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THE IMPLEMENTATION OF GIS IN THE CENSUS DISSEMINATION MAPPING PROGRAM OF STATISTICS CANADA

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I. INTRODUCTION

1. Dissemination maps identify census geographic areas (boundaries and names) that assist users in relating census data to actual physical locations. Statistics Canada publishes its census data for most of its standard levels of geography, ranging from the smallest geographic area, called the enumeration area (EA), through various intermediary levels up to the provinces and territories, and Canada as a whole.

2. A number of dissemination map series at different levels of detail have traditionally been produced after every census. This paper focuses on the dissemination maps at the most detailed level of geography, the EA. These are large-scale maps showing the placement of the EA boundaries as well as the detailed street network and other features within the EA.

3. EAs are created primarily for census collection activities to ensure all households are contacted and to ensure an equitable workload for the thousands of enumerators (each enumerator is generally assigned one EA). EAs must cover the 9 million square kilometres of Canada's landmass where the population density ranges from almost 70 people per square kilometre in urban centres to less than one person per square kilometre in rural areas. About 78% of Canada's 30 million people live in 4% of its total land area.

II. CANADA'S EA BASE MAP SYSTEM

4. Although Statistics Canada introduced some automation of geographic processes back in 1971, it wasn't until the 1981 Census that research started investigating automating its mapping activities. Prior to that time, all mapping activities were manual drafting efforts, the most challenging of which was the large-scale mapping required to depict EA boundaries. The strategy adopted by Statistics Canada to implement its EA-based collection activities was to maintain a Canada-wide coverage of paper base maps that could be updated for every census in terms of reference features and boundaries. These same base maps were also used for dissemination maps.

5. Since EAs are based on the number of dwellings (normally ranging from about 125 in rural areas to 400-440 in urban areas), EAs can range in size from a few floors in a large apartment building to several thousand square kilometres in the northern, less inhabited parts of Canada. Thus, it is impossible for one single source of base maps to satisfy the needs of EA mapping in Canada.

6. Canada's EA base map system reflects the level of habitation: northern remote areas, rural areas, small urban areas and large urban centres. In Canada's northern territories, one map is used to cover the remote areas of each of the territories. In the rural parts of the provinces, a series of approximately 2,400 map sheets is used, produced by another federal department, Natural Resources Canada (responsible for topographic mapping for Canada). This series, called the National Topographic System (NTS) forms a grid covering Canada at either 1:50,000 in the southern most inhabited portions and 1:250,000 in the more northern part of the provinces.

7. In most of the smaller urban centres, maps have been manually drafted as required showing the street network, EA boundaries, and boundaries of some of the larger geostatistical areas. These maps are all different scales and sizes depending on the characteristics of the urban centre. There were approximately 800 maps covering the 8,200 EAs in the smaller urban centres in the 1996 Census.

8. The larger urban centres in Canada are formally delineated following specific criteria and guidelines. These urban centres are called Census Metropolitan Areas if their urban core

contained a population of 100,000 or more at the previous census, or Census Agglomerations if their urban core contained a population between 10,000 and 100,000. If the urban core contained 50,000 or more people on the previous census, the urban centre is further subdivided into neighbourhood-like areas called “census tracts”.

9. Census tracts are permanent, small neighbourhood-like or rural community-like areas established in large urban-centred regions with the help of local specialists interested in urban and social science research. Census tracts follow physical features, have a population of approximately 4,000 persons and are as compact as possible.

10. The early base maps for these “tracted” urban centres were manually drafted showing the street network and EA boundaries in a single census tract, each map being at a different scale and size. The number of census tracts in Canada has grown from approximately 3,600 in 1986 to 4,200 in 1996. The focus for automation of Statistics Canada’s geographic processes was these large urban centres where the majority of Canada’s population lived. For dissemination, these base maps were photographically reduced and 2 to 3 census tracts on a single map sheet.

III. TRADITIONAL APPROACH TO DISSEMINATION MAPPING

11. The largest costs for a census are incurred for its data collection activities and budgets for dissemination activities can sometimes be reduced either because of over-runs in the collection phase, or to contribute for planning of the next census. Thus, dissemination mapping costs are generally constrained and every effort is made to produce the maps within tight budgets. In addition, the first results of a census in Canada are published about 12 months after a Census. In order to interpret these results correctly, it is imperative that the maps are available at the same time. Given that the EA boundaries themselves are often not finalised until after the census (changes and corrections come in through the field operations), the time available for dissemination map production is limited.

