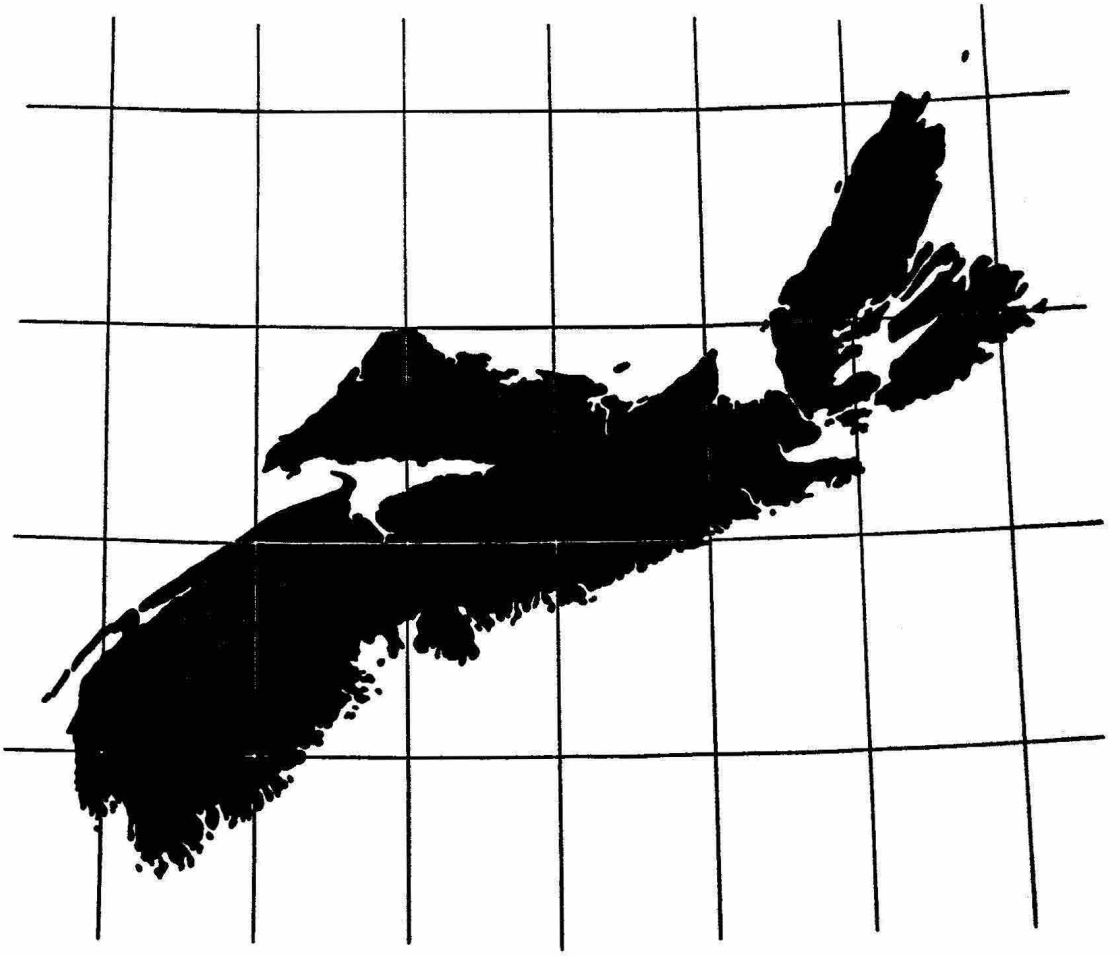
The NOVA SCOTIAN SURVEYOR



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The NOVA SCOTIAN SURVEYOR

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ERROL B. HEBB
President

EDWARD P. RICE
Secretary-Treasurer

R. E. MILLARD
Editor

Volume 17

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MINUTES OF THE

FOURTEENTH ANNUAL MEETING

ASSOCIATION OF PROVINCIAL LAND SURVEYORS OF NOVA SCOTIA

FRIDAY, NOVEMBER 6, 1964

Mr. Archibald opened the meeting at 10:30 a. m. He first introduced the Manager of Citadel Inn, Mr. John Peters, to say a few words of welcome to the members. Mr. Peters welcomed the members and said he would be only too glad to help with any problems.

Mr. Archibald, President, then gave his address to the members present. He then introduced his first guest, Mr. Dick Shaw, President of the Canadian Institute of Surveying, Ottawa.

Mr. Dick Shaw thanked the Association on behalf of all the members of the Canadian Institute of Surveying across Canada for inviting him here to our annual meeting, and on their behalf he wished us the best of success.

The President introduced Mr. Sam Gamble, Director of Surveys and Mapping Branch, Department of Technical Surveys, Ottawa. Mr. Gamble on behalf Of the Department of Surveys wished us all the best of success. He spoke of the "History of Surveying in Canada", being written by Mr. Thompson in Ottawa. It is hoped that the first volume will be published before Christmas next year. He wished to thank all the gentlemen in the Halifax area who have helped Don Thompson, author of this book, for the assistance they have given him.

