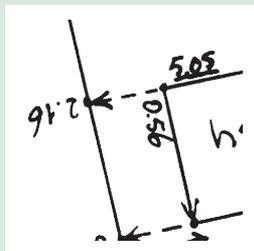
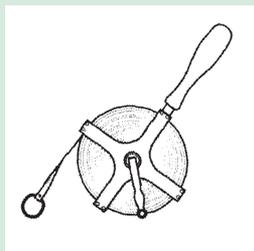


# Simple construction surveying for rural applications

Agrodok 6 - Simple construction surveying for rural applications



# **Agrodok 6**

## **Simple construction surveying for rural applications**

Jan H. Loedeman

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# Foreword

In autumn 1996 Agromisa asked me to act as a mediator in finding a qualified author for revision of the first version of this booklet, published in 1990. The request meant an open invitation because I felt challenged to include some of my own ideas about the kind of surveying a new edition of Agrodok 6 should address. As usual, a pertinent difference manifested itself between the inception of an idea and its realisation. Several sources of inspiration kept me going.

The unflagging encouragement I have continually received from Agromisa's publications manager Marg Leijdens and her successor, Margriet Berkhout, has been decisive. I'm grateful for their unrelenting confidence. I tender my thanks to Johan Boesjes, president of GITC bv, who financially enabled the proof-reading of my texts. Without the instantaneous dedication of Kate Ashton this would never have succeeded in time. Kate also served as my voluntary reference reader. She assured me that this Agrodok makes surveying open to the non-professional. Being a non-surveyor by profession myself, I was greatly relieved when my colleague and friend Marc Chieves – licensed surveyor in the USA and currently editor of *The American Surveyor*– assured me that my treatise on the subject was sound. The one-liner with which he communicated his opinion to me will not be easily forgotten.

A vital source of inspiration for this booklet dates back to 1972, to my stay in the Khroumir region of Northwest Tunisia. There I had to swallow some hard lessons from subsistence farmers. As I lived amongst them for five months they gradually made me understand that important aspects of subsistence farming practices do not lend themselves to measurement in the most literal sense. Nevertheless, they showed a lot of interest in the surveying instrument I used to assess the size of their fields in hectares, a quantity that they didn't need at all. In their turn, these illiterate but skilled and clever men gradually grasped the intellectual power of measurements in combination with models and calculations. The realisation of this booklet is a humble tribute to them and to their current colleagues elsewhere.

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# 1 Introduction: scope & structure

The majority of farmers in the world still practise some form of subsistence farming. Their draught-animal and handwork-based farming practices, however, cannot be compared with the completely mechanised and highly automated precision-farming practices that are becoming the norm for many of their North American colleagues. Hence, ‘farming’ is a term too general to be explanatory.

The same may be said of the term ‘surveying’. A modern surveyor cannot anymore do without a digital computer, which he needs to swiftly perform complex mathematical operations on measurement data he acquires with sophisticated and highly automated equipment. The same technology enables an earth-moving machine automatically to dig a canal or to terrace a slope, according to the spatial form that has been geometrically designed in a computer and transferred to the machine’s navigation and operating system. But like all farming, surveying too is based on some generic concepts independent of the technology used to put these into practice.

## **For whom Agrodok 6 is (not) meant**

This booklet is written for those who have an interest, for whatever reason, in measurement techniques related to ‘construction & building’ that go beyond the ones a carpenter applies. He or she is supposed to have at least some idea of basic geometric principles. Though factual knowledge of the branch of mathematics called ‘plane geometry’ is not a prerequisite, it will ease the grasping of most subjects presented.

This booklet is definitely not written as a manual to satisfy those who expect or need detailed instructions, presented in cookbook style. Though some ‘recipes’ are included where this is appropriate or clarifying, too much is left open to the imagination of the reader to make this book a comprehensive surveying manual. It is neither meant as that, nor as an aid for drilling surveyors. The purpose is to help people to understand some basic principles that lie at the heart of surveying in general.

## What Agrodok 6 is (not) about

This booklet presents surveying in a way it is not practised by any single professional surveyor. This sounds both cryptic and unrealistic, but the opposite is true. Getting to grips with surveying is not so much a matter of learning what a surveyor does, but of what he thinks. Historically, surveying has been characterised by a high degree of labour specialisation. This is reflected in the tasks surveyors perform and the education they receive at various professional levels.

