

The Department of Geodesy  
at Wuhan Technical University of Surveying and Mapping, (WTUSM)

Observations and recommendations based

on a stay from June 18-30, 1990

by

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## 1. Introduction.

The Wuhan Technical University of Surveying and Mapping (WTUSM) is - as the name indicates - specialized in research and education in the surveying and mapping area. Geodesy is here one of the main disciplines, which technically supports the other main fields at WTUSM, photogrammetry and cartography.

I will here report on my observations on the geodesy education (section 2), on the geodetic research (section 3) and on the management and administration (section 4). The report is based on several long interviews and on visits to the Department of Geodesy, the library and the computer center. The observations have not been checked by my hosts at WTUSM, and I apologize for all errors.

The final section 5 contain a summary of my recommendations.

I was joined at this visit by my wife, professor Janni Nielsen, who assisted me during the interviews. We both visited WTUSM first time in 1981. Since this time WTUSM has become a leading institution at the international level. Teaching, research and physical conditions have improved very much in the intermediate period. Our Chinese colleagues and friends are to be recommended

very much for their greath progress.

## 2. The geodesy education.

We had 2½ hours of information exchange and discussion with 10 teachers, including the president prof. Ning and the head of the Geodesy Department, Prof. Tao.

Students have to pass an entrance examination (in math. and english), at which point they already have to chose specializa- tion in geodesy. Only by special permission can a student be allowed to change "field". 30 students are accepted, of which only 10% are female. (For the whole university 30% are female). The admitted students are divided in two groups, depending on their knowledge of math. and english, and first year taught according to their level.

The B.S.-degree is a 4-year program, and there is given appr. 2100 lecture hours, plus appr. the same amount of excersice and practic hours. The year is devided in 2 semesters of 20 weeks. Exams after each semester.

The curriculum is divided in compulsory and optional subjects, of which the students must choose a minimum of 2 subjects.

First year consists of:

Compulsary: Mathematics, Physics, English, Sport, History of China, Basic computer language, Plane surveying

Optionally: a second language, either Russian, German, French or Japanese.

Second year consists of:

Compulsary: Mathematics, Physics, English, Political econom- ics, Philosophy, Physical experiments, Adjustment surveying, Mechanics, Gravimetry,

statistics and probability, and some basic course in specific disciplines depending on the students specialization.

Optionally: Integral transforms, Fourier Analysis, Complex functions, Advanced map projections.

Third year consists of:

Compulsary: Astronomy, applied theoretical geoastronomy, by the end of the 3rd year students have 2 weeks of gravimetry praxis and 2 weeks of astronomy praxis.

Optional: Digital electronic technology, advanced english, scientific information retrieval, advanced computer course.

Besides the students make geodetic experiments and do field practice, sometimes in other provinces.

Fourth year consists of:

Compulsary: Physical geodesy, Satellite geodesy, Earth shape and it's external gravity field, Surveying and mapping, Engineering surveying.

Optional: Complex function theory, survey law, marine geodesy, land management, Extra terrestrial laser ranging.

By the end of the 4th year the student has to write a dissertation. The teachers suggest different topics - but students may also choose a topic of their own. The students are given 10 weeks to write the dissertation, which may be the result of individual

work, or the work of a group (max 3 persons). The evaluation board of dissertations consists of 3 persons, one being a professor from outside the Wuhan tech. Univ.

Approximally 90% of the 30 students per year in geodesy graduate with a B.Sc. and they were reported to have no difficulties in finding jobs. 10% out of the Batchelors (3-4 students) go on to study for a M.Sc.

In order to be accepted as a grad. student an English national test must be passed. Students are then selected based on an entrance exam. Of the total body of M.Sc. students, 14 comes from within the university, and 34 has B.Sc. degrees from other universities including students who have been out in practice. The M.Sc. degree is not a fixed program like the B.Sc., but more individually based. It is estimated to take 2 years, at the most 2½ year. During this time the student also give courses - which may be completely unrelated to the students own research - to younger students.

The main courses for the Master degree in geodesy are:

- Advanced physical geodesy
- Geodynamics
- Generalized surveying adjustment
- Optimization & design of geodetic networks
- Satellite geodetic data processing
- Theoretical geodesy
- The application of probability statistics in surveying
- Integrated geodesy

They are all optional. However, the choice of courses depends

upon the students specialization and the research of the advisor. During the 5th year the student must take a course in dialectic research methods, and he must pass an exam in advanced English. Besides these subjects, the students are also given the choice of a second language, which include Russian and Japanese. During the 6th year courses in advanced computations, data processing and datamanagement are also given.

