Best practice guidelines – enhancing the value of the surveyor

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Key words: professional surveying, best practice, guidelines, quality assessment, benchmarking

SUMMARY

The task of the modern-day surveyor is not primarily to deliver coordinates, but rather to add enough information for coordinates to be useful within a specific context or application. Also, the surveyor needs to be prepared for a "life cycle perspective", where coordinates are likely to be used (and re-used) for different purposes.

With this in mind, we discuss the role of best practice guidelines for surveying professionals and try to address the following questions:

- How can best practice guidelines bridge the gap between surveyors and potential clients?
- What can the surveying community learn from other professions where quality assessment and benchmarking is a vital part of improving the working process?

We specifically look at a Swedish set of guidelines called "HMK" and how these can be used by surveyors and clients to support quality assessment in the surveying process. Examples from the HMK guidelines include recommendations for verification of measurement uncertainty in detail surveys based on GNSS and terrestrial techniques.

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1. INTRODUCTION

Surveying has been a well-established profession since Roman antiquity and maybe even earlier. Mapping out new territories, establishing land ownership, and setting the geodetic basis for city planning and engineering projects have impacted much of what we associate with modern society.

However, the rapid development of information and positioning technologies in the 21st century has transformed the art of surveying in many ways. With low-cost GNSS receivers routinely integrated into smart devices and vehicles, coordinates are now available around the clock. Coordinates can be shared and interpreted by different sensors, machines and web services – often with little or no human intervention. This inevitably leads to the question how we, as a society, will understand and value the surveying profession in the future.

This paper explores some trends as observed by stakeholders within the Swedish mapping and surveying community. It also discusses the role of best practice guidelines as a toolbox for enhancing the value of professional surveying, with some examples from a Swedish set of guidelines called HMK.

2. PROFESSIONAL SURVEYING – A COMMON VIEW?

Although the development of professional surveying may have taken slightly different routes in different countries it has typically been seen as a public profession. This has also been the case in Sweden where most surveying and mapping was regulated by law until 2010, the most recent of which was called *Mätningskungörelsen*, or "MK" in short (roughly translated as "The Surveying Announcement").

2.1 The end of the civil servant era

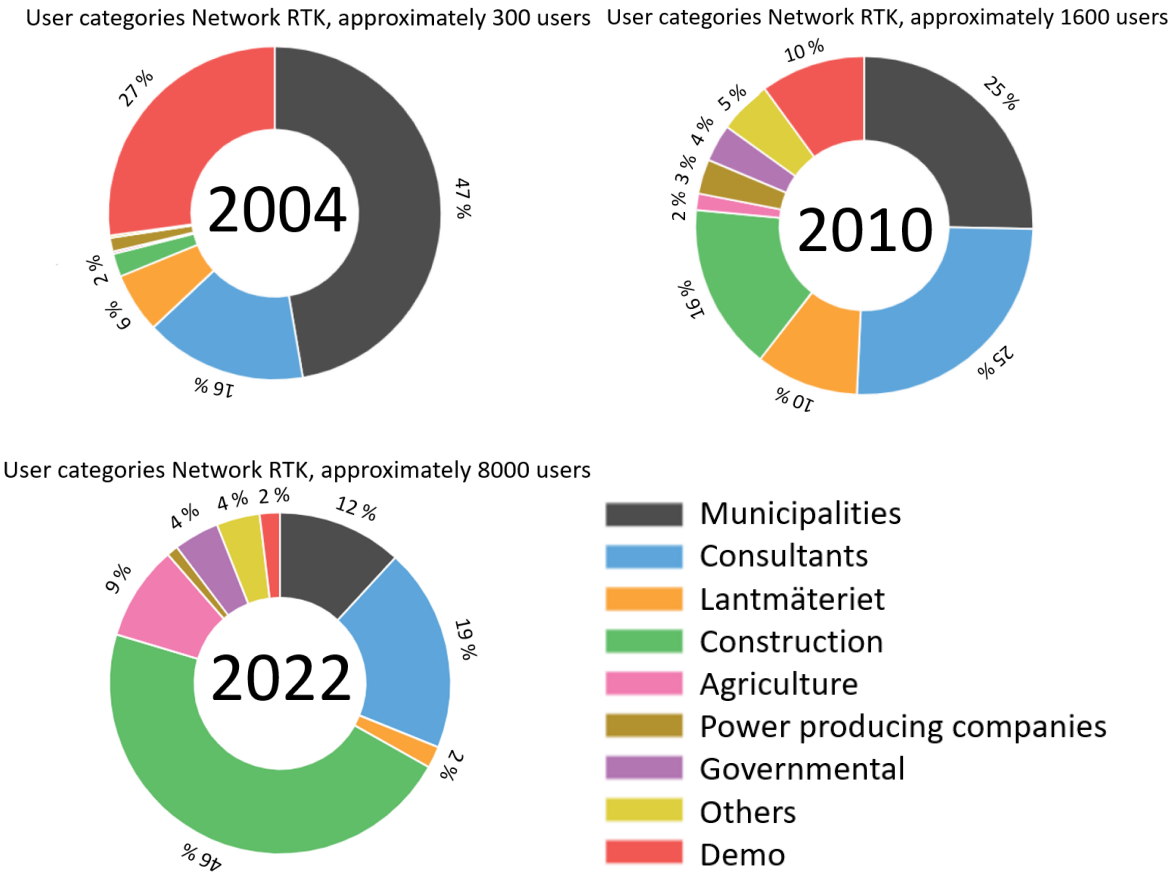
The MK law from 1974 mandated that surveying and mapping should be carried out by chartered/authorized surveyors. One criterion for authorization was employment at a mapping agency (either governmental or municipal) and another criterion was education within surveying or civil engineering, combined with some work experience. Education and work experience put together should equate a total of six years.

