

## Presidential Address

XXIII IUGG General assembly, Sapporo, Japan July 2003

by Fernando Sansó

Ladies and gentlemen,  
Dear friends and colleagues

Four years have passed since the last IUGG General Assembly in Birmingham and, as customary, the IAG President has to address all geodesists convened here in Sapporo, or better all geodesists that want to listen to us, with a speech where the point is made on the development of our science and of our organization, the International Association of Geodesy.

This implies looking at the last four years work, to our achievements, to how good we have been in promoting Geodesy and then looking at the future trying to understand where geodesy is going, at the sill of the new millennium and how we should best serve the purposes of our science in terms of an international scientific organization, but before doing that let us remember those geodesists that can not be with us anymore:

|                   |                                |
|-------------------|--------------------------------|
| P.V. Angus-Leppan | (Former President of IAG)      |
| S. Bakkelid       | (Norway)                       |
| T.K. Colic        | (Croatia)                      |
| J.F. Dracup       | (U.S.A.)                       |
| R.C.A. Angle      | (U.K.)                         |
| L.A. Haller       | (Sweden)                       |
| J. Lerch          | (U.S.A.)                       |
| J.J. Levallois    | (Former IAG General Secretary) |
| A.R. Robbins      | (U.K.)                         |
| T. Vincenty       | (U.S.A.)                       |
| H.G. Wenzel       | (Germany)                      |
| J. O'Keefe        | (USA)                          |

As for the past period I shall be very short because we have decided to leave room to Section presidents to present directly their own reports and it would be a waste of time just repeating what they will say in a better way.

To me is only left the duty to comment on the quality of the work done by our Sections and the underlying structure of Commissions, Special Commissions, Special Study Groups, Services and whatever other group has worked in the name of IAG. I hereby want to acknowledge formally that all the body of IAG, its officers, and primarily our Section Presidents Alan Dodson, C.K. Shum, Mike Sideris, Bernard Heck and Clark Wilson, have comprehensively done an excellent job which is witnessed by the number and the quality of Symposia, scientific meetings, schools, proceedings, books, publications of any kind in our own journals and even more in journals of our sister sciences.

In particular I have to mention the great success of our Scientific Assembly in Budapest where, with the effort of all of us and also thanks to our policy of

promoting and supporting the participation of young scientists and scientists from developing countries, we have been able to run, to my knowledge, the largest IAG meeting, showing that IAG can indeed collect the interest of a larger community and provide focus and guidance for the international geodetic research.

This is done by firmly advocating our scientific identity and by strengthening the cross-fertilization of ideas, methods and results that come from one sector of our geodetic activity into the other.

So we are here back again to define what is geodesy because this is necessary to look into the future.

Geodesy is an applied science; as a science it is defined by its object and its methods, as an applied science it is defined by its products and services.

Objectives:

Here I would like to use a pseudo-Helmert definition; the object of Geodesy is knowing the surfaces of the earth: the geometric surface by positioning and e.m. surveying, and the physical surface, i.e the gravity field, by land, marine or satellite gravimetry, and their time variations.

This "object" is naturally interlaced with other physical properties of the earth both through deep processes affecting its surface and through the gravity field at all different scales from the global to the regional and local, where most engineering applications take place.

Methods:

Are typically those of modelling observation equations including as many physical effects as can be identified by specific measurement techniques and then studying the statistical nature of residuals by several means.

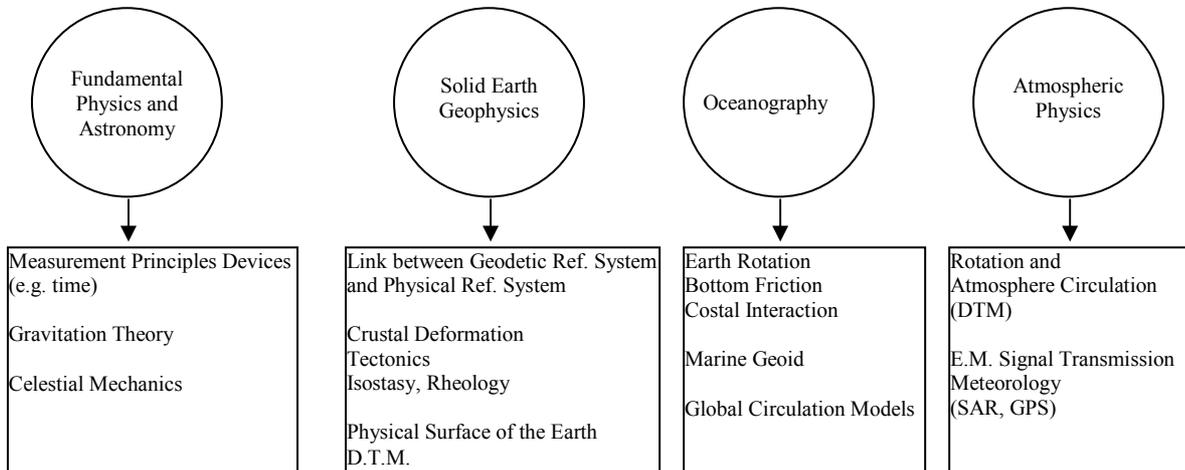
In the end we are then left with an optimal estimation problem where the unknowns can be either discrete in nature (sometimes even integers) or continuous like time signals or spatial fields, either governed by precise system equations or by approximated laws and henceforth either deterministic (at least in the average) or stochastic in full right.