Next Mr. Lester B. Higbee, Chairman of the Board of Directors, of W & L. E. Gurley Instruments Ltd. was introduced by the President. Mr. Higbee said it was a great pleasure to come to our meeting to watch and see what we are doing in surveying and that he enjoys our hospitality and fellowship. He brought greetings and felicitations and wishes for the best of success from all members of the American Congress of Surveying and Mapping.

Mr. Charles Robart, President of the New Brunswick Land Surveyors Association brought greetings from the sister province and association. Mr. Roberts said, "Thank you for this kind invitation." Our annual meeting this year is to be held in Moncton and any of you who can come are cordially invited to attend. In fact if we have this amalgamation of provinces, it is likely that they will all be held in Moncton."

Col. Willis Roberts, Director of Surveying, Department of Lands and Mines, New Brunswick said that it is the first time that he has come from Fredericton and made it on time. He brought greetings land best wishes from the Department of Lands and Mines branch of New Brunswick and the personnel in it. It was planned that four members from the department would attend; however, due to change in schedules he is the only member that attended.

Mr. G. E. Streb, principal of the Nova Scotia Land Surveyors Institute thanked us for the kind invitation extended to him and his wife. He said that he enjoyed

the meeting very much last year and looked forward to it again this year. Ile thanked us for inviting the second year students who were extended the invitation to attend the annual meeting as observers.

Mr. E. A. Green, Supervisor, Provincial Educational School brought us greetings from the Department of Education and wished us great success.

The President asked for the members to stand for a moments silence in memory of deceased members.

The President then named the members who have joined the association during the past year:

Chester W. Gehue, Donald J. MacNeil, Robert E. O'Brian, John Covert, Donald Campbell, J. R. Maharaj, Donald L. Rix, Harold E. Smith, Brian David Peel, David M. Hamilton, Gregory Joseph MacDonald, Stewart E. Cameron and Murray J. Banks.

The President named the exhibitors who registered with us this year: Eastward Industries Ltd., Norman Wade Co. Ltd., Jena Scientific Industries Ltd., Tellurometer of Canada Ltd., Enamel and Heating Products, Hughes - Owens Ltd.

The President asked the secretary to read the minutes of the Thirteenth Annual Meeting. The Secretary, Mr. E. P. Rice, moved that the minutes be adopted as read and printed in the September issue of the Nova Scotian Surveyor.

The President asked for the financial report. Mr. Rice moved that the financial report be adopted as printed and distributed. Seconded by Mr. Millard. Motion carried. Following the adoption of the financial report, the Secretary thanked all the members for coming. He then made apologies for the error that was made in the biography of J. D. MacKenzie which was sent out with the ballots, and apologized to Professor E. 0. Temple Piers, who was not only the president for the first year but was the president for the second year also, and was the founder of the Association. The Secretary then thanked Mr. Roy Dunbrack for being chairman of the convention and mentioned the fact that he had worked since the first week after the last annual meeting, preparing for this one, at the Citadel Inn. The Secretary thanked the president, J. F. Archibald for the assistance given him during the year and then he thanked Ted Hollingum, Assistant Secretary, for the assistance he had given him especially during the months of January and February and March, writing out bills for the Association, and again during the month prior to the Annual Meeting.

A thank you went out to the councillors for attending the council meetings throughout the year at their own expense.

The President then asked Colonel Spencer Ball to report on his attendance at the British Columbia Land Surveyors Annual Meeting in January. Colonel Ball stated he had challenged the president of the Association as to why he was not wearing his Nova Scotia Tartan tie. The President of B. C. I. S. apologized and put it on. The meeting in B. C. was held much the same as they are here. They have the same problems as we have. Finance of course is always foremost in the Corporation of Land Surveyors of B. C. Mr. Archibald then read a letter from the President of the Massachusetts Land Surveyors Association.

Mr. Archibald asked for the report from the scrutineers. Mr. Hollingum read the report:

President - Errol Hebb
Vice-President - H. B. Robertson
Secretary-Treasurer - E. P. Rice
Counsellor for Halifax City - George Bates
Councillor for Halifax County - K. W. Robb
Counsellor for Western N. S. - Robert A. Miller
Counsellor for Eastern N. S. - Gordon Nicholson
Counsellor for Cape Breton - John S. Pope
Counsellor at Large - J. D. MacKenzie

Mr. Rice, the Secretary, brought up the cost of Association Certificates which is $1.00 to have names printed and 14¢ to mail. According to the by-laws, the Association may only charge $2.00 which leaves 86¢ for replacement. Mr. Rice then asked for suggestions which would enable the Association to have a higher replacement value.

