A DISCUSSION ON STANDARDS OF EDUCATION IN PHOTOGRAMMETRY AND REMOTE SENSING.

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Abstract

The paper suggests a basis for discussion about standards of education in Photogrammetry and Remote Sensing with an emphasis on the various gradings of education at professional levels.

An analysis of "Active" and "Passive" Photogrammetrists and Remote Sensing specialists is made to determine the minimum amount of Photogrammetry and/or Remote Sensing required for a meaningful education of professional specialists in associated fields such as Surveying, Cartography, Civil Engineering and other professions making frequent use of Photogrammetry and Remote Sensing.

Suggested education required for specialists in Photogrammetry and/or Remote Sensing is also discussed.

Finally minimum requirements for technician education and training are also suggested.

Introduction

The ideas and opinions on education in Photogrammetry and Remote Sensing on a world wide basis are so varied that it will be hard to achieve some degree of consensus on internationally recognized standards.

While the question of the extent of Photogrammetry is reasonably defined, the same cannot be said about Remote Sensing. The question of what should be included in a course in Remote Sensing will vary from person to person and opinions will be influenced by the discipline from which the writer or speaker originally entered the field.

It is quite obvious that the author of this paper comes from a photogrammetric background and will willingly accept criticism and suggestions to put Remote Sensing into a perspective acceptable to a majority.

The aim of this paper is to start a discussion on the standards of education in Photogrammetry and Remote Sensing on an international level with the hope of agreeing upon some standards which will be mutually recognized by the members of the ISPRS.

The topics to be introduced, number of hours allotted to the various to topics, the pre-requisite studies and other detail discussed in this paper are only initial suggestions based on the literature researched and are subject to changes agreed upon by the participants of the Congress.

The break up of "active" and "passive" experts in Photogrammetry (see Hothmer P.E. and R.S., 1976) and Remote Sensing suggested in the paper are also subject to negotiations and changes. The author while realizing that various regions and countries of the world have differing requirements, could not avoid being influenced by his own region, past experience and the literature researched.

Classification of Standards

It is suggested to break down the whole problem of standards of education according to the following table:

"Active" : All active experts in Photogrammetry and/or Remote Sensing should fall under the classification of professionals. The levels suggested should be:

1. At post graduate level:

   (i) Ph.D standard;
   (ii) Masters standard;
   (iii) Graduate Diploma standard.

2. At under graduate level:

   (i) B.Sc. (or Eng.) in Photogrammetry;
   (ii) B.Sc. (or Eng.) in Remote Sensing.

"Passive" : Users of some aspects of Photogrammetry and/or Remote Sensing may be professionals in other fields which apply some techniques of the above sciences in their own fields. The number of professionals using or likely to use Photogrammetry and Remote Sensing for their own purposes is very large and includes, to a degree, more technical and scientific fields.

"Technicians" : These should be "Active" experts in the practical aspects of Photogrammetry or Remote Sensing operating equipment and physically executing procedures within the production processes in Photogrammetry and Remote Sensing. Their work should be performed under the supervision of a professional in the appropriate branch of Photogrammetry or Remote Sensing.

The author sees little room for an additional grading of "Technologist", which seems to be neither professional nor sub-professional.

It should be noted that a further breakdown of the gradings of classification may be necessary to allow for qualitative and quantitative topics within the sciences.

While "Active" experts in Photogrammetry and/or Remote Sensing must have a good background in both, qualitative and quantitative elements of the appropriate profession, it is not so for "Passive" and Technician standards.

A "Passive" Photogrammetrist may need only some metric topics in Photogrammetry and/or Remote Sensing. In such a case a good knowledge of associated mathematics and physics are prerequisites. Such is not the case where some knowledge of the interpretational aspects is required.

Similar is the situation for Technicians required to perform practically only some tasks in one of the sciences under the supervision of a responsible professional.

Contents and Duration : To arrive to a reasonable proposal for curricula for the various classifications a great number of university and college handbooks have been consulted. Again the contents should be regarded only as a first attempt to formalize minimum requirements.

ACTIVE

1. Post Graduate

(i) Ph.D : The study should be of at least two years duration post bachelors degree level for "Active" candidates with some practical experience after graduation, or one full year (12 months) post masters level. The study should be highly specialized and a large percentage of the work, or all of it should be research. The assessment should be made on the basis of a submitted thesis.

Because of specialization and originality no curricula can be set for the actual research, while pre-requisite studies largely depend on the research topic.

Ph.D standard qualifications should only be awarded by reputable institutions with some tradition in research and post graduate teaching.

(ii) Masters : A masters degree should be of such a standard as to be undertaken by either a graduate with a B.Sc. qualification in Photogrammetry and/or Remote Sensing, i.e. "Active" or a B.Sc. or similar qualification in one of the associated fields, i.e. "Passive".

A masters candidate in the field of "Active" Photogrammetry and Remote Sensing should study mainly by research with course work in the advanced topics of the science only. A candidate from the "Passive" field should be able to acquire more advanced theoretical knowledge in Photogrammetry and/or Remote Sensing than he already had from his undergraduate studies and produce a minor thesis as a result of investigating a project of a reasonable size.

The duration of studies should be of a minimum of one calendar year after a first degree.

(iii) Graduate Diploma : The course of studies should be aimed mainly at the "Passive" Photogrammetrists or Remote Sensing Specialists. These have usually not acquired knowledge in the full range of topics in the science of their choice. A Graduate Diploma should be a transition course from a "Passive" to an "Active" professional in one of the sciences mentioned (i.e. either Photogrammetry or Remote Sensing) and be not necessarily of a standard higher than a B.Sc. in Photogrammetry and/or Remote Sensing.