The masters thesis is evaluated by a group of 3 professors, one of which is from outside, appointed by the Ministry of education on the basis of suggestion from a Ministerial board of university professors.

The Ph.D. degree is not a fixed program (no formal lectures), but individually based.

About 1-2 M.Sc. students go on to study for the Ph.D.-degree.

They must submit

- a research proposal
- 2 letters of recommendation from professors

Also, the student must pass an entrance examination.

It is estimated that a Ph.D. study takes 3-4 years. This includes the 1 year service (which may have no relation to the profession) out in the country which students are required to do after graduation.

The Ph.D. student regularly gives seminars on his research. Besides that they also teaches regular courses for younger students.

### 3. Geodetic Research.

The geodetic research at WTUSM was discussed in a 3½ hour session, in which participated both professors, lecturers and

graduate students.

The Geodetic Department has quite a complicated structure, consisting of several sections and laboratories, and a separate Geodetic Research Institute. The latter organizes members of the staff, who are assigned 100% to research. The remaining staff execute research, in the time they are not doing teaching or administration. There is no fixed percentage research/lecturing/-administration. However, several mentioned, that they also used their free time for research.

Research is naturally also carried out by Ph.D. and M.Sc. students, who generally contribute to the research projects of their advisors.

The teachers may select their own research topic, but contribute also to joint research projects. Several of these projects (6 out of 25) have received external support (national grants), either from China National Science & Technique Council or from the National Scientific Research Foundation. Funds equivalent to 230000 \$ U.S. have been obtained for projects lasting 2-3 years, generally. Since the WTUSM is financed by the National Bureau of Surveying and Mapping, it is likely that extra funds may also be obtained from this Bureau, (which acts like an independent government department).

The important issue related to projects founded externally is that they may include funds (currency) to acquire instruments, books and computer equipment from outside China, and also travel grants.

The department of Geodesy is the leading geodetic research unit in China, both because of its quality and its size. Computing geodetic research centers are The Institute of Geodesy and

Geophysics (also in Wuhan), the Research Institute of the National Bureau of Surveying and Mapping in Beijing, and the Shanghai Observatory.

WTUSM organized in May 1990 the 8'th international Symposium on Geodetic Computations. Out of totally 113 papers, 33 were submitted by scientists from WTUSM, 51 from other Chinese Institutions and 29 by foreigners. This is a good indication of the role WTUSM plays in Chinese geodesy.

The main research fields are: Space Geodesy, Gravity Field Modelling and Gravimetry, Geodynamics and Surveying adjustment and data processing. Both theoretical, computational and instrument/measurement techniques are dealt with. The research is organized in 25 projects, of which 8 are considered main projects. The main projects are the result of a two-way agreement between WTUSM and the National Bureau. And the initiative to give a project high priority may come from either of the two places. They are executed by 11 (full) professors, 26 associate professors, 16 lecturers and technical supporting staff, which includes 2 superior laboratory technicians.

Appendix 1 lists the main research projects as of May, 1990.

The research is published primarily in Chinese journals of which some issues are translated into English. Lately, a few papers have been published in international reviewed journals (Bulletin Geodesique, published by the International Association of Geodesy and Manuscripta Geodesica, published by Springer Verlag). Otherwise international publishing has primarily been in un-reviewed symposia proceedings. One of the problems here is clearly, the imperfect knowledge of the English language. Here

support, using professional translators, would very much improve the quality (readability) of the papers. (Some papers submitted to Bulletin Geodesique, of which I am the Editor-in-Chief, have been nearly unreadable).

Much of the research published is theoretical, primarily improvements of mathematical models. Few discuss numerical procedures, and very few deal with actual data. Here some of the problems are related to:

- (a) In China geodetic data are still considered partly military secrets (positions, gravity)
- (b) Some data available e.g. from the World Data Centers or even from other Chinese institutions are considered expensive (even 100-200 \$ U.S. is a lot of money)
- (c) Access to data are frequently in the western world obtained on an exchange basis. Here the secrecy policy (a) limits possibilities for using this procedure to obtain data.

The emphasis in geodetic research at WTUSM has correctly been put on research in:

- (a) support of providing basic geodetic position (latitude, longitude, height) and gravity networks and
- (b) geodynamic research, supporting earthquake and land movement studies.