It was moved by Mr. March that the fees be set by the Council for the certificates so that the proper price will be paid. Seconded by Eric Millard. Mr. Chisholm brought up the point that the council cannot be empowered to change the by-laws, so therefore we charge $2.00 for the certificate and if the member wants his name put on it we charge him an extra dollar. Mr. Robertson said that council could not change by-laws but the motion could be left and the council be empowered to go to the governor-in-council to have a by-law changed. This was added to the motion at Mr. Robertson's suggestion which was accepted by Mr. March and seconded. Motion carried.

Mr. Rice said that our Association had no initiation fee for joining the Association and perhaps one should be had as most organizations have. Mr. Robertson brought up the fact that new members are mostly young people getting out of the School and they are not financially able to pay more than the $10.00 to join the Association.

Mr. Martel moved that the by-laws be left as is for the present. Seconded by John Pope. Motion carried.

Mr. Higbee, having read our publication said there were two things he would like to comment upon. He said they have the problem of moving around for holding their annual meetings. To solve the situation, they hold their annual meeting in Washington, D. C., but for those who like to move around they have a mid winter meeting which is held in different parts of the U. S. He does not want to leave the impression that they are against moving meetings around as in Massachusetts.

Professor Chisholm asked when and if the Association of Provincial Land Surveyors was incorporated and Mr. Archibald said he would inquire and report back.

Mr. Gamble said that any chain in Canada can be sent to the National Research Council and for a small fee it can be certified. A tape from anybody else unless it is certified by the National Research Council will not be accepted.

Re page 8 of the Nova Scotia Surveyor, Mr. Crawley asked if Sable Island was actually part of the error, or being a sand bar it had merely shifted position in the Atlantic Ocean.

Mr. Bert Robertson brought up the fact that the honorarium for the Secretary-Treasurer of the Association had not been changed for years and even though the work of the Association had increased, the honorarium had remained the same. Mr. Robertson then moved that the honorarium to the Secretary-Treasurer be increased to $250.00 per annum. Seconded by Eric Millard, adding that it be made retroactive to January, 1964. Motion carried.

There being no further business at this time. Mr. Archibald called for a recess for the annual C. I. S. luncheon and cocktail party.

At 12:30 p. m. the Halifax Branch of the Canadian Institute of Surveying held a cocktail party and luncheon.

Following the luncheon, films on surveying were shown by the Department of Lands and Forests. Some of the exhibitors also showed films on their instruments.

SATURDAY, NOVEMBER 7, 1964

Mr. Archibald called the meeting to order at 10 a. m. The first order of business this morning is the report of committees.

Mr. Hebb, Chairman of the Discipline Committee, reported that there were a few matters of minor importance dealt with during the year.

Mr. March, Chairman of Legislative Committee, reported that last year there was a minor amendment which was supposed to be passed in the House bet it was not passed due to the fact that we were too late getting it in to the government. Mr. March said that the deadline is December 4. Therefore if there are any changes in legislation they must be made before that date. Mr. March said that the amendment which was suggested yesterday should be put in also at that time.

Report from the Coordinating Committee. Mr. March said that there was not much done in regard to the coordinating system, due to his ill health through the past year, but this afternoon at the panel discussion on the coordinate system, we may be able to come up with something more definite. Mr. March said that all committees should be notified when they would be required to give a report and also be notified when they would be required to give a report and also be notified by the Secretary of their appointment.

Mr. Robertson was asked to report on the percolation test committee. Mr. Robertson said that Mr. Robb was more familiar with this problem so W. Robertson asked Mr. Robb to speak on the problem of the percolation tests.

This committee was formed during the year by the Council because of a complaint as to the way the Municipality of the County of Halifax By-Laws were written. The Regulations require that all lots be certified that they are adaptable for septic tanks. It further says that this certificate may only be signed by a Sanitary Inspector or a professional engineer. Council felt that in some instances the public may wish to employ an engineer who may perform all duties in lieu of a surveyor who may only do the surveying.

Mr. Robb said that he feels that the land surveyor can be trained to do percolation tests and that this should help in remote areas where it is difficult to obtain sanitary inspectors to do the tests or professional engineers. Mr. Robb suggested that the Association take the initiative to have a course organized for the land surveyors. Mr. Robb said that the committee should be re-formed for the coming year. It was moved by Mr. Hebb that the same two gentlemen have the same authority to carry out their work. Seconded by Mr. Millard, carried.

Mr. Archibald said that during the year, Mr. Dickie was appointed to chair a committee to write a text book on Part TI of the legal exam.

At this time, Mr. Archibald introduced Mr. Lewellan Schofield from the Massachusetts Association of Professional Engineers and Land Surveyors. Mr. Schofield brought words of welcome and best wishes from the Massachusetts Association of Land Surveyors and Professional Engineers. He thanked the members for inviting him.

The next order of business was brought up by Mr. Eric Millard as chairman of the Lands Titles Act. Following Mr. Millard's report, Mr. March said that the Land Titles Act was very good, where the land cost would be high, to determine the correct title to the land; but that in areas of relatively low value, it is completely useless lawyers who are forced to use this and the work they have to prepare to take it to court, would not want to use it because the cost would be more than the land is worth.