In manipulating an increasing catalogue of physical phenomena showing up into the observations of

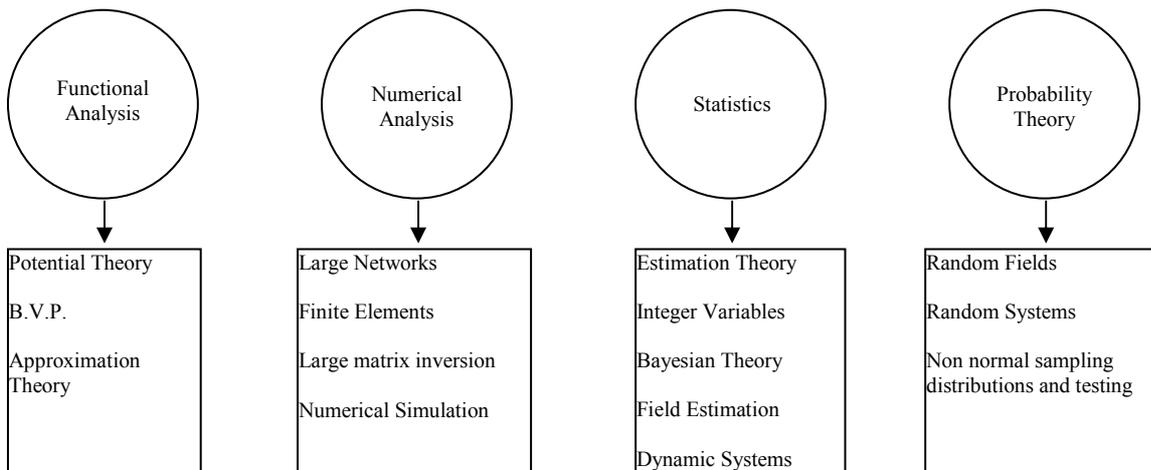
geodetic quantities we have enormously extended the baggage of knowledge which has to be in our arsenal of geodesists and the fields of their applications. I have been trying to outline the main interfaces of

Geodesy with other Sciences, which I have grouped into 3 families: **Physics**, **Mathematics** and **Engineering**. I'm sure this picture is far from being complete, however I hope it is representative and I will need it later in this talk.

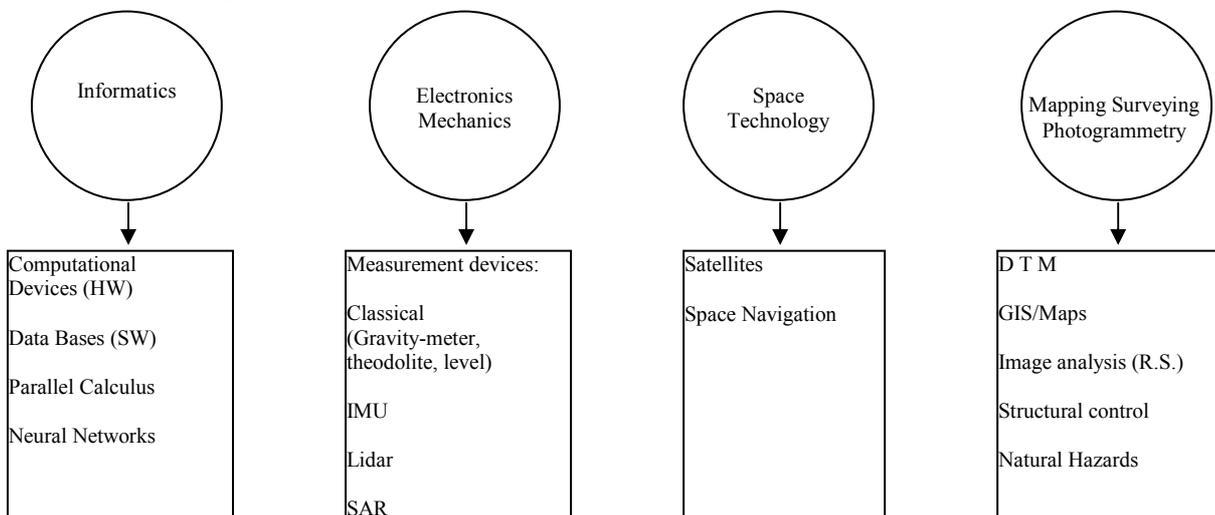
## PHYSICS



## MATHEMATICS



## ENGINEERING



## General Products:

Are indeed the knowledge of the objects of our investigation, i.e. the geometric surface of the earth and its gravity field jointly with their time variations.