However, in the western world two areas are now important:

- (c) studies related to global change/climate change and
- (d) research related to resource exploration (oil and gas).

Here are research areas, which could be cultivated also at WTUSM. (Two of my lectures were related to these topics).

It is clear, that much high-quality research is carried out at WTUSM. A major jump forward has taken place since my visits in 1981 and 1984, respectively. This is surely due to a good local leadership and an increased contact with scientists outside China. However, these contacts could be further improved. Still relatively few scientists participate in meetings outside China. The new restrictive policy (since May, 1989) also have created new difficulties. Even in case funds are made available from outside, a Ph.D. students will not be able to obtain permission to go abroad for an extended time, except in special cases. Young staff members mentioned that it is senior staff members who are allowed to travel, even when it would have been more appropriate to send a younger scientist.

Part of this policy of restricting Ph.D. students possibilities for studying abroad are understandable, considering the large number of Ph.D. students, who did not return after May, 1989. However, the news strict rules will make it even more unlikely that the students will return. M.Sc. and B.Eng. are requested to serve their country at least 5 years after their graduation, before they can go abroad. Students with overseas relatives may leave after paying a 4000 \$ U.S. deposit (1% interest). Chinese colleagues did comment, that this surely would mean that the students would stay abroad, because they would consider their obligations towards their country to be relieved by paying (giving up) the 4000 \$ U.S.

Research equipment (instruments) was described as being generally sufficient. 4 new Trimble Global Positioning System receivers have recently been acquired. However, the department did not realize that they had not ordered an important unit to be used when using the GPS receivers in navigation mode. This extra unit is badly needed in one of the major research projects.

Computers are readily available - to a certain extent. 7 PC of varying capacity are available, and the Department has access to the Siemens mainframe and the Vax computers at the computer center. However, all the computers are heavily booked up, and local increased computation power is very much needed. The implementation of a computer network, connecting the Department with the computer center has been delayed due to lack of funds. Such a network would be extremely important for optimal use of the existing and new computer resources.

Outside China, low-speed, low-volume computer networks have very much enhanced scientific communication and data exchange. (BITNET, for example). It would be extremely important to have WTUSM and other research institutions in China connected to this network. WTUSM would be an excellent place to test such a network in China, and it goes without saying that it would ease the life of visiting scientists, who in this way could keep contact with their home institution while away - and maintain close contact with chinese colleagues after having returned to their home.

We discussed several times with the Chinese hosts, who they would like as visitors in the future. Several names of well known geodesists were mentioned. Considering the research plans of WTUSM, and the above mentioned underdeveloped research topics, I would recommend prof. R.H. Rapp, and prof. C. Goad, both Ohio

State University (USA), prof. K.-P. Schwarz, University of Calgary (Canada), address are given in Appendix 2. Prof. R.H. Rapp deals with gravity field modelling, is president of the International Geoid Commission and could very much help with several of the research projects. Prof. C. Goad is one of the worlds leading GPS expert, and has very much experience with the type of receivers acquired by the Department. Prof. K.-P. Schwarz is the leading expert in inertial surveying and navigation. He has already extensive contacts with this and other Chinese universities.

#### 4. Management, administration and other non-academic issues.

The management and administration was discussed in a 2 hour session with participation of professors, lecturers, graduate students and representatives of the Foreign Affairs Department. This was followed by a 1½ hour visit to office and research facilities.

The WTUSM has a top-down management structure. Suggestions may come from the Department, but the president of WTUSM decides. Students and technical staff has no formal influence. The students Union may consulted by the president if he finds it needed.

Considering last years student unrest, it seems urgent to establish a more democratic structure, which directly engage the academic and technical staff and the students in the decision making and planning process. This probably has to be implemented gradually, considering the lack of democratic experience in China in general.

A teaching carrier generally starts with an appointment as an

assistant lecturer. After 5 years one may apply for a position as a lecturer, and will have to pass an english test. The applicants to positions as lecturer and higher positions are also judged based on their performance in teaching (quantity), and research. We explicitly asked whether service to the community, such as having worked at the countryside, would play a role. This was denied. Only academic qualifications counts.

Promotions does not (anymore?) depend on seniority. It was mentioned that a 35-year old scientist recently was promoted to associate professor.

We mentioned the problem, that little exchange of staff with other chinese universities took place. Open positions are not announced nationwide. However, it was mentioned that this could maybe change in the future. Here is a major defect in the university system. On the other hand, several of the professors worked part time as professors at other Chinese Universities (the Department Head were associated with two other universities). So in this way some cross-fertilisation does take place.