Mr. Kendall said that a lot of lawyers would not want the Torrens System because they can make more money searching titles than they could if they had the Torrens System. Mr. March asked if it was intended to be proclaimed for the province as a whole or for each country. Mr. Millard responded by saying that it was intended that the Lands Titles Act be proclaimed for each county of the province, as required.

Mr. Schofield spoke on the success that they have had in Massachusetts with the Torrens System and that the State of Hawaii copied their story word for word, as it has been working so well. Mr. Schofield said that he had given a paper on it in New Brunswick, and that if anyone wanted to discuss it with him further, he will be available. Mr. Roberts from New Brunswick said that they had passed the Torrens Act in New Brunswick in 1944. In New Brunswick they sent people to Massachusetts and to Winnipeg to study this Torrens System. He said you cannot have the Torrens System unless you have something on the ground which can be related to the deed description and that the two can be married together. That is to say that until a coordinated system is established on the ground, then we are not ready for the Lands Titles Act or the Torrens System.

Mr. March suggested that the Association of Provincial Land Surveyors should concentrate their efforts to endeavor to have adopted in this province the Coordinate

system of Surveys. This must come before anything g can be done in the matter of the Torrens System.

Mr. Archibald read a letter which he received from Mr. March in regard to the Coordinate system.

Mr. Robertson said that all efforts should be made towards instigating this.

Mr. J. R. Chisholm - The way things are growing around the Province of Nova Scotia, it is almost necessary to have the Coordinate system established, mainly due to the fact that the land value system is going up and surveyors need a sound system to work with.

Mr. Gamble - Director of Surveyors, Ottawa. From the Federal Surveys point of view it is better to help the department which is establishing maps of the area and that they also help to establish control in that part of the country. Mr. Gamble said that when we are ready to start this system, his department will provide all the assistance they can, especially in the aerial system control.

Mr. Hebb said that we have the necessary things now and that we should take steps to form a committee to start the ball rolling on this system.

Mr. Pope said he knew very little about the Torrens System and that before we convince the public that they need the Torrens System, we must know what it means.

Mr. March said that several years ago the Torrens System was printed and distributed to all the surveyors and perhaps the secretary had them on file.

Mr. Rice said there were no Torrens System papers on file.

Mr. Robertson said that we should not jump to conclusions now in forming committees but should wait until this afternoon, after panel discussion on the coordinate system. We would understand the situation once having heard the coordinate system and then the Torrens System.

Father Burke-Gaffney gave his paper on the Satellites, at 11:00, which was very much enjoyed by all.

Mr. President asked the Board of Examiners to give their report. Professor Chisholm, Chairman of the Board gave the following report:

Supplementary examinations were given in December and a full set of exams were given in May. The board has approved the awarding of certificates to:

Mr. George E. Streb
Mr. Ralph Erin
Mr. Gerald Conrad
Mr. Duncan MacGregor

There are another few students at the school who have to write one or two supplementaries before they can be approved as candidates for P. L. S.

Mr. Chisholm paid tribute to Mr. Joseph Archibald who took over as Secretary of the Board since Mr. V. P. Harrison had been taken ill. He also paid tribute to Mr. Fitzner who is representative of the Association of Professional Engineers. During the year, the certified chains and tape had been established at the university and this system is in operation so that these tapes and other instruments may be certified by the Inspectator of Instruments. Unless there are any questions, this is the end of the report.

Major Church came up to the stand to face the audience. He pointed out first that the cost of obtaining a certificate is $2.00. He said that he is vitally interested in the education and training of surveyors. He said that according to the financial report, the examination fees were $1,182.00 received. Expenses for examinations $675.50 showing a profit of over $500.

Professor Chisholm responded to Mr. Church's question re legal examinations at Lawrencetown. The legal paper consisted of nine questions. Six questions on one paper and three on another. The second page was not distributed to the students in Lawrencetown. However, consideration was given to this fact and the students in Law-

rencetown were only marked on the six questions, and the questions omitted in Lawrencetown did not affect the students in writing.

Profssor Chisholm asked that Mr. Archibald instruct the incoming council to take up the other question made up by Major Church.

Mr. Pope asked for clarification of what was said by Professor Chisholm, that the paper consisted of nine questions and there were only six questions to answer.

Mr. Archibald clarified the matter.

Mr. Robb asked for clarification as to the duplication of student's questions. This was clarified by the fact that the Part II exams had questions similar to Part I exams.

Mr. Rice brought up the fact that since the financial report was made, another addition of bills for $256.50 were received and paid on October 30 and therefore do not show up in the financial report.

Mr. Bates - Some of the questions were answered and some were not of Mr. Church. Mr. Bates suggested that Major Church and Professor Chisholm get together with the Board of Examiners and that a full report be made to the Association. Mr. Bates said that this demands a full report and investigation and that it be given to the Association.