The duration of such a course should be one academic year, i.e. about 8 months of full time or the equivalent of part time study.

2. Undergraduate

(i) B.Sc.(or Eng.) in Photogrammetry

The course of studies should contain at least a three year program after the necessary successful completion of high school studies. (12 years of schooling). The entrant should have a valid university or college entrance certificate with prerequisite studies in mathematics, physics and possibly also computer science. These prerequisite studies should be of a standard which will give the candidate a reasonable chance of success in the tertiary course undertaken.

The suggested composition of the course should be:

Year of Course	Subjects	Hrs/Wk
1	Mathematics 1	5
	Statistics 1	1
	Physics 1	3
	Computer Science 1	4
	Photogrammetry 1 (Theory)	3
	Photogrammetry 1 (Practice)	5
	Image Interpretation	2
	Total	23

Year of Course	Subjects	Hrs/Wk
2	Mathematics 2	2
	Statistics 2	1
	Computer Science 2	2
	Elementary Surveying (Theory and Practice)	4
	Cartography for Photogrammetrists (Theory and Practice) 1	3
	Photogrammetry 2 (Theory)	3
	Photogrammetry 2 (Practice)	5
	Remote Sensing for Photogrammetrists (Theory and Practice)	4
	Total	24
3	Cartography 2	3
	Computer Cartography	4
	Photogrammetry 3 (Theory)	3
	Photogrammetry 3 (Practice)	5
	Remote Sensing for Photogrammetrists (Theory and Practice)	4
	Dissertation	2
	Management Techniques	2
	Total	23

(ii) B.Sc.(or Eng.) in Remote Sensing

The course of studies should be of a similar structure to the one in Photogrammetry with an emphasis on Remote Sensing. Previous educational prerequisites should be identical to the course in Photogrammetry.

The composition of the course :

Year of Course	Subjects	Hrs/Wk
1	Mathematics 1	5
	Statistics 1	1
	Physics 1	3
	Computer Science 1	4
	Remote Sensing 1 (Theory)	3
	Remote Sensing 1 (Practice)	5
	Image Interpretation	2
	Total	23

Year of Course	Subjects	Hrs/Wk
2	Mathematics 2	2
	Statistics 2	1
	Computer Science 2	2
	Elementary Surveying (Theory and Practice)	4
	Cartography for Remote Sensing 1 (Theory and Practice)	3
	Photogrammetry for Remote Sensing 1 (Theory and Practice)	5
	Total	24
3	Cartography 2	3
	Computer Cartography	4
	Photogrammetry for Remote Sensing (Theory and Practice)	4
	Remote Sensing 3 (Theory)	3
	Remote Sensing 3 (Practice)	5
	Dissertation	2
	Management Techniques	2
	Total	23

PASSIVE

A great majority of users of Photogrammetry and Remote Sensing belong to this category. The category consists of professionals in other fields each using some Photogrammetry and/or Remote Sensing. The tuition of Photogrammetry and/or Remote Sensing is often only for the purpose of keeping the associated profession in touch with available techniques. In other cases some limited practical skills and knowledge may be required. In all cases however, the time available for teaching Photogrammetry and/or Remote Sensing is limited and the best possible use must be made of the time allocated.

Proposals for the teaching of Photogrammetry and/or Remote Sensing in the courses with frequent use of the science only will be discussed here.

(i) Contents of Photogrammetry and Remote Sensing for Surveying Courses.

After investigating University handbooks of some 15 Surveying course structures in several countries around the world, it was found that in general Photogrammetry and/or Remote Sensing is taught in at least 2 years of the Surveying degree courses usually in the penultimate and ultimate years. While the time devoted to the subjects varies considerably between the courses, a content of 2-3 hours per week in the penultimate year and 3-4 hours in the final year seems to be a good average. As a percentage of the total content of the penultimate and final years of a surveying course, Photogrammetry and/or Remote Sensing amounts to approximately 10-15% in the penultimate year and 15-20% in the final year of many Surveying course curricula.

Consequently, the weekly loading suggested here follows the principles mentioned above.

The penultimate year of a Surveying course should have a 3-4 hours per week loading in Photogrammetry and Remote Sensing. This should include all lectures and practical/laboratory work.

In the final year of a Surveying course a 4-5 hours per week photogrammetric and remote sensing content including laboratory work should satisfy the requirements of a surveying graduate.

The aim of the teaching of Photogrammetry and Remote Sensing in a surveying course is to appreciate Photogrammetry and Remote Sensing as a surveying tool, to enable the surveyor to execute simple tasks and to be able to assess the potential of photogrammetry and remote sensing for tasks beyond his own knowledge and level of competence in Photogrammetry and Remote Sensing.

(ii) Contents of Photogrammetry and Remote Sensing for Cartography Courses.

The variations in the contents of Photogrammetry and Remote Sensing between various courses in Cartography around the world is even greater than in the Surveying courses. While some put strong emphasis on the drawing skills, others on thematic aspects, others again on computer cartography, in general however, there is a reasonable content of Photogrammetry and/or Remote Sensing in most of them. Some have as much as 30% of Photogrammetry and Remote Sensing in at least two years of the course.

It is recommended to have at least 15-20% Photogrammetric and Remote Sensing content in the penultimate year of cartography courses while in the final year a content of 20-25% is suggested. In hours per week this would mean a loading of 4-5 hours for the penultimate and 5-6 hours for the final year of the course including practical and/or laboratory work.