There seems to be a reasonable amount of laboratory space, however, my hosts said, that they easily could use more. Only the head of the department has a separate office. Other offices are shared between up to 8 scientists, and are of this reason primarily used for meetings of branch or laboratory staff. Some scientists mentioned, that they of this reason went back to work in the evening, because they then could work undisturbed. It should be mentioned, that PC's were placed in a computer room (air-conditioned!), and not available in the offices. Also the offices had no phones. No books seems to be readily available, but are read in the staff reading room at the library.

The building of the Geodesy Department is one of the oldest on the campus. Funds should be put aside for a complete renovation of the building. Also building maintenance seems in general to be a problem. Investments are directed to the establishment of new offices and staff living quarters. But it is depressing to see buildings deteriorating, due to the humid weather of Wuhan and the normal wear, as a result of intensive use by staff and students. But even a little fresh painting here and there would change things very much! Landscaping around buildings are nicely laid out, but absolutely unkept. Weeds are not removed, for example.

Lack of leadership and experience in building maintenance could be the main reason for the defects. Learning simple maintenance of buildings is essential, and along with this the management and organization of a maintenance team.

Papers are frequently typed by the scientists themselves. Typing assistance using latin letters is not available at Department level. Text-processing using PC's seems not to be used, as also good printers are not common. Besides computer use costs money. Disks - even paper is considered expensive.

The staff all live at the university. The professors in apartments with an area of up to 90 m. Younger lecturers, even married couples (with a child) lives in one room (appr. 25 m<sup>2</sup>), sharing kitchen with others on the same floor and bathroom with everybody in the building. When asked they agreed that even under these conditions they had better conditions in terms of status than skilled workers of the same age and clearly better conditions than at most places in the countryside. But they naturally would like to have more space, especially because many also worked at

home due to the scarce and crude office space.

The responsibility for keeping order in and clearing the living quarters belong to the families living there. But in the building we saw stairs, corridor and kitchens which were filthy. It seems the cleaning insponsability only is felt to cover one's own room. Proper management and organization of cleaning team could greatly improve the common areas. And paint of walls and e.g. linoleum on the floors would be an improvement and make cleaning possible. Using linoleum on stairs and floors instead of concrete walls and stairs would make cleaning and maintenance possible.

#### 5. Conclusion and recommendations.

The geodetic education is very specialized and seems not to have much overlap with the other fields of education at WTUSM. However, all obligatory subjects are relevant, except the history of China and political economy. These subjects should not be obligatory.

It was my impression, that the teaching is of high quality. This was also confirmed by the masters thesis and Ph.D. dissertations, which I inspected.

The staff produce high quality geodetic research, which attracts national funding. The published papers mainly deal with theoretical or computational problems. Few numerical results are published probably due to the military security restrictions. This makes it difficult for the scientists to participate in data exchanges, through which they could get access to e.g. new satellite information.

The research topics are primarily in areas of direct interest for the National Bureau of Surveying and Mapping. It should be

broadened to include research related to global change and climate change and resource exploration.

Geodetic research is global, and requires global cooperation. The contact with scientists outside China should be improved. More, especially younger scientists, should be able to participate in scientific conferences or schools outside China.

Computers are used extensively, and are heavily booked. A local computer network would help to exploit the existing capacity to its full extent. It would be extremely important, if a local network could be connected to the international scientific network, BITNET.

WTUSM has a top-down management structure. Experiments should be started, where advisory committees are established with participation of both staff and students.

A high degree of in-breeding takes place. Positions as assistant or full professor should be announced nationwide, in order to attract staff from other universities, from sector institutions or overseas Chinese.

Offices are scarce and are shared between many staff members. A residential space is equally scarce, it makes the working conditions difficult.

Buildings are not always maintained properly. The heat and humidity in Wuhan makes the conditions difficult, but efficient building management and maintenance should be implemented.

## Appendix 1. The main research projects as of May, 1990.

### Main Research Projects & Outcomes

#### Contemporary Adjustment Theory and Application

Main contents of this research are:

- Models for advanced surveying adjustment
- Dynamic Kalman Filtering
- Rank-defect network adjustment
- Variance-covariance component estimation
- Error analysis and gross error detection

A series of results with both theoretical and practical values have been obtained, some of which were awarded the prizes for National Scientific & Technological Progress by National Bureau of Surveying and Mapping and by National Education Council respectively.