Mr. Joseph Archibald said that this would be dealt with by Council.

Mr. Church made a motion that this meeting instruct the board of examiners to come under the direct control of the council. Motion seconded by Mr. Robb.

Mr. Dunbrack said that the motion was out of order and should be taken up under new business. Motion not carried.

Recess for lunch at 12:00 p. m.

At 1:30 p. m. the members assembled in the meeting room and a panel discussion on the coordinate system was held. Members of the panel were as follows:

Chairman - H. B. Robertson

Panel Members - Mr. J. F. Doig; Mr. L. Dakin

Mr. Doig spoke on the mathematics of the coordinate system and Mr. L. Dakin spoke on the relation of the coordinate system to photogrammetry and aerial surveys

Following the panel discussion, the President brought up the following name for honorary life membership in the Association:

Mr. Ralph Kendall, Sydney, Nova Scotia.

It was moved by Mr. John Pope and seconded by Mr. Eric Millard that the above mentioned member be made an honorary life member in the Association. Motion unanimously carried.

At this point, Mr. Dick Shaw, President of the Canadian Institute of Surveying, expressed his thanks on behalf of he and his wife for the enjoyment they had attending the annual meeting and functions.

President, Mr. J. F. Archibald turned the meeting over to the incoming president, Mr. Errol Hebb.

Mr. Hebb thanked the retiring president for the excellent job he had done during his year in office. He also expressed his thanks to the committees and hoped they would continue their good work during the following year.

Mr. Elliott Whitby brought up the fact that in Nova Scotia, persons who are not qualified land surveyors are doing surveys and that the said work was being accepted by the Registrar of Deeds for Recording in the Registry offices of Nova Scotia. He stated that in some cases the survey work was being done for gain.

Due to the time running late and preparations having to be made for the annual dinner, it was moved by Mr. Dunbrack and seconded by Mr. Pope that the Fourteenth Annual Meeting be adjourned.

At 6:30 p. m. a reception was held followed by the Fourteenth Annual dinner in the banquet room of the Citadel Inn. The dinner was followed by the annual dance.

Respectfully submitted,
E. P. Rice, P. L. S.
Secretary-Treasurer

Introduction to Spherical Trigonometry

Reference Texts:

Plane and Solid Geometry - Wentworth & Smith $4.80

Plane and Spherical Trigonometry - Wentworth & Smith $4.12

Publishers Ginn & Company Toronto

James A. H. Church P.L.S Nova Scotia

It is hoped that this, and subsequent contributions to the Nova Scotian Surveyor, may be of some assistance to students-in-training who may be without benefit of education other than Grade XII Nova Scotia; but it must be presumed they are competent to deal with the subject matter contained in the Grade XII text on Plane Trigonometry.

Before submitting himself to the discipline, requisite for the study of this interesting subject, the student should consider two alternatives: —

(1) The mere memorising of a minimum number of formulae will lead only to blunders which cause loss of time and prestige, or

(2) A thorough knowledge of the proofs, illustrated by the requisite diagrams, of the basic formulae will, in the long run, save a deal of time and render the student capable of appreciating the contents of the reference texts. Recommended for further study is "Notes of Instruction" on the subject of Plane and Spherical Trigonometry by John E. Jackson O.L.S. D.L.S. P.Eng. C.E. Published by the Association of Ontario Land Surveyors and obtainable from the Secretary of the Association.

General Considerations

1. Spherical Triangle is that portion of a spherical surface bounded by three arcs of Great Circles. p.127

Fig. 1

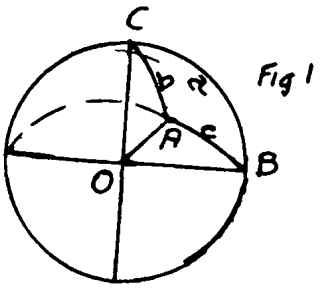

Fig 1

ABC is a spherical triangle the three points being designated by the capital letters A, B, and C, and the three sides by the small letters a, b, and c. The lines OA, CB, and OC being radii of a sphere are all equal. Solid Geometry p.381.

2. The Solution of a spherical triangle is the chief object of spherical trigonometry. p.187.

3. Ref. Fig. 1 The sides of the triangle can be measured only by the angle each subtends at O the centre of the sphere - the radius being indeterminate VIZ a = angle BOC, b = angle AOC, and c = angle AOB.

4. Ref. Fig. 1 The spherical angles A, B, and C are those contained between the planes of the two great circles which meet at each point designated.