(iii) Contents of Photogrammetry and Remote Sensing for Some Engineering Courses.

It was found that the content of Photogrammetry and Remote Sensing varies from nothing to approximately 10% of the contents of the courses in two years of such courses. The content, as far as there is one, is mostly in civil engineering courses, though some courses in mechanical and other engineering have specific topics on their curricula.

To recommend a compromise, a content of 3 hours per week in a single year of civil engineering courses, in one of the more advanced years of the course, would be equitable. For other engineering courses, making use of special topics only, a recommendation is not made.

(iv) Contents of Photogrammetry and Remote Sensing in Other Courses.

Some courses in Geography, Environmental Science, Landscape Architecture and some others have in some instances a fairly sizeable content of Photogrammetry and/or Remote Sensing.

The content is usually of the qualitative type with photointerpretation and interpretative remote sensing as the main topics.

The amount of content is around 8% of the contents in one or two years of the courses usually in the earlier years of the courses.

It is recommended to have 3 hours of Photogrammetry and Remote Sensing in one year of the courses. The topics should cover mostly the quantitative fields with little prerequisite knowledge in mathematics and statistics necessary.

TECHNICIANS

The classification of "active" and "passive" do not apply to technicians. All technicians are actively involved, but usually only in a part of photogrammetric or remote sensing operations. Their theoretical knowledge can be limited to a background to the operations they will be required to execute, but their skills and practical knowledge in the field of their choice must be good. Hence, in almost all cases in photogrammetry and most cases in remote sensing, a healthy stereoscopic vision is necessary. This is because stereoscopic imagery will frequently be used during their working life.

While it is hard to pick all possible fields where technician training may be necessary, some of the most popular fields are mentioned below.

An investigation of several technician training courses disclosed that a course of 8 months duration has a good chance of turning out good technicians. All suggested technician courses here will be of a period of 8 months duration.

(i) Photogrammetric Operators

Prerequisites : Normal stereoscopic vision, ten years of previous schooling.
Recommended Course Duration : 6-8 months.

The aim of the course is to train people to become competent at operating photogrammetric equipment and other functions necessary to efficiently operate the equipment. As modern machines are often computer connected, some training in operating computers and microprocessors is also necessary. While education should predominantly consist of hands on equipment training, some 20% of the time must still be devoted to the teaching of theory required in connecton with photogrammetric mapping.

(a) Theoretical Training : This should consist of simply explained principles of the topics listed without going deeply into the mathematical aspects.

Basic principles of stereoscopy and parallax, the geometry of a single aerial photograph, tilt and height displacements, aerial mosaics, planning photography, principles of photointerpretation, orthophotography and rectification, the geometry of a photographic pair, the theory of orientations, analogue instruments, analytical plotters, comparators, terrestrial photogrammetry, terrestial cameras, and aerotriangulation.

(b) Practical Training : The trainee should be exposed to as great a variety of equipment as possible and acquire the skills of operating monoscopic and stereoscopic equipment. It is impossible to prescribe equipment which should be used, because of the great variety of existing instruments. The skills to be acquired should include the following:

The use of stereoscopes, pocket and mirror, orientations on stereo equipment, height and detail plotting, preparation of base sheets, plotting from terrestrial and non topographic photographs, numerical data collection and preparation of data bases, preparation of cross-sections and profiles, aerial triangulation using dependent and independent models, analytical triangulation from comparator data, orthophoto production and rectification, photography using terrestrial and non topographic cameras, the use of a microprocessor as a slave to a photogrammetric instrument.

(ii) Image Interpreters

Prerequisites : Normal stereoscopic vision, ten years previous schooling.
Recommended Course Duration : 5-6 months.

The aim of this course is to train people to competency in reading of imagery obtained either from inner or outer space. This imagery may be from cameras scanners or other devices as they come into existence. In addition to reading imagery, interpretation must also be taught for cases where image detail is not quite uniquely defined. Such detail may often be identified by deduction, hence the differentiation between image reading and interpretation.

Again, some theoretical principles in the fields of photography, photogrammetry and remote sensing must be taught. However, the greatest part of the course must be occupied by practical exercises.

A 20% theory, 80% practice ratio is recommended.

(a) Theoretical Training : This should include the following topics:

Basic principles of stereoscopy and stereoscopic parallax, the geometry of a photograph, tilt displacement, height displacement, aerial mosaics, flight planning, reading photography, interpretation of photography, multispectral photography, radar imagery, landscape imagery, interpretation equipment.

(b) Practical Training : The trainee should learn to use all aids and equipment available at the teaching institution. He should also learn the latest available techniques in interpretation of all types of imagery and draw overlays to base maps of various thematic maps such as geological, statistical, environmental and a great variety of others. The skills to be acquired should include the ones listed:

The use of pocket and mirror stereoscopes, the use of differential stereoscopes, pantographs, optical pantographs, projectors, rectifiers and other projecting, enlarging and reducing equipment, preparation of base sheets and the various thematic overlays to these sheets, the use of digitizers, the preparation of the thematic parts of data bases, the use of keyboards to computers or microprocessors.

(iii) Draftsmen

Recommended Course Duration : 5-6 months.

Though the need for draftsmen artists has diminished with modern technology, there is still need for trained draftsmen capable of producing good manual linework. However, the more important task of the modern draftsman is to use modern technological aids to the best of their ability and efficiency. The draftsman must also understand principles of generalisation and have a good training in understanding colour harmony and must develop an eye for aesthetics. The aim of the course is to give the student an elementary training in the above skills.