A few universities in Sweden contributed a steady supply of new surveyors to a limited number of employers within the public sector. This was a stable eco-system for a long period of time. But the nearly 400-year-old system of chartered surveyors in Sweden came to an end

in 2010, when the MK law was repelled. The driving force behind this was changing market dynamics: the growth of private enterprises and a growing demand for surveying services, also for non-traditional purposes. This transition happened simultaneously with the GNSS revolution and the rapid spread of accurate positioning techniques to a wide range of users and applications.

User statistics from the SWEPOS™ Network RTK service can be used as a kind of proxy for the transition that took place within surveying. In figure 1 we can see the different user segments when the RTK service was launched nation-wide in Sweden. Roughly 2/3 of the paying users (i.e. unique organizations) were from the public sector, mainly the local municipality authorities. In 2010 (figure 1b), the private and public sectors had become equally large in terms of number of users, with construction businesses being the fastest growing segment. And now, in 2022, the total number of Network RTK users have increased five-fold from 2010. The construction segment has nearly 50% of the users, and the agriculture segment is significant - and growing. The majority of the RTK receivers are installed on working machines such as tractors and excavators, and not operated by a traditional surveyor.

Figure1: User Categories SWEPOS Network RTK Service 2004, 2010 and 2022.



We have experienced a rapid transition within surveying during the 2000s. Land surveyors working from geodetic survey marks with geodetic methods have to a large degree been replaced with new user groups (or machines), new instruments and new applications. Will there still be a proper surveying profession ten or twenty years ahead?

We asked a few stakeholders within the Swedish surveying community to share their thoughts on the value of surveying – and the surveyor. They represent major stakeholder groups, namely:

- public institutions, e.g. local municipal authorities responsible for urban planning and development, and the different governmental authorities that provides geographical data on a national level,
- academic institutions responsible for higher education and research within mapping and surveying,
- private institutions, e.g. surveying firms and similar technical consulting, and building and construction entrepreneurs.

The answers here have been selected from a few different questionnaires. They do not necessarily represent all stakeholder perspectives but are representative of those answers that was given overall.

2.1.1 Stakeholder #1: Swedish municipality authorities

The land area of Sweden is divided among 290 local municipalities, which typically corresponds to urban centers and their closest surroundings. The municipal authorities are responsible for all land use and urban planning and development within their legislative boundaries. This includes mapping and surveying to provide large-scale geographical information to the public and other stakeholders. The local municipalities are different in terms of size, population density, real estate prices, rate of economic development etcetera, which means that they face different needs and challenges, including resources available for mapping and surveying.

What value does the professional surveyor bring today?

