Liège, Institut de Physique, B5  
B- 4000 Sart-Tilman par Liège 1, Belgique  
Tel: 041 563648, secr. 041 563339  
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#### 3. Comments on Financial Matters

1. All participants of this NATO workshop were speakers. The Scientific and Organizing Committee decided to give to every one a fixed amount of 1400 FF to cover a part of the living and travel expenses. A group flight was organized by the General Secretary of the "Insitut Scientifique de Cargèse" from Paris to Ajaccio for a price of 1100 FF double way. For the participants who utilized this group flight the sum of 1400 FF was divided in 1100 FF ( or 550 FF single way ) as travel expenses and 300 FF ( or 850 FF ) as living expenses; for the others the whole sum of 1400 FF was given to cover a part of the living expenses.
2. The members of the Scientific and Organizing Committee who were speakers and also moderators and chairmen of different sessions ( program and book of abstracts already sent to NATO ) and some other participants who presented two or more contributions received a sum greater than 1400 FF till 5000 FF , the last one in our opinion covering all expenses (approximately 1000 FF per day , per person, including travel for the participants of Central Europe).
3. The values of this report noted with " \* " are not amounts really changed in French francs but transformed in French francs using an exchange rate of 1FF = 6.26 BF ( average of the exchange rates : 6.20, 6.25, 6.24, 6.36 really performed ). This transformation was made in order to have the same currency for the Section 5 of this report.
4. The source 2 was not awarded cash : the University of Liège covered the expenses related to mail, telex, fax for the period of the preparation of this workshop till the amount of 200000 FB. A request for a supplementary fund to cover the difference of these expenses was already made.

4. STATEMENT OF INCOME

A. NATO FUNDS

Amounts

(a) Summary of NATO payments

	Awarded BF (i)	Received (ii)*	Reporting (FF) (iii)*	Exchange Rate (iv)*
1st instalment (1/3) .....	400000	( 1 / 9 / 88 ) 400000	12750 10000 41289*	(10/5/89) 1FF = 6.20 FB (29/9/89) 1FF = 6.25 FB 1FF = 6.26 FB
2nd instalment (2/3) .....	800000	( 2 / 5 / 89 ) 800000	128205	( 8 / 5 / 89 ) 1FF = 6.24
Supplements for Greek, Portuguese and Turkish participants (if applicable) .....	35800	( 5 / 5 / 89 ) 35800	9670	( 5 / 10 / 89 ) 1FF = 6.36 FB
	5000	( 16 / 6 / 89 ) 4921		
	21000	( 3 / 10 / 89 ) 20821		
Other supplements (if applicable) .....	/	/	/	( / / )
<b>Sub-total (a) .....</b>		X	201914	

(b) Other income subject to NATO conditions

Bank interest on NATO funds after subtraction of all bank charges .....	2859 FF
Contributions paid by participants from NATO countries .....	/
<b>Sub-total (b) .....</b>	2859 FF
<b>TOTAL (A = a + b) .....</b>	204773 FF

B. FUNDS FROM OTHER SOURCES

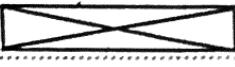
Source 1 : University of Liège 10000 FB .....	1597* FF
Source 2 : University of Liège 20000 FB .....	31949* FF
Source 3 : Association Universitaire de Mécanique (France) 4000 FF .....	4000 FF
Source 4 : .....	/
<b>TOTAL (B) .....</b>	37546 FF
<b>GRAND TOTAL* (A + B) .....</b>	242176 FF

\* NOTES :

- Column (ii) please indicate in the parentheses the date of receipt of the funds.
- Column (iii) use only one currency in this column which should also be the currency used in completing Section 5 of the report (preferably Belgian francs, otherwise one of the currencies used in column (ii)).
- Column (iv) indicate the exchange rates used to convert values in column (ii) to those in column (iii); the date of this exchange rate should be noted in the parentheses.

Note: Please complete using currency as in column (iii) of Section 4 of this report

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	Covered by NATO funds	Covered by other sources
	Currency FF.....	Currency FF.....
(a) Living Expenses of		
- director(s) .....	3000	/
- key speakers .....	23500	2170
- other participants .....	39220	/
(b) Travel Expenses of		
- director(s) .....	2000	/
- key speakers .....	13900	1550
- other participants .....	26450	/
(c) Rentals if charged separately from (a) (e.g. conference rooms, equipment, transport) - specify .....		
( conference room, equipment, insurance, during meeting, phones from Cargèse, trans.)	41896	/
(d) Clerical and Technical Assistance (specify) .....		
( secretary and permanent presence during the workshop ).	15435	/
(e) Organizational Expenses (1)		
- publicity .....	/	/
- mail, telex, telephone .....	2406	43730
- lecture notes .....	7972	/
- other (specify) (meetings of Sc. and Org. Comm., deplac.)	39704	/
(f) Director's Discretionary Fund (2) .....	/	/
(up to BF 50,000)		
(g) Speakers' fees (3) .....		/
<b>Total Expenditure</b> .....	215483	47450
<b>Income (4)</b> .....	204773	37546
<b>6. BALANCE (income - expenditure) (5)</b> .....	-10710 FF	-9904

- (1) Please note that expenses related to publication of proceedings in the NATO ASI Series are covered by a special grant and thus should not be included in this report.
- (2) This fund has a ceiling of BF 50,000 and may be used by the director to cover contingency costs and miscellaneous expenses not covered by the other budget items. An accounting of expenditure is not required for this item.
- (3) Directors should note that the NATO award may not be used to pay honoraria of any kind. If honoraria are paid to speakers from other sources they should be entered here.
- (4) The amounts to be indicated here should correspond to TOTAL (A) and TOTAL (B) in Section 4.
- (5) ANY POSITIVE BALANCE MUST NOT BE RETURNED TO NATO UNTIL INSTRUCTIONS ARE GIVEN BY THE SCIENTIFIC AFFAIRS DIVISION. A negative balance will be covered by NATO, up to a maximum of 5% of the award, and subject to the conditions stated in the award letter.

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7. INFORMATION ON ACCOMMODATION

(a) Name and address of Hotel/Campus/Other (delete as appropriate): Institut d'Etudes Scientifiques de Cargèse, 2031 Cargèse Corsica, France hotels, apartments and rented rooms in the village of Cargèse.

(b) Total amount paid by the Director to the above mentioned location : 41550 FF

(c) Cost of Accommodation (per person)

Currency : 1FF = 6.26 FB

Type of room occupied	Full board daily rate	Half board daily rate	Accommodation only	Restaurant expenses per day	Minimum number of days
Single	/	60	150 - 200	~ 350	5 days ( 6 nights )
Double	/	120	240 - 350	~ 700	5 days ( 6 nights )

(d) General Information

(i) Please detail facilities available and services provided *inclusively* in the above prices (if any)

Lunches were served at the Institute to all the participants and their families willing to join them. The charge was 250 FF per person for the whole duration of the meeting ( 5 days ). Breakfast was served at the Institute for those who rent the rooms in this place ( 50 FF per person for the whole meeting ).

(ii) Please detail facilities available and services provided at *extra cost* (if any)

- Dinners were not provided; they were taken either at the hotels, or in restaurants of the village ( typical cost : 250-320 FF per person ).
- Phones, fax, photocopies of private use were not included, the others related to the workshop were covered ( see section 5 ).

I hereby declare that the details in this report and its Annexes are correct.

Date: November 29, 1989

Signature:

*[Handwritten Signature]*

Attachments

- Annex 1 - Summary of funds distributed to Director(s) and Key speakers
- Annex 2 - Summary of funds distributed to other Participants

one annex for both