5. Every intersection of a spherical surface by a plane is a circle. Solid Geometry p.382

6. Great Circle is one whose plane passes through the centre of the sphere. Solid Geometry p.382

7. Small Circle is one whose plane does not pass through the centre of the sphere. Solid Geometry p. 382

8. Spherical Trigonometry is concerned only with Great Circles.

9. When dealing with sides and areas contained by Small Circles recourse must be had to Solid Geometry. p.421

10. Sides of a spherical Triangle. The sum can not exceed 360° ie. the sum can not be greater than the circumference of the sphere. p. 188

11. The sum of two sides is greater than the third side. p.188

12. Angles of a Spherical Triangle If two angles of a triangle be unequal the sides opposite are unequal, the greater side being opposite the greater angle and conversely. p.188

13. Sum of the angles in a spherical triangle is greater than 180° and less than 540°. p.188

14. Parts of a spherical triangle are six in number VIZ 3 sides and three angles. Given any three elements the other three may be determined even if the three given be the three spherical angles.

15. A spherical triangle may be right, obtuse, acute, scalene, isosceles, or equilateral.

Cosine Law for Spherical Triangles

Experience, gained as Instructor at the Nova Scotia Land Survey Institute from its earliest inception, has led to the conclusion that the generality of the students-in-training find the Transition Method, from Plane to Spherical Trigonometry, more readily understandable than the proof from solid Geometry. The Transition Method will be shown first.

Figs. 2 and 3

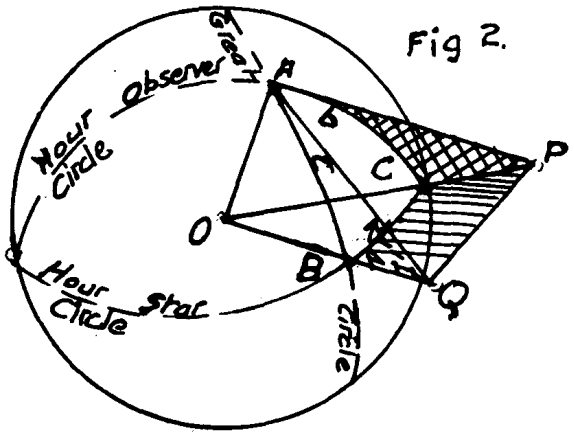

Fig 2.

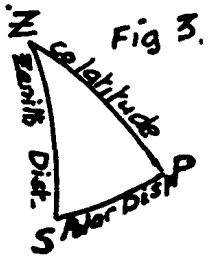

Fig 3.

Fig. 2 is a diagram of the Celestial Sphere.

Point O is the centre of the sphere.

Points A, B, and C are on the surface of the sphere and are joined by arcs of Great Circles.

The sides of the spherical triangle are respectively a opposite the angle A, b opposite the angle B, and c opposite the angle C.

The spherical triangle ABC is oblique.

The lines OA, OB, and OC are all equal being radii of the sphere.

The solid figure OABC is a spherical pyramid the base ABC being the curved surface of the sphere, the planes ABO, BCO, and CAO being the sides of the spherical pyramid and O the apex at the centre of the sphere.

IF, at point A, a plane be drawn tangent to the sphere and therefore at right angles to the Line OA, this plane will be intersected by OC produced in P, and OB produced in Q.

By this procedure a triangular pyramid has been produced in lieu of a spherical pyramid.

Those portions of the triangulr pyramid, which are partially out-with the sphere, are shown hatched in both Figs. 2 and 4.

Fig. 3 is merely a conventional diagram of the PZS triangle and is included as a convenience in the study of Field Astronomy as are the notations in Fig 2 on the arcs of the three Great Circles AB, BC, and CA.

Fig. 4

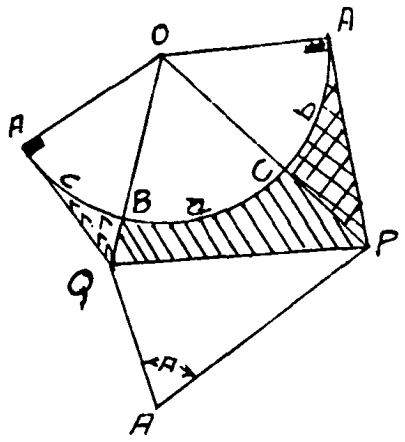

Fig. 4

Fig. 4 is a model of the triangular pyramid OAPQ standing on the base APQ with apex at O. The pyramid had been split along the lines OA, AQ, QP, AP, PO, and OQ the four plane faces of the model being reassembled in the proper order on a flat surface, the arc of the surface of the sphere, radius OA, being shown.

In Fig. 4 because OAPQ is a triangular pyramid

the triangles QAP and QOP are congruent

therefore angle QAP = angle QOP. Solid Geometry p. 389 Const.

Angles OAQ and OAP are both right Angles.

Triangle OPQ $PQ^2 = PO^2 + QO^2 - 2PO.QO.\text{Cos } POQ$ plane trig

$= PO^2 + QO^2 - 2PO.QO.\text{Cos } a$ (i)

Triangle PQA $PQ^2 = PA^2 + QA^2 - 2PA.QA.\text{Cos } PAQ$ plane trig.