- "Professional surveyors can provide and combine geographical data in a way that is useful for different kinds of municipal/societal purposes, from planning to construction."
- "Surveyors can assess the need for local geodetic infrastructure such as control networks and levelling benchmarks, which usually is a significant cost for the mapping and surveying departments [in the municipality authorities]."
- "Geographical information needs to be of good (and known) quality. This requires professional surveyors and other educated personnel that can collect and provide relevant metadata. Surveyors can also perform quality control at the right time and place."

What skills will professional surveyors need in the future?

- "More data will be collected with UAVs and remote sensing techniques, especially those that allow fast digitalization of large volumes of objects with good resolution and low measurement uncertainty."
- "If we look at the surveyor as someone who creates digital models of physical objects, a wider range of skills including GIS, CAD and 3D modelling will probably be of great value."
- "Professional surveyors working for municipality authorities have to be more involved when client specifications are created. Other professions within urban planning and development are often niched and cannot be expected to have detailed knowledge about data collection and quality control".

2.1.2 Stakeholder #2: Universities

A handful of institutions are responsible for the ongoing education and research within mapping and surveying in Sweden. Three of those have programs at bachelor level or higher. The rest are vocational schools with shorter programs, 2 years or less.

What value does the professional surveyor bring today?

- "The importance of professional surveying is most evident in urban planning, where the surveyor is responsible for data collection, managing different design and engineering plans, and controlling the constructions according to the guidelines and technical specifications."
- "Professional surveying has (and will have) an important role in urban development, from the first (planning stage) to the end of the process and construction steps (quality control)."
- "The role of the professional surveyor has changed from 'master of instrument' to 'master of whole process'. The surveyors are not only responsible for data capturing; they are increasingly involved in data processing and mapping/visualization, which to some degree replaces time spent on surveying equipment and its outputs."

What skills will professional surveyors need in the future?

- "Innovations will change client expectations. The surveyors have to work with more advanced and integrated instruments that increase productivity and decrease the cost of large (or long-term) projects."
- "The surveyor will work more with Big data, use Augmented Reality (AR) and provide a broader range of services. This will open new opportunities for land surveyors to work in multidisciplinary fields."
- "Many technicians and surveyors think that classical surveying tasks will disappear, which is unfortunate and incorrect. Those tasks are still alive, and one cannot ignore them (even in the future). For example, establishing geodetic infrastructure (e.g.

precise geodetic control networks for deformation monitoring projects) needs a good knowledge of surveying."

2.1.3 Stakeholder #3: Private surveyors

Private surveyors are found in organizations of various sizes, from one-person firms to large technical consulting companies with hundreds of employees that are working simultaneously with many projects and with several clients. Long-term clients are often found within the public sector, such as Trafikverket (the Swedish transportation administration) or municipal authorities. New investments in urban development and large regional road and railroad construction projects will continue to expand the market for private surveyors in the foreseeable future.

What value does the professional surveyor bring today?

- "Professional surveyors have (or should have) the proper knowledge to connect the digital 3D world with reality."
- "Projects involving 'digital twins', 'BIM', and '3D coordination' are still focused around how to get different software and exchange formats to work together. The geodetic foundations of these projects are sometimes overlooked: the surface of the earth is still curved, and objects need to be placed and related correctly in that context."
- "My job is not really about producing coordinates. If that was the case, I would have to compete with millions of smart phone users. The purpose of my job is to deliver things with *quality*." [emphasis added]

What skills will professional surveyors need in the future?

- "Surveyors will be involved in more aspects of the projects. From 'deliverer of coordinates' (previously) to be more of a participant and contribute to an unbroken flow of information (in the future)."
- "The surveyor needs to have a bigger tool-box, at least to certain degree: some CAD, some coding, some non-conventional surveying, and a deeper understanding of what will happen when the data has been delivered to the client."
- "Business areas that are driven by digitalization will have more autonomous/smart sensors. Surveyors will have to adapt to this, maybe by employing other means of quality control."

2.1.4 Stakeholder #4: Lantmäteriet (the Swedish mapping, cadastral and land registration authority)

What value does the professional surveyor bring today?