In large construction works those who have received the lowest level of education perform most measurements. Some basic and crucial concepts need not to be explained or known at this level because, within the context of labour distribution, these concepts are addressed at a higher level in the organisation, at which the surveying *process* is monitored. Many textbooks that deal specifically with ‘simple’ surveying techniques may therefore be of little help in providing an overview of these concepts and that process. On the other hand, at the higher level of education, surveying is dealt with from a mathematical starting point. At this level too methods and techniques are presented and discussed one by one, without surveying being explicitly addressed, from head to tail, as a process.

A more generic problem related to any introductory presentation of surveying lies in the linking of two quite different ‘worlds’. What the surveyor is doing, for instance at a construction-site, is clearly visible and not very different from what the carpenter and the builder are doing there: he takes measures with a device. These actions form the ‘real world’ aspect of surveying. The connection between individual measurements and the cohesion of a surveyor’s actions rely on an abstract world that obeys the laws of geometry and other branches of mathematics.

Geometric models are at the heart of all surveying. Generic surveying problems and their solutions therefore require a transition from the real world (wherein the measurements take place) to the abstract world of geometric models (wherein acquired measurement data are actually used and mutually related). The results of mathematical operations have to be migrated back to the real world again, either on the site or on a piece of paper. From a practical point of view, surveying is

actually to a large extent a matter of on-the-job training. In consequence, the distinction between the real world and the abstract world becomes easily blurred.

This booklet has been conceived as an attempt to present surveying in a generic form by applying geometric concepts without using mathematics. Though abstractions are deliberately not shunned, the presented line of thought is definitely a practical one. Construction surveying offers a very practical context within which to illustrate what surveying is about. The qualification ‘simple’ has been included in the title to express the idea that the technological level of measurement techniques presented is ‘intelligible’ and ‘understandable’. This qualification certainly does not imply an ‘unsophisticated’ or ‘naive’ approach to underlying surveying concepts.

### **What Agrodok 6 contains and how it is structured**

The best way to learn surveying is to be trained and drilled on the job by a professional surveyor. Surveying is like riding a horse or a camel: one will never get to grips with it by merely studying a book about the subject. And, as with so many crafts, it needs a lot of practice. Moreover, some pitfalls and hurdles cannot be addressed on paper at all, like the reconnaissance of a construction-site that needs to be surveyed. Other aspects that require practice are, for instance, keeping clear and tidy field notes, and the level of detail that has to be provided by the survey in relation to a specific construction.

*Chapter 2* discusses what comprises construction surveying (Sec. 2.1). The principal aim of construction surveying is to realise a construction at a site, not merely to make maps (Sec. 2.2). In some instances, however, a site map may be helpful in the design and construction process if it meets certain specific requirements (Sec. 2.3). Setting out a construction at a site implies an inversion of the mapping process, for which the same survey techniques are used (Sec. 2.4). The possibility for errors lurks in every phase of a survey; prevention and timely detection are at the basis of ‘good surveying practices’ (Sec. 2.5).

*Chapter 3* begins with clarifying how in a surveying process real-world space is connected to some artificial mathematical space. Our real-world space is split up into two ‘flat’ spaces: horizontal vertical. In real space, two sorts of geometric quantities are measured: lengths between positions and angles between directions. These quantities must be geometrically related to the artificial mathematical space. And inversely, geometric quantities must be literally realised at a site before a construction can be built (Sec. 3.1). Points and lines have to be materialised, either temporarily or permanently, on a construction site (Sec. 3.2). Devices are used to measure lengths between positions along survey lines (Sec. 3.3). Square and non-square angles are used to realise directions both horizontally (Sec. 3.4 & 3.5) and vertically (Sec. 3.6 & 3.7).

*Chapter 4* addresses accurate measurement of height differences (vertical lengths) over large horizontal lengths, which requires the use of a levelling instrument. Very limited space available for this chapter means that all that can be presented are the concepts of levelling (Sec. 4.1) and a description of common equipment (Sec. 4.2). There is no room to address applications. Methods are presented in a rather brief manner (Sec. 4.3), followed by tips regarding error prevention (Sec. 4.4).

*Chapter 5*, in two pages presents a summary of ‘good surveying practices’ as related to the methods and techniques presented in chapters 2, 3 & 4. It is the only part of the book demonstrating a clear cookbook style.

The *glossary* included after Chapter 5 comprises a description of most technical terms used throughout this Agrodok.

Advice for *Further Reading* is presented on the closing page.