#### The Modeling of the Earth's Gravity Field

The method has been investigated for determining the high-degree harmonic expansion coefficients of the Earth's gravity field, using heterogeneous data available including those from SLR, Doppler tracking, Satellite altimetry and global ground gravimetry. The research has also involved in combination adjustment technique with both ground gravimetric data and satellite tracking data, and in the application of Fast Fourier Transformation technique (FFT) to the computation of the gravity field modeling.

#### The Theory and Application of Earth Tide and Ocean Tidal Loading

The main task of this research project is to investigate the effects of the earth tide and ocean tidal loading on various geodetic observation quantities such as gravity, precise leveling measurements, etc.. A campaign for the observation of earth tide and ocean tidal loading was carried out at Wuhan, Halbin, Cuelyang and Wannin lasting two years. All the measurements were made using Lacoste-Romberg "ET" gravimeters. The data obtained was processed and analyzed. It shows that the results are of important scientific and practical values to various activities in the fields of Geodesy, Geophysics, Seismology, Oceanphysics and Geology etc..

#### The Theory of Combined Adjustment of Satellite & Terrestrial Network and Its Application in the Northwest Satellite Network of China

The purpose to set up the Doppler Network in Northwest region of China is to densify the National Control Network and to meet the needs of petroleum exploration and mining. The project was sponsored by Oil & Mine Ministry of China. The theory and technique of combined adjustment with two types of data (satellite & terrestrial) were widely investigated and a best model (including the software) for the data processing was presented. The results were also awarded the prize for the

### Surveying & Mapping in Antarctica

The geodetic activities in the Antarctica region involve in the following items:

- The establishment of geodetic reference systems for the two scientific expedition stations of China, the Great Wall station and Chong-shan station, including the establishment of the geodetic origin, horizontal datum and vertical datum, and the set-up of geodetic control networks, precise leveling networks and gravity networks.
- The topographic surveying in the vicinity of the two stations and on Feildes peninsula, with the map scales 1:1000 and 1:2000.
- The establishment of the deformation monitoring network along the Feildes fault zone. The re-observation of the network and the results analysis.
- Monitoring the movement of the glacier and glacial cap on the Halswin island.
- Monitoring the subsidence and deformation of the constructions at the two stations.
- The test of the close-up photogrammetry in the Antarctica area.
- The experiment of the adaptability of gyro-theodolite in high-latitude region.

### The Software Package for Surveying Adjustment

The software package is developed for the use on microcomputers which have already had a large number of users in China. The package is made up by following modules:

- Module for leveling network adjustment
- Module for triangulated height network adjustment
- Module for triangulation network and distance-angle network adjustment
- Module for trilateration network and distance-angle network adjustment
- Module for traverse network adjustment

These modules are designed such that they can be performed flexibly and efficiently.

### Microcomputer-Based Geodetic Data-Base System

The system has been developed as the data base and the management base for various geodetic data, original observations and adjusted results, within a scope of a provincial or a local region. Supported by plenty of software, the system has its strong editing and maintaining capacity. As an example, by using the base, an adjustment of densified network can be easily performed. The adjusted results will be placed back into the data base and a sketch of the adjusted network will be plotted automatically.

## Static-&Dynamic-Integrated-Geodesy and-Corresponding-Software-Package

Integrated geodesy approach and its softwares allow integrated processing of all types of geodetic observations including those of terrestrial and spacial ones to simultaneously determine 3D positions of points on the earth's surface as well as the gravity field parameters. It can also be used for various kinds of ordinary geodetic data processing, such as 2D or 3D geometric adjustment, geoid determination using astronomical and gravity data in a physical geodesy way. The software package of dynamic integrated geodesy can be applied to processing and analyzing the monitoring data of crust deformation to determine the Earth's stress-strain parameters.

### Facilities

Various types of geodetic instruments, both conventional and modern, are available in the Department. They are:

- .GPS receivers (Trimble 4000 sst)
  - .Doppler receivers (CMA722B, MX1520)
  - .Gravimeters (Lacost-Romberg ET, G)
  - .Synthetic Mapping System (Sp900A)
  - .Universal Theodolites (T4 DKM3A)
  - .Cesium Clock
  - .Microcomputers (Great Wall,  
IBM286, AST386)
- and other theodolites, EDMs and Levels.

Appendix 2. Adresses of scientists proposed to visit WTUSM  
in the future.

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