In this respect we have to stress that knowing the geometric surface means also being able to attach precise coordinates to points lying on it and this can be done only by defining on the same time a unique reference system to which all positions have to be referred.

This is one of the most important general products of IAG, provided to all the other geo-sciences and techniques; namely how to refer any spatial event on the earth and in the surrounding space to a unique reference system attached to the earth.

In a very similar fashion when we speak of the knowledge of the gravity field, particularly in terms of one of its equipotential surfaces, we implicitly mean that we are able to accomplish the unification of the many more or less local representations of it for instance identifying in a unique mode the queen of these surfaces, the geoid, to serve as a unique reference surface for heights on the earth, i.e. the unified worldwide height datum.

## Services:

Are structures, that have autonomously accepted to serve under the IAG banner, although they might on the same time be working for other organizations too, that are focussed on providing specific products and spreading them among the users.

The actual list of Services working in the IAG framework is:

|       |  |
|-------|--|
| IGS   | International GPS Service                              |
| ILRS  | International Laser Ranging Service                    |
| IVS   | International VLBI service for Geodesy and Geodynamics |
| IDS   | International Doris Service (New)                      |
| IERS  | International Earth Rotation Service                   |
| IGFS  | International Gravity Field Service                    |
| BGI   | International Gravimetric Bureau                       |
| ICET  | International Center of Earth Tides                    |
| IGeS  | International Geoid Service (Milano)                   |
| PSMSL | Permanent Service for Mean Sea Level                   |
| BIPM  | Bureau International des Poids et Mesures, Sec.2       |

As you can see in the case of the gravity field a federation of different centers has been implemented and I think some unification process could be advisable

as well in the galaxy of Services related to different space techniques.

Now that we have shortly re-defined what we are, let us try to understand from where most likely we shall receive impulses for progress. Apart from our internal strength we try to look into the external sources of fuel for our machine. Without any doubt our first resource is the investment that the society in general is willing to do in matters concerned with geodesy.

In this respect we have to be clear that, as for the past, the resources will be most easily provided at a national level for the purpose of some specific geodetic job (e.g. setting up a national positioning service or computing a high resolution local geoid), while it is more difficult to achieve a strong support for those activities that, though fundamental from a scientific point of view, have no immediate direct impact on the social life, like the global geodetic monitoring of the earth and the maintenance of a global Reference Frame.

For instance when it happens to me to say to a politician that I'm a geodesist, and this has to do with the monitoring of the earth, even in the best case from the cultural point of view, I'm usually required to give opinions on earthquakes predictability.

All that has two important consequences: the first is that we should never think of our new and challenging global scientific work as a killer of the local level geodetic work. Rather the contrary, the local level work can help us in claiming that we need, as we do, a worldwide unification of the geodetic information, which is essential to be able to distinguish the local features from global effects. The second consequence is that IAG has to produce a large and well organized effort in order to let the general community understand the importance of what we do for the other sciences and techniques and, ultimately, for the Society itself.

Apart from economic and social matters, I think that scientific and technological impulses on geodesy, in the next 10 years, will come from:

- Informatic HW and SW development. In particular the exponential low for the development of computing power has not yet exhausted its trend and completely new technologies are close to enter into the market

- More advanced technology in geodetic instrumentation with two main characteristics : one is the usual trend in improving accuracy, the other is to increase enormously the mass of information, also thanks to the diffusion of a large number of geodetic apparatus with may be a lower accuracy performance but also with a very low cost, which makes

them accessible to a large community of users (as an example think of GPS)

- More advanced spatial technology for an improved surveying both at a global scale (think for instance of the new gravity missions CHAMP, GRACE and GOCE) and at a local scale (think for instance of the high resolution imagery or the inSAR surveying), to the effect of continuously growing the mass of information available to us; and all that, not only for the Earth but also for the other planets, which are our job as well (let us take the occasion to wish the greatest success to the recent missions to Mars)
- more advanced knowledge of the physics of the solid Earth, e.g. to facilitate the modelling of the crust deformation in geodetic surveying, of the ocean, e.g. in improving the knowledge of the global circulation pattern thus making more usable the satellite altimetry for the estimate of the marine geoid, of the atmosphere, e.g. providing better corrections for the effects of the propagation of our GPS signals,
- certainly a stronger progress in mathematics (e.g. in the area of dynamic systems or that of random fields) as well as in statistics and data handling, driven by the great possibilities provided by the new electronic tools.