(a) Theoretical Training : This should consist mainly of the teaching of combining tone, colour, linework, lettering and artwork. Some of the more successful methods of teaching are the use of films, slides, overhead projectors and any other visual methods to demonstrate to the student the difference between what is true and false, good and bad.

Theoretical training should also include the use of modern equipment, hardware and software and the relevant theory for a good choice of map projections. Elementary map design should also be taught.

(b) Practical Training : The above theoretical teaching must be supported by extensive practice with modern equipment and drafting aids available at the teaching institution. Practical use of computer terminals for access to software used to draw sheets and graphic display units is also necessary.

Though hand drafting and lettering is not very often used in modern establishments, a draftsman trainee must still master these skills. It is therefore an essential part of a draftsman's practical training.

(iv) Other Fields

There may be room for other fields of technical education, the above three however cater for most of the needs at the present.

Course Contents

Any academic institution with post-graduate courses in Photogrammetry and/or Remote Sensing following an undergraduate level course as suggested earlier in this paper does not need advice about what to teach in such courses. Syllabus contents in this paper will be suggested for undergraduate courses of the active as well as passive type only. Block diagrams will also show the percentage of contents of Photogrammetry and Remote Sensing compared to the total loading in the active courses and the relative Photogrammetry and Remote Sensing contents between active and passive courses.

Syllabii for the Photogrammetry and Remote Sensing Subjects of B.Sc. in Photogrammetry and Remote Sensing (see pages 3, 4 and 5).

(a) Active

PHOTOGRAMMETRY 1

Duration: 8 hours per wek for 30 weeks.
Theory : 3 hours per week.
Practice : 5 hours per week.

Prerequisites: Matriculation mathematics.
Matriculation physics.

Syllabus Details:
Definitions.
Optics for Photogrammetry.
Camera, aerial and others, photography.
Photographic materials and processing.
Camera calibration.
Stereoscopy and parallax.
Radial line methods.
Photographic measurement.
Refinement of measurements.
Orthophotography, rectification.
Tilted photographs.
Plotting instruments.
Introduction to terrestrial methods.
Analogue photogrammetry, instruments.
Model formation, relative and absolute orientation.

Practical Work Syllabus:

Stereoscopic exercises.
Parallax bar exercises.
Radial line plotting exercises.
Flight plan design.
Aerial photo indexing.
Rectification of tilted photographs.
Orthophotography exercises.
Stereoplotter orientation exercises.

Practical Project: A photogrammetric manuscript of four models in one block including marginal information.

Assignment Work: 8 assignments of five problems each in the computational aspects of the subject.

PHOTOGRAMMETRY 2

Duration: 8 hours per week for 30 weeks.
Theory : 3 hours per week.
Practice : 5 hours per week.

Prerequisites: Photogrammetry 1
Mathematics and Statistics 1
Computer Science 1

Syllabus Details:

Comparator measurements and their reduction.
Corrections to image co-ordinates.
Theory of analogue relative and absolute orientations.
Methods of relative orientation.
Theory of analytical relative orientation.
The collinearity principle.
Block formation.
Introduction to block adjustment.
Non topographic and terrestrial methods.
Microphotogrammetry.

Practical Work Syllabus:

The use of a range of stereoplotters.
The use of comparators.
The use of computer assisted instruments.
The use of software packages.

Practical Projects:

1. Comparator observations of photos for block of six models in two neighbouring strips.

2. Independent model observations of the same block.

3. Block co-ordinates of the block produced by a program supplied.

4. A photogrammetric plot of detail and contours of the 6 models mentioned.

5. Terrestrial photography and plots of 2 terrestrial models.

6. Calibration of an ordinary camera and the plotting of one model of photography taken by that camera.

Assignment Work: 10 computational assignments of at least 5 problems each.

One computer program for the calculation of setting of elements of orientation form parallaxes observed at 6 schematic positions on a stereo-plotting machine.

PHOTOGRAMMETRY 3

Duration: 8 hours per week for 30 weeks.
Theory : 3 hours per week.
Practice : 5 hours per week.

Prerequisites: Photogrammetry 2
Computer Science 2

Syllabus Details: Theory of adjustments:
- Strip adjustment.
- Methods of block adjustment and their principles.
- Theory of adjustment by simultaneous strips, independent models, bundle, self calibration, additional parameters.
- Accuracy prediction of adjusted co-ordinates; advanced concepts in non topographic photogrammetry, hologrammetry, X-ray photo-grammetry, moire topography.

Practical Work
Syllabus: The use of computer programs for adjustment procedures, writing of computer programs for various photogrammetric operations.

Evaluation of holograms and X-ray photographs.

Practical Projects:

1. Observation of a block of at least 24 photographs in 4 neighbouring strips on a comparator.
2. Observation of the models of above photographs as independent models.
3. Adjustment of co-ordinates within the block from both sets of observations.
4. Writing of a modular program for block adjustment.
5. Plotting detail from one pair of holograms and one pair of X-ray photographs.

Assignment Work: 10 assignments of not less than 5 computational problems each.

One modular computer program to compute block adjusted co-ordinates from comparator measurements.

PHOTOGRAMMETRY FOR REMOTE SENSERS 1

Duration: 4 hours per week for 30 weeks.
Theory : 2 hours per week.
Practice : 2 hours per week.

Prerequisites: Matriculation mathematics.
Matriculation physics.