Lantmäteriet currently has a three-part interest in surveying:

- Nation-wide (i.e. small-scale) mapping by aerial photography and aerial laser scanning are mostly done by Lantmäteriet, or by private companies with Lantmäteriet acting as a client.
- Cadastral surveying can only be performed by surveyors from cadastral authorities, of which Lantmäteriet is the largest one. There are also a few local cadastral authorities, in roughly 15 % of the Swedish municipalities.
- Lantmäteriet has a coordinating responsibility for mapping and surveying on a national level. This responsibility is regulated by law, although not specified in detail. One of several coordinating tools is a set of guidelines for surveying and mapping called HMK. These guidelines are primarily aimed at professional user groups.

What skills will professional surveyors need in the future?

One of the greatest challenges for Lantmäteriet in coming years will be skills supply overall. This includes surveyors. The nation-wide mapping will probably be relatively well-functioning and streamlined, and not dependent on a large group of surveyors per se – although image handling and photogrammetry skills will still be required by some.

Cadastral surveying, on the other hand, will continue to be a very demanding task. Most real estate boundaries will still have to be physically marked and accurately surveyed in the national reference frame, SWEREF 99 (the Swedish ETRS 89 realization). Even if more cadastral surveying will be done through UAV photogrammetry and other "wide area" techniques, geodetical methods will probably be required for quality control.

The trend over the last 25 years has been that field work and proper documentation from the cadastral surveys have been simplified, almost to the degree that coordinates are no longer traceable and possible to assess in terms of quality. This was not necessarily a problem at a time when only neighboring real estate owners were interested in the actual location of the boundaries, and these boundaries were marked in the terrain. Today, however, digital information about real estate boundaries is increasingly used by a variety of stakeholders, including municipality authorities for urban planning and building. There are potentially huge economic consequences if urban development is delayed (or impossible) because of lack of quality in cadastral information, including proper geographical location of boundaries and property rights.

This implies that properly skilled surveyors will be needed in the foreseeable future, given that they can adapt more of a "life-cycle perspective" on surveys. This means ensuring that enough information is captured in surveys to benefit more potential down-streams users of the geographical data. The increased use of 3D modelling and BIM applications will likely contribute to this trend. This is even more apparent for stakeholders within civil engineering projects, such as Trafikverket (the national transport administration). Lantmäteriet's national coordination responsibility for geographical information also implies that surveyors will be in high demand as a knowledge resource, at least within the areas of mapping and surveying.

3. BEST PRACTICE GUIDELINES – A MULTI-PURPOSE TOOL?

A common notion of best practice guidelines is that uniform quality can be achieved by adopting uniform procedures, regardless of who is executing the task. Another perspective is that best practice guidelines should lead to incremental improvements and increased efficiency for a given task. Martin (2008) summarizes best practice in the following way:

"[Best practice] maintains that with proper processes, checks, and testing, a desired outcome can be delivered with fewer problems and unforeseen complications. […] The notion of best practice does not commit people or companies to one inflexible, unchanging practice. Instead, it is an approach that encourages continuous learning and improvement. Best practice in a field can be expected to evolve as new information, instrumentation and methodology becomes available."

The purpose of best practices guidelines will vary depending on the role of the organization responsible for creating the guidelines and the target audience for the guidelines. We will briefly discuss some alternative purposes of best practice guidelines in the context of professional surveying:

- as a tool for streamlining methodology and terminology
- as a tool for bridging the gap between surveyor and client
- as a tool for stakeholder cooperation and benchmarking

3.1 Streamlining methodology and terminology

Best practice guidelines within surveying have traditionally (and non-surprisingly) been designed as methodological guidelines, usually by a mapping and surveying authority, with the straight-forward purpose of streamlining or promoting uniform procedures/practices (see e.g. ICSM, 2020). In this context, the addition of new guidelines often means *new surveying techniques* – such as GNSS/RTK – or older techniques/methods if they have been insufficiently described so far.