$= PA^2 + QA^2 - 2PA.QA.\text{Cos } A$ (ii)

Triangle OPA $OA^2 = OP^2 - AP^2$

$\text{Cos } POA = \frac{OA}{OP}$ and $\sin POA = \frac{PA}{PO}$ (iii)

Triangle OQA $OA^2 = OQ^2 - AQ^2$

$\text{Cos } QOA = \frac{OA}{OQ}$ and $\sin QOA = \frac{AQ}{OQ}$ (iv)

$PO^2 + QO^2 - 2PO.QO.\cos a = PQ^2$ (i)

$PA^2 + QA^2 - 2PA.QA.\cos A = PQ^2$ (ii)

Subtracting

$(PO^2 - PA^2) + (QO^2 - QA^2) - 2PO.QO.\cos a + 2PA.QA \cos A = 0$

$OA^2 + OA^2 - 2PO.QO.\cos a + 2PA.QA.\text{Cos}A = 0$ (iii) (iv)

$2PO.QO.\text{ Cos } a = 2OA^2 + 2PA.QA\text{ Cos } A$

Dividing through by 2PO.QO

$$\cos a = \frac{OA}{OP} \cdot \frac{OA}{OQ} + \frac{PA}{PO} \cdot \frac{QA}{QO} \cdot \cos A$$

$$\cos a = \cos b . \cos c + \sin b \cdot \sin c . \cos A$$

Cosine Law

$$\cos a = \cos b \cdot \cos c + \sin b \cdot \sin c \cdot \cos A$$
$$\cos b = \cos c \cdot \cos a + \sin c \cdot \sin a \cdot \cos B$$
$$\cos c = \cos a \cdot \cos b + \sin a \cdot \sin b \cdot \cos C$$

Any person interested in this transition method of obtaining the Cosine Law for spherical triangle may see, at the Nova Scotia Land Survey Institute Lawrencetown, a wooden model of the Celestial Sphere from which the spherical pyramid may be removed and a triangular pyramid, made of plastic, substituted. This model has been in use for twenty years with advantage to many students.

Geometric Proof of Cosine Law

Using the identical triangle, ABC in Figure 2, to prove the value of cos b.

Fig. 5

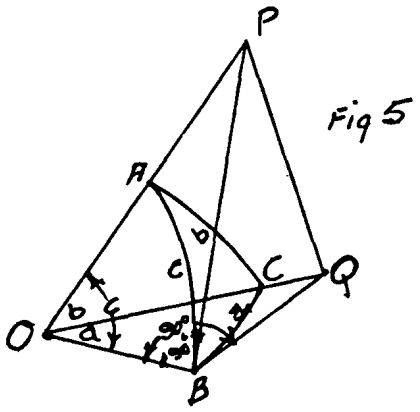

Fig 5

ABC is an oblique spherical triangle with O as the centre of the sphere.

At point B tangents are drawn to arcs BA and BC.

The line OA is produced to intersect the tangent to arc BA at P and the line OC produced to intersect the tangent to arc BC in Q

P and Q are joined.

In triangle PQR angle PQR is the measure of side b Solid Geometry p. 388

$$PO^2 + QO^2 - 2PO.QO \cos b = PQ^2 \qquad (i)$$

In triangle PBQ angle PBQ = angle B

because BP and BQ are tangents to arcs BA and BC by construction Solid Geometry p. 389

$$PB^2 + QB^2 - 2PB.QB \cos B = PQ^2 \qquad (ii)$$

In triangles OPB and OQB both are right angled. const.

$$PO^2 - PB^2 = OB^2 \qquad (iii) \qquad QO^2 - QB^2 = OB^2 \qquad (Iv)$$

$$\cos c = \frac{OB}{OP} \quad \sin c = \frac{PB}{OP} \quad \cos a = \frac{OB}{OQ} \quad \sin a = \frac{BQ}{OQ}$$

$$PO^2 + QO^2 - 2PO.QO. \cos b = PQ^2 \qquad (i)$$

$$PB^2 + QB^2 - 2PB.QB. \cos B = PQ^2 \qquad (ii)$$

Subtracting

$$(PO^2 - PB^2) + (QO^2 - QB^2) - 2PO.QO. \cos b + 2PB.QB \cos B = 0$$

$$2\,PO.QO.\cos b = (PO^2 - PB^2) + (QO^2 - QB^2) + 2PB.QB \cos B$$

$$2PO.QO.\cos b = OB^2 + OB^2 + 2PB.QB. \cos B$$

Dividing through by 2PO.QO

$$\cos b = \frac{OB}{OP} \cdot \frac{OB}{OQ} + \frac{PB}{OP} \cdot \frac{QB}{QO} \cos B$$

$$\cos b = \cos c.\cos a + \sin c \cdot \sin a.\cos B$$

Sine Law deduced from Cosine Law

Given $\cos a = \cos b \cdot \cos c + \sin b \cdot \sin c \cdot \cos A$

$$- \cos A \cdot \sin b \cdot \sin c = \cos b \cdot \cos c - \cos a$$

Squaring both sides

$$\cos^2 A.\sin^2 b.\sin^2 c = \cos^2 b.\cos^2 c - 2 \cos a. \cos b. \cos c + \cos^2 a$$

$$(1-\sin^2 A)\sin^2 b.\sin^2 c = (1-\sin^2 b)(1-\sin^2 c) + 1 - \sin^2 a - 2\cos a. \cos b . \cos c$$

$$\sin^2 b.\sin^2 c - \sin^2 A.\sin^2 b.\sin^2 c = 1 - \sin^2 b - \sin^2 c + \sin^2 b \sin^2 c + 1 - \sin^2 a - 2 \cos a \cos b \cos c$$