Syllabus Details:
- Definitions, optics for photogrammetry, stereoscopy and parallax.
- Aerial mosaics, vertical photography.
- Camera calibration
- Planning photography.
- Radial line methods.
- Elements of photointerpretation relevant to remote sensing.
- Tilted photographs.
- Plotting instruments.
- Instrumental relative and absolute orientation.

Practial Work Syllabus:
- Stereoscopic exercises.
- Parallax bar exercises.
- Radial line plotting.
- Fliqht plan design.
- Photo indexing.

Assignment Work: 6 assignments of five problems, each in the computational aspects of the subject.

PHOTOGRAMMETRY FOR REMOTE SENSERS 2

Duration:
- 4 hours per week for 30 weeks
- Theory : 2 hours per week.
- Practice : 2 hours per week.

Prerequisites: Photogrammetry for Remote Sensers 1.

Syllabus Details:
- Theory of analogue photogrammetry.
- Photographic measurement.
- Refinement of co-ordinates.
- Analytical relative and absolute orientation.
- The collinearity principle.
- Introduction to block adjustment.

Practical Work Syllabus:
- The use of stereoplotters.
- The use of comparators.
- The use of computer assisted instruments.

Assignment Work: 6 computational assignments of at least 5 problems each.

Note: Practical work and assignments for Remote Sensing will be dependent on the availability of equipment in each teaching organisation and must be set accordingly. Suggestions for some projects are listed after Syllabus Details.

REMOTE SENSING 1

Duration: 8 hours per week for 30 weeks.
Theory : 3 hours per week.
Practice : 5 hours per week.

Prerequisites: Matriculation mathematics.

Syllabus Details:
Overview and historical development of remote sensing.
The nature of electromagnetic radiation.
Idealized remote sensing systems.
Energy sources.
Atmospheric effects.
Target interactions.
Sensor systems.
Ground investigations for remote sensing.
Electromagnetic spectrum and its regions.
Photographic sensor systems.
Remote sensing platforms.

In particular, natural resouces satellite systems.
Landsat satellite system.
Introduction to optical-mechanical scanners and other digital data collectors used on natural resource satellite systems.
Introduction to digital images and the processing of collected data.
Remote sensing - future prospects.

REMOTE SENSING 2

Duration: 8 hours per week.
Theory : 3 hours per week.
Practice : 5 hours per week.

Prerequisites: Remote Sensing 1.

Syllabus Details: Detailed consideration of the arbitrarily defined regions of the electromagnetic spectrum.

Sensors considered:
- Short wavelength sensors (eg. gamma ray and X-ray sensors).
- Ultra-violet band sensors.
- Visible band sensors.
- Infra-red band sensors.
- Microwave band sensors (eg. RADAR).
- Sonar and radio wave systems.

Spectral characteristics of earth surface features.
How and where to obtain your own remote sensing data.
Programming and software for remote sensing.
Digital image analysis.
Detailed study of applications of the sensors considered above.

REMOTE SENSING 3

Duration: 8 hours per week.
Theory : 3 hours per week.
Practice : 5 hours per week.

Prerequisites: Remote Sensing 2.

Syllabus Details: Platforms for remote sensor systems, in particular satellite systems.
Landsat program.
Other present and future natural resource satellite systems.
Orbital theory.
Geometric correction of satellite data.
Storage of information.
Image processing and enhancement.
Computer assisted classification.
Mathematical methods for spatial analysis.
Analogue Landsat image analysis.
Digital image analysis systems.

Applications of Landsat satellite data and computer-aided analysis techniques:
- forest resource management,
- water resource monitoring,
- land use mapping,
- soil and rangeland mapping,
- crop yield estimates,
- geological exploration,
- cartographic applications.

REMOTE SENSING FOR PHOTOGRAMMETRISTS 1

Duration: 4 hours per week for 30 weeks.

Prerequisites: Matriculation mathematics.
Matriculation physics.

Syllabus Details:
Overview and historical development of remote sensing.
The physical basis of remote sensing.
Idealised remote sensing systems.
Electromagnetic spectrum and its regions.
Ground investigations for remote sensing.
Photographic sensor systems.
Satellite remote sensing, in particular, Landsat system.
How and where to obtain your own remote sensing data.

REMOTE SENSING FOR PHOTOGRAMMETRISTS 2

Duration: 4 hours per week for 30 weeks.

Prerequisites: Remote Sensing for Photogrammetrists 1

Syllabus Details:
Remote sensing systems (visible and non visible).
Introduction to digital images and the processing of collected data.
Digital image analysis.
Detailed study of Landsat system and other natural resource satellite systems.

Analogue Landsat image analysis.
Applications of Landsat satellite data and computer-aided analysis techniques:
- forest resource management,
- water resource monitoring,
- land use mapping,
- soil and rangeland mapping,
- crop yield estimates,
- geological exploration,
- cartographic applications.

PRACTICAL PROJECTS FOR REMOTE SENSING

- Essay on theoretical aspects.
- Exercises involving the analogue analysis of photographic remote sensing system.
- Exercises involving the analogue analysis of non-visible remote sensor data.
- Exercises involving the digital analysis of non-visible remote sensor data.
- Seminar paper on a particular aspect of R.S.
- Detailed study of a Landsat image.
- Exercises on particular applications involving a variety of remote sensing data and platforms.
- Investigation and utilization of computer methods for implementing analytical techniques used with remote sensing data.
- Study of the structure and capabilities of software packages.
- Familiarization and utilization of an image processing system.
- Development of part of an image processing system (eg. thresholding subroutine; grey level histogram; principal component analysis).
- Ground work exercise involving collection of "ground truth".
- Visits to digital image processing establishments and other remote sensing installations.