Streamlining practice can be useful for one or several of the following reasons:

- To promote formal standards
- To describe well-established practices, especially to non-experienced professionals
- To replace de facto established but perhaps undesirable practices
- To suggest new practices that are not yet standardized, accepted or known – but nevertheless desirable

Streamlining does not necessarily have to be restricted to methodology. An often-overlooked area is *terminology*. Without a common and concise terminology, guidelines and specifications are more likely to be misinterpreted and result in less uniform or suboptimal practice. This is especially important when working with a set of guidelines, or with references to specifications or mandated practice. The actual contents and format of the

guidelines are also important to consider. How detailed and extensive should they be? Are they only intended for professional surveyors? What is the right balance between descriptive and prescriptive? TSA (n.y.) and LINZ (2019) are a couple of examples that indeed suggests a wide array of answers to the question what a best practice guideline look like.

3.2 Bridging the gap between surveyor and client

A more recent way of using best practice guidelines is as a tool to facilitate the dialogue between surveyor and potential clients (e.g. RICS 2010). This implies that other aspects than streamlined methodology should be considered, and also that the client can bring those other aspects to the table. "You get what you ask for" could end up meaning two diametrically opposite things for a client, and it is important for a professional surveyor to understand the difference.

If we look at best practice guidelines as a potential "interface" between surveyor and client, the following aspects could be useful:

- To explain techniques and methodology to the client in a clear and coherent manner
- To support the client in producing specifications that are useful for the purpose
- To show that you as a surveyor adhere to professional excellence
- To suggest useful ways of performing client/customer control

All of these aspects can help the client to focus on the "what" instead of the "how", to avoid detailed (unnecessary) knowledge of the surveyor's working process, and to achieve a proper and effective quality assurance of the delivered job.

3.3 Stakeholder cooperation and benchmarking

A potential, but so far unexplored, purpose of best practice guidelines could be to facilitate stakeholder cooperation and benchmarking. Stakeholder cooperation and benchmarking is often important, or even crucial, to professions and industries that rely on high and uniform quality in their working processes and/or struggle with skills supply.

In the context of a profession like surveying, potential benefits could include:

- To find common ground on what best practice and professional excellence is
- To compare practices and identify potential errors improvements
- To facilitate networking and spreading information and new ideas
- To better adapt best practice guidelines to their intended audiences
- To promote active ownership and participation in the development of guidelines

4. THE SWEDISH HMK GUIDELINES – PAST, PRESENT AND FUTURE

With different purposes of best practice guidelines outlined above, we finally look at some experiences from Sweden, where a set of mapping and surveying guidelines called HMK have been around for almost 30 years.

4.1 First generation HMK guidelines – lessons from the past

As previously descibed, mapping and surveying in Sweden was regulated by law until 2010. The original version of the "MK" law from 1974 consisted of 10-15 paragraphs, e.g.

- that surveying and mapping should be performed with care, accuracy and in a well-planned and uniform manner – so long as this did not imply excessive costs and interference in relation to the purpose,
- that "surveying" meant establishing the location of points horizontally and vertically, either by ground-based (direct) geodetic methods or by (indirect) photogrammetric methods,
- that geodetic control networks should be established with permanent markers, surveyed and calculated numerically, and tied to the national horizontal and vertical reference frames,
- that surveying instruments should be thoroughly controlled and calibrated and otherwise in such condition that the expected level of quality could be achieved
- that Lantmäteriet – the Swedish mapping, cadastral and land registration authority – was a supervisory authority with the right to issue regulations for the application of MK,
- that surveying and mapping should be carried out by chartered surveyors, where one criterion was employment at a mapping agency (either governmental or municipal) and the other criterion was level and type of education, combined with some work experience.

Given that most of these paragraphs were rather brief and non-detailed, MK was soon supplemented by technical explanations and detailed instructions on how to apply the MK for different purposes, e.g. large-scale maps for city planning, road and railway construction, or cadastral surveys. This included appropriate mapping scales and accuracy standards, as well as specifications for the survey, i.e. methods, corrections, tolerances, documentation etcetera that should be applied for specific purposes.