Of course I don't even attempt to be exhaustive but I think that the mentioned items will really impress a strong push to geodesy. So we can ask now, what will Geodesy do for the other sciences?

First of all we shall pursue our general scopes, and in that we will serve all the other geosciences by providing a global geodetic reference frame maybe with an accuracy in the millimetric range and a unified height datum, maybe in the centimetric range.

In this respect let me be clear; I know we have talked about the 1cm geoid since years, however we are still far from this goal in absolute sense, and maybe with the help of the new gravity satellite missions we will be able to approach that figure as an overall upper bound of the error.

Already being able to bridge at such a level of accuracy between the geometrically/kinematically defined reference frame and the physical reference systems, both in the sense of the gravity field and of the rotation of the earth, is an enormous step ahead in understanding the physical behaviour of this complicated "system Earth" and geodesy seems to be in pole position not only to provide the necessary experimental information, but also to solve the difficult knot of modelling the interactions of the subsystems of the earth.

In addition we expect geodesy to take the leadership of the new concept of continuously surveying the Earth from space even at a regional level, exploiting its natural skill in combining different observation equations in a unique system.

To do this I'm sure that an improved structure of IAG Services will play a major role in providing data and specific products, for instance in such fields as engineering positioning and navigation, regional crustal deformation, digital elevation modelling, gravity and gravity variations surveying, atmospheric parameters monitoring, steady oceanic circulation and variability etc.

On the other hand geodesy, with its new big challenge of optimal combination of different huge data sets, will be able to work out, as it happened in the past, original methods of field modelling and spatio/temporal signal analysis thus giving contributions to different areas of mathematics in terms of interesting problems and advanced solutions, for instance for items like satellite dynamics, boundary value problems, random fields analysis, general estimation theory with integer variables etc.

Remember that all the other sciences, including classical signal analysis, have been living for more than one century on the concept of least squares, which has been worked out in a geodetic context and thus is in its full right a contribution of geodesy to all other sciences.

I wish and I believe it will be possible that something similar will happen in the next years for instance by proposing a unified view on the very general item of field estimation, especially for inverse and improperly posed problems theory.

I think we have the human potential to achieve all that, but is IAG ready to help with its structure this process?

When I Answer yes, I'm very confident that I'm just saying the truth. The deep reorganization of IAG and the new Status and ByLaws, which have been voted by the IAG Council at the extraordinary meeting in Budapest and are now implemented after the General Assembly, have been illustrated several times and will again be presented by our new (in a few days) IAG President Gerhard Beutler, who had a very large part in driving the renovation process.

Here I want only to recall the three main principles of our restructuring:

1. we have added lots of flexibility to our organization; in fact we have eliminated one layer in the structure creating new Commissions which will be able to set up different substructures or disband them, when necessary, in a very fast and informal way, for instance giving rise to joint Study Groups with other Commissions and / or other Services,
2. we have greatly enhanced the role of Services who are now directly represented in the IAG E.C. through 3 regular members; in addition Services, which are now at the same level as new Commissions, can organize their own work in terms of projects, working groups etc. where individual scientists are invited to participate,

3. we have created new structures to give a much greater visibility to IAG among other sciences and to the general public; such is the Communication and Outreach Branch and in a sense also the IAG project IGGOS that will help to let the great job done by services to be known to a very large community and hopefully acknowledged.

Somehow corresponding to these three principles we can identify also three main lines of the IAG policy:

1. The flexibility should be a factor of internal strength to better cooperate among us and to open the doors to any scientist willing to approach IAG and work with us.
2. The enhanced role of Services is on one side the guarantee that all the other geosciences and techniques that do need us now, will continue to need us for a long time; on the other side their activity, proposed also to individual scientists interested in some particular cooperation, can be a powerful tool to penetrate more the world of national services and agencies showing to them how they can valuably contribute at an international level; and this can be very effective in particular for the diffusion of IAG into developing countries.
3. The communication and outreach branch is somehow the diplomatic structure of IAG to help our scientists to be recognized in general as well as in the environment of the disciplines that mostly communicate with us.

Based on these concepts I would like to close with a small warning and a wish.

I'm absolutely in favour of so many of us working in geodesy as well as in our sister sciences, but I warn you to do that without forgetting where you came from.

My wish is that in the next 10 years geodesists would spread in all geosciences and techniques, but at the same time they would find the work of IAG so interesting in itself, that they could become just ambassadors of geodesy demonstrating the usefulness of its international organization, the interest of participating in its symposia, of publishing in its journals and bulletins so that in the end we could really look at ourselves and be proud of being IAG members because this means being an engine of human knowledge of the Earth and the planets.