(b) Passive

While the total content of Photogrammetry and Remote Sensing in the active courses should be about 43-45% for the first, 50% for the second and 60% for the third year of the courses, the content in the passive ones should be much less. It is suggested to have some 15% of Photogrammetry and Remote Sensing content in the penultimate year of passive courses with approximately 15-20% in the final year. The choice of topics may be made from the syllabii of active courses listed earlier according to the needs of the passive user.

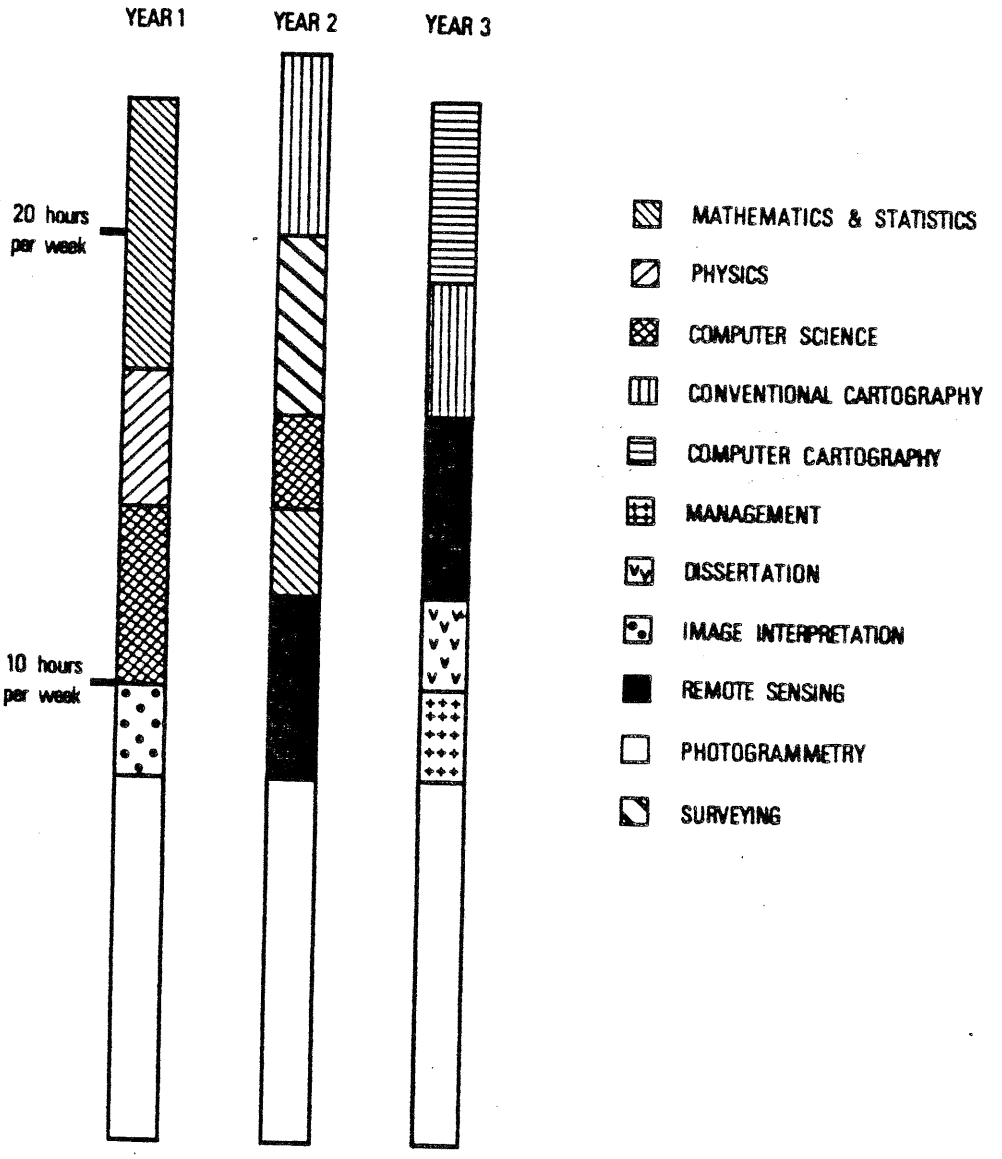
Conclusion.

It is hoped that the material presented will encourage a discussion resulting in a recommendation for curricula in the various courses. It must be made clear that the contents of this paper are merely ideas of the author and do not represent the official view of the ISPRS.

Block Diagrams.