However, the technical nature and strictly formal language of these explanations/instructions meant that they were primarily read and interpreted by experienced surveyors. Eventually in the mid-1990s, 20 years after the MK law was put into place, the first generation of more accessible surveying and mapping guidelines were published by Lantmäteriet – HMK (simply meaning: "Handbook for MK") (Lantmäteriet, 1994-1998). The themes included control surveying, detail terrestrial surveying, GPS surveying (at the time: static baseline GPS surveying), geodetic survey marking, photogrammetry, digitalization, databases, cartography and legislation.
In terms of contents and format, HMK was a mix between best practice guidelines and student literature; basic facts about mapping and surveying, as well as practical advice on how to meet the somewhat vague expectations in the MK law. In retrospect, the HMK guidelines were a huge boost for the surveying community. The guidelines were widely spread and used both by professional surveyors and in educational settings. The blue-colored paperback books were a familiar sight at working places of Swedish mapping, surveying and cadastral

authorities. This also meant that colleagues and managers in different roles within the organizations had a common reference that they could literarily read together. With HMK as a de facto standard for professionals, it became possible to build more purpose-oriented standards and specifications (e.g. geodetic surveying for house or road construction) on a uniform foundation.

The challenge with HMK, as with many other technically oriented publications, was that large parts of the guidelines soon became obsolete and needed large-scale revisions. In 2010 the MK law was repelled, which was effectively the final nail in the coffin for the first generation of guidelines. Lantmäteriet´s supervisory role was also changed from a supervisory role to a coordinating role for mapping and surveying on a national level. Lessons from this first effort was that best practice guidelines can be a success story, but it takes considerably effort - and it can fade away quickly if you fail to find the proper publishing format, routines for revision and a long-term cooperation within the surveying community.

4.2 Second generation HMK guidelines – where we are today

Cautiously trying to navigate this new coordinating role, Lantmäteriet entered a prolonged dialogue with stakeholder within the mapping and surveying community. They agreed that a reboot of HMK could help turning the tide of "reckless surveying" that followed in the footsteps of the new technology and the scrapped MK law. The first versions of the new guidelines were published in 2013-2014 as pdf documents at Lantmäteriets web site (Lantmäteriet, 2013-2021). The acronym HMK was kept but was now interpreted as "Guidelines for mapping and surveying".

4.2.1 Purpose, themes, formats and publishing

The stated purpose of the HMK guidelines is to contribute to an efficient and uniform practice within mapping and surveying in Sweden. The new guidelines are primarily based on the shared experiences of the municipality authorities Lantmäteriet and Trafikverket (the Swedish transport administration), both as surveying employers and as clients in procurement of surveying services.

New themes in this generation of HMK guidelines include digital maps for city planning, GNSS-based detail surveying, digital height models, orthophoto and laser scanning from air, ground, and mobile platforms. All documents are available in Swedish and some of them are also translated in English, in abbreviated form.

The new HMK documents support both professional surveyors and clients. The look and feel of the guidelines are similar to the previous ones, including the use of colored boxes to highlight either important facts, recommendations or requirements. *Requirements* ("shall") are only legally binding as part of business contracts for a tendered service where HMK guidelines are used as reference, i.e. HMK have no legal status on its own. *Recommendations* ("should") describe a practice that is desirable or useful. Both requirements and

recommendations are numbered so they can be referenced in a specific guideline (name and version).

The HMK guidelines are published online at https://www.lantmateriet.se/hmk, free of charge. The guidelines are also supplemented by short online courses, as well as technical literature that cover topics related to HMK more in-depth. All guidelines have an annual checkup to maintain good editorial quality and ensure that all references and links are correct. If major revisions are needed, e.g. because of new and/or adjusted requirements and recommendations, these are usually planned one year in advance.

4.2.2 Support for quality assessment

The thematic guidelines are process-oriented, meaning that they focus on quality aspects of methodology, rather than specific surveying instruments, services and applications.

Table 1: Examples of quality assessments by surveyor, from the GNSS/RTK guidelines (Lantmäteriet, 2013-2022)

Step in the working process	**Example of quality assessment**
Planning	Risk assessment of environmental factors: – signal obstruction and multipath – atmospheric and tropospheric disturbances Estimated measurement uncertainty based on: - CORS network “density” - distance to closest reference station
Instrument settings	Parameters that affect quality of registered RTK data – Elevation cutoff – DOP values – QC values
Surveying methodology	How to handle measurement uncertainty: - Short term randomness: coordinates registered from 5-15 epoch mean values - Medium- to long-term systematics: reoccupations properly separated in time to reduce correlation How to identity gross errors and verify quality: - Control points with tolerances based on known(!) quality - Reoccupations with tolerances based on estimated uncertainty
Documentation	Metadata, quality parameters, control procedures, descriptions of methodology etc.