$+\sin^2 b.\sin^2 c$ is common to both sides of the equation

$$\sin^2 A.\sin^2 b.\sin^2 c = \sin^2 a + \sin^2 b.\sin^2 c + 2 \cos a.\cos b. \cos c - 2$$

Inspection of the equation will assure one that the right hand side of the equation would be identical if one began with either cos b or cos c.

Therefore $\sin^2 A.\sin^2 b.\sin^2 c = \sin^2 C. \sin^2 a . \sin^2 c$

Dividing through by $\sin^2 b$

$$\sin^2 A \cdot \sin^2 c = \sin^2 C \cdot \sin^2 a$$

Sine Law $\quad \pm \frac{\sin A}{\sin a} = \pm \frac{\sin B}{\sin b} = \pm \frac{\sin C}{\sin c}$

Conclusion of Part 1 of the Introduction

It may be assumed that introductions should not be too long and so far only a few definitions and two basic formulae have been considered. There remains consideration of two special triangles viz. The Right and the Polar triangles and the problem of areas of spherical triangles which is proportional to what is called "Spherical Excess". Spherical Excess may be defined as the amount by which the sum of the spherical angles of a triangle exceeds 180^0.

These subjects will be dealt with in Part 2 of the Introduction which will appear in the succeeding issue of the Nova Scotian Surveyor.

James A. McCheek
P.L.S. Nova Scotia

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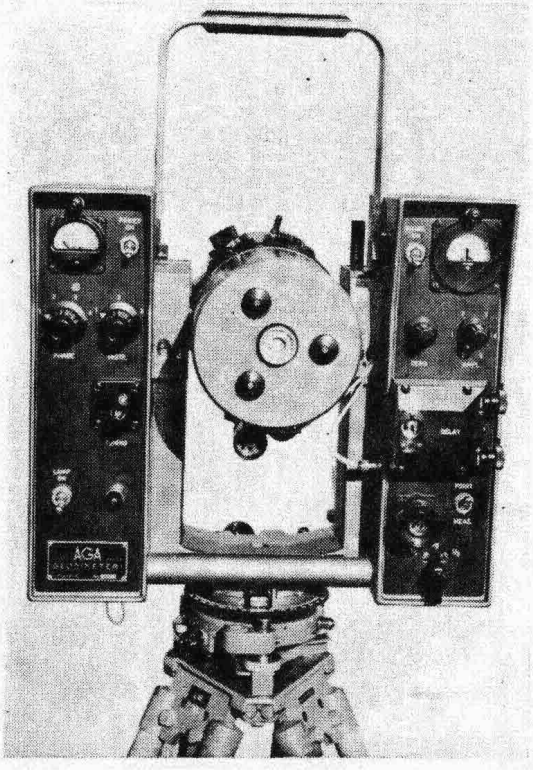

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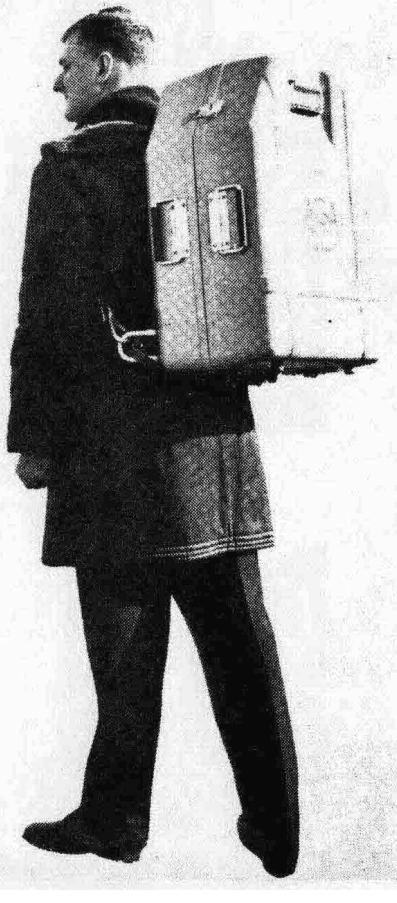

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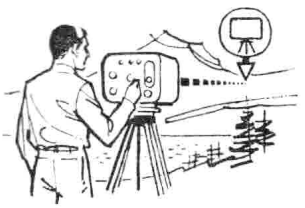

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