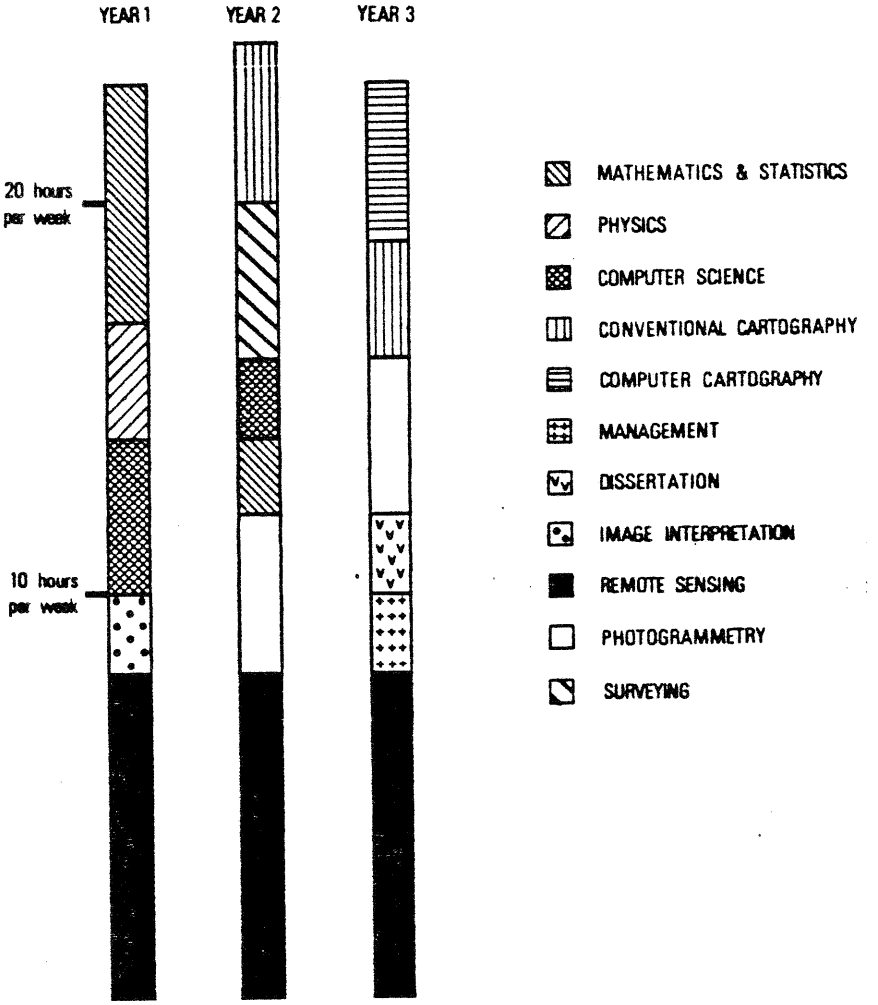
Block diagrams showing time allocation for Photogrammetry and Remote Sensing in the various courses compared to the other subjects of the course, or compared to the Photogrammetry and Remote Sensing content in an active course, follow.