4.2.3 Support for client specifications

The client is not supposed to have detailed knowledge of the surveying or geodata collection process. HMK therefore offer support for client specifications, including quality assessments in order to get an end product with the specified quality. Four HMK standard levels (0-3) have been defined covering mapping and surveying for national (level 0), regional (level 1), municipal (level 2) or building/construction (level 3) purposes. Each HMK standard level includes a set of parameters, thereby helping the client to define the product in a specification.

4.2.4 Stakeholder cooperation and benchmarking

One of the main differences between the first and the second generation of HMK guidelines is that a deeper level of stakeholder cooperation has been established and formalized: a reference group, from which smaller groups is formed on a need-to-do basis, e.g. working groups or focus groups

As of April 2022, the reference group have 80+ member organizations, representing all major stakeholders that were described previously. All new or revised guidelines are made available for review by the reference group, and members are also encouraged to bring ideas and suggestions to be considered for future updates.

4.3 The third generation HMK guidelines – what is ahead?

Several stakeholders, including private surveyors, have somewhat surprisingly expressed the need of a more regulated practice, where best-practice guidelines are shaped more as specifications than as recommendations. When asked to clarify, they point to the fact that there is no general professional standard in place. A larger portion of "requirements" rather than "recommendations" have therefore been suggested by the reference group.

The HMK reference group have also suggested themes that are not covered by HMK today, for example engineering surveying and how to connect traditional geodetic surveying and 3D applications.

There are ongoing projects to complement the guidelines with interactive e-learning HMK-courses and, more long-term, to move or translate the HMK guidelines onto a fully digital platform with APIs and web services.

5. CONCLUSIONS

Surveying is not about producing coordinates, but rather about making coordinates and geographical information useful for different purposes, while maintaining or adding quality along the way. Professional surveyors will still be in demand in the future. But they will need a wider range of skills in order to adapt to the rapidly changing digital environment and add

value to their clients. Experiences from 30 years of working with the Swedish HMK guidelines show that the same challenges apply to best practice guidelines – adapt or die!

Best practice guidelines can be a useful tool to enhance the potential value of the surveyor

- by streamlining methodology and terminology
- by bridging the gap between surveyor and client
- by facilitating stakeholder cooperation and benchmarking.

REFERENCES

ICSM, 2020, *Standard for the Australian Survey Control Network (SP1)*, Version 2.2, The Intergovernmental Committee on Surveying and Mapping, Australia, https://www.icsm.gov.au/publications

Lantmäteriet, 1995-1998, *HMK - Handbok till mätningskungörelsen*, Lantmäteriet, Sweden, https://www.lantmateriet.se/sv/Om-Lantmateriet/Samverkan-med-andra/Handbok-i-mat--och-kartfragor-HMK/lasarkivet/#faq=0fb8

Lantmäteriet, 2013-2022, *HMK – Handbok i mät- och kartfrågor*, Lantmäteriet, Sweden, https://www.lantmateriet.se/sv/Om-Lantmateriet/Samverkan-med-andra/Handbok-i-mat--och-kartfragor-HMK/handbockerna-i-hmk/

LINZ, 2019, *Specification for Geodetic Services*, Land Information New Zeeland, New Zeealnd, https://www.linz.govt.nz/data/geodetic-system/standards-specifications-and-publications/geodetic-specifications

Martin, D., 2008, *Review of Standards, Best Practice, Testing and Calibration in Global Navigation Satellite System (GNSS)*, France, International Federation of Surveyors Article of the Month, September 2008, https://www.fig.net/resources/monthly_articles/2008/september_2008/martin_september_2008.pdf

RICS, 2010, *Guidelines for the Use of GNSS in Land Surveying and Mapping*, 2nd edition, Royal Institution of Chartered Surveyors, Great Britain, https://www.rics.org/uk/upholding-professional-standards/sector-standards/land/guidelines-for-the-use-of-gnss-in-land-surveying-and-mapping/

TSA, *Client Guide - Topographical Surveys*. The Survey Association, Great Britain, https://www.tsa-uk.org.uk/downloads/

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