BACHELOR OF APPLIED SCIENCE IN PHOTOGRAMMETRY

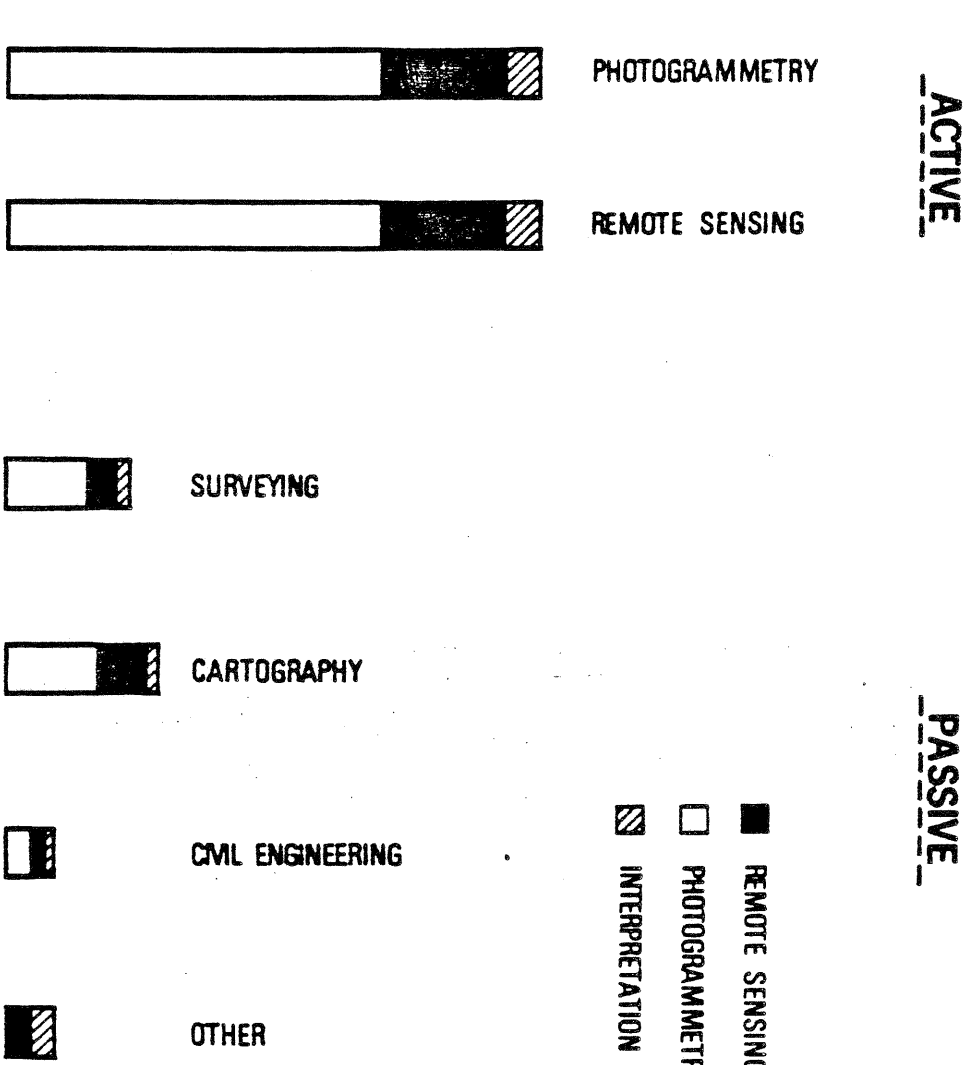


Block diagram no. 1

BACHELOR OF APPLIED SCIENCE IN REMOTE SENSING



Block diagram no. 2



Block diagram no. 4

BIBLIOGRAPHY

ADAMEC, A.	A Proposal for University Standard Courses in Photogrammetry and Remote Sensing.	1983 S.E. Asian Regional Conference, Kuala Lumpur.
ADAMEC, A.	Teaching of Photogrammetry and Remote Sensing at Australian Tertiary Insts.	1982 Symposium, Mainz.
ADAMEC, A. and ELLIS, G.P.	Remote Sensing: The Problems Involved in Designing Suitable Courses.	1980 Congress Papers.
ANDERSON, James	Standards of Competence for Civil Engineers.	1982 Symposium, Mainz.
AYTAC, M., ORMECI, C., and ALTAN, M.O.	Ausbildung fuer Photogrammetrie und Fernerkundung an der Technischen Universitaet, Istanbul.	1980 Congress Papers.
BADEKAS, John	Activity Report of WG VI-10 on Collection of Curricula (Photogrammetry).	1982 Symposium, Mainz.
BRANDENBERGER, A.J.	Activity Report of ISP WG VI-1, Period 1976-80 World Status of Photogrammetric Education and Research.	1980 Congress Papers.
BRANDENBERGER, A.J.	World Wide Analysis on Photogrammetric Education.	1976 Congress Papers.
BURTCH, Robert	Photogrammetric Education at the College Level.	1982 Symposium, Mainz.
EREZ, M.T.	Photogrammetric Course Curricula in Developed Countries.	1980 Congress Papers.
FAGERHOLM, P.O.	Optimum Photogrammetric Education in Developing Nations.	1980 Congress Papers.
FERSCHKE, H.	Minimales und Maximales Programm der Photogrammetrie - Ausbildung fuer Kartographen.	1980 Congress Papers.

GHOSH, S.K.	Activity Report of WG VI-8 on Stimulation of Education.	1982 Symposium, Mainz.
GHOSH, S.K.	Status of Activities in Photogrammetry at Academic Institutions in the USA.	1980 Congress Papers.
GRIESKE, Ludwig	Necessity of SoC European Considerations.	1982 Symposium, Graz.
HARDY, John R.	Standards of Competence for Cartographers.	1982 Symposium, Mainz.
HOTHMER, J. Dr.	Ausbildung fuer Bauingenieure in Photogrammetrie und Fernkundung in der Bundesrepublik Deutschland.	UN Centre for National Resources, Energy and Transport. 1978.
HOTHMER, J. Dr.	Education for Users of Photogrammetry.	Photog. Engineering and Remote Sensing. Vol. 42, 1976.
HUNT, G.E. Dr.	Remote Sensing at Imperial College. M.Sc. in Remote Sensing - Curriculum.	
ITC	Program of the Short Postgraduate course in Remote Sensing Applications for Earth Sciences.	Pamphlet
JERABEK, O.	Education of Photointerpretation and Remote Sensing.	1976 Congress Papers.
KARARA, Sam	Standards of Competence for Industrial Photogrammetrists.	1982 Symposium, Mainz.
LOBANOV, Alexander	Photogrammetric Education in the USSR.	1982 Symposium, Mainz.
MEJIJA, Leonidas	Standards of Competence for Soil Specialists.	1982 Symposium, Mainz.
MOLENAAR, M.	What Should a Future Photogrammetrist Know About Statistics and Adjustment?	1980 Congress Papers.

MOHL, Hans.	The "International Advanced Training Centre for Photogrammetric Operators (IPO) Stuttgart".	1982 Symposium, Mainz.
MORAIN, Stanley	Necessity for Standards of Competence in the USA.	1982 Symposium, Mainz.
PALA, Simsek	Multidisciplinary Education in Remote Sensing.	1982 Symposium, Mainz.
ROKOS, D.K.	Photogrammetry and Remote Sensing Education and Research in Greece and Cyprus.	1980 Congress Papers.
ROY, K.	Analysis of Photogrammetric Education in Developing Countries.	1976 Congress Papers.
SAVIGEAR, R.A.G.	Proposals for the Development of Post-graduate Teaching Modules in Remote Sensing.	Workshop 23-27 July, 1979 ITC
SITEK, Z., JACHIMSKI, J., and MIERZWA, W.	Minimum and Maximum Program of Photogrammetric Education for Geodesists and Surveyors.	1980 Congress Papers.
SITEK, Z.	Standards of Competence for Geologists.	1982 Symposium, Mainz.
UNESCO	Necessity of SoC European Considerations.	1982 Symposium, Mainz.
UN BACKGROUND PAPER	Training and Education of Users of Space Technology	UN Conference Papers, 1981
VISSER, Jan and PARESI, Christian	Standards of Competence for Professional Photogrammetrists.	1982 Symposium, Mainz.
VOUTE, Ceasar	Standards of Competence for Remote Sensing Specialists.	1982 Symposium, Mainz.

VOUTE, Ceasar	Essential Elements of Educational Programs on Space Science and Technology.	ECA/ECWA Seminar Addis Ababa
	Final Report of the S.E. Asian Regional Conference on Photogrammetry and Remote Sensing, 1983.	
	Computer Assisted Remote Sensing Applied to Land Resources.	International Training Course.
	Course Details from Handbooks of Various Universities Around the World.	