12. To meet the two fundamental constraints of time and money, Statistics Canada dissemination mapping programs have utilised maps and technology available from the census collection mapping program. For large-scale maps, this has meant reusing the base maps and cartographic specifications as maintained for collection maps with updates to the EA boundaries as required. This has often lead to sub-optimal dissemination maps since requirements for collection maps may not generally match those for dissemination maps.

IV. OPPORTUNITIES FOR AUTOMATING DISSEMINATION MAPPING – INPUTS

13. Automation of labour intensive production processes has been recognised as a means for cutting costs and time for many years now. EA maps have traditionally been produced through a manual drafting operation. For the 1981 census, this manual drafting and EA delineation operation consumed about 80 clerical and drafting person-years, and cost approximately $1.8 million (1996) dollars.

14. Statistics Canada has used GIS technology in some of its census operations since 1971 when it developed one of the earliest GIS. This early GIS was called the Geographically Referenced Data Storage and Retrieval System (GRDSR) designed to facilitate the linkage of census data to small geographic units for the retrieval of data for user-defined geographic areas. Commercial GIS packages started appearing in the 1980’s and provided more efficient means for the automation of geographic processes. However, since these commercial packages were generally complex and expensive, Statistics Canada, as did most organisations, undertook a lengthy research activity to demonstrate the cost benefits prior to purchasing a

particular package. Meanwhile, automated mapping using in-house systems continued to be investigated during the 1980's using opportunities available through its GRDSR efforts. These early efforts proved the feasibility of automating large labour-intensive production systems.

Data Requirements for Dissemination Mapping

15. Dissemination maps require (1) the boundaries and names of geostatistical areas and (2) the reference features (streets, rivers, landmarks, etc) and their names to provide the context for identifying the relative position of the boundaries. The scale of the maps and the amount of reference information must be sufficient to enable accurate identification of the boundaries, but not so dense that boundary interpretation becomes difficult. For automated mapping, these requirements translated to digital geographic bases, which were not available in Canada in the early 1970's with one exception.

Meeting These Requirements for Automated Maps

16. The first digital data requirement Statistics Canada met for automated mapping was that for the reference features. At the core of the GRDSR was the production of a digital street network base that encoded streets and other features such as hydrography, along with the feature names and address ranges at street intersections. In 1971, this digital street network base was called the Area Master File (AMF) and subsequently renamed the Street Network Files (SNFs) in 1992. Since SNFs were originally designed to facilitate data retrievals for small geographic areas, they were created for only the larger municipalities in the large urban centres where the population was dense and confidentiality would not be an issue.

17. The second data requirement for digital boundaries was not met until the 1991 Census. Some digital boundary files had been created as early as 1976 using a manual roamer and key entry techniques, however, these were created only for the larger geostatistical areas (census tracts, municipalities and counties), and mainly for internal quality assurance procedures. Digital boundaries for thematic mapping purposes were created after the 1986 Census, however different levels of geostatistical areas were created from different sources and did not match each other or the SNF. It was the availability of the SNFs that provided the main impetus to research automated mapping at Statistics Canada. The first study to explore the feasibility of a large map production system using the SNFs and computer-assisted techniques was initiated.

V. THE 1981 CENSUS EXPERIENCE

18. The goal of the first study was to reproduce the paper base maps and resulted in a prototype system that was tested during the 1981 Census. An in-house system was developed to generate double-line street patterns from the single-line SNF and to automatically position street names and address ranges on the maps. Where necessary, text was repositioned interactively using a commercial interactive mapping system. This produced a map for each census tract on which the EA boundaries were manually drafted. For collection, these maps were copied and cut up into individual EA collection maps. For dissemination, the maps were copied as is and photographically reduced. This prototype system produced 32 census tract maps and their 200 constituent EA maps for the 1981 Census. A single map took approximately 9 person hours using the prototype system. Although this was a significant reduction from the 17 hours to manually draft a map from scratch, it was considered comparable to the time to manually update a paper base map. Note that it was still considered less costly to manually draft the EA boundaries onto the computer-generated maps rather than creating them digitally and adding them interactively.

VI. THE 1986 CENSUS EXPERIENCE

19. For 1986, the prototype system used in the 1981 Census was improved to reduce the processing costs as well as to reduce interactive editing time using better text placement algorithms. A total of 1,200 maps by census tract were produced (which were used to create 8,000 EA collection maps) for the 1986 Census. The overall throughput ranged from an average of 75 census tract maps per month to a peak level of 150 maps per month. The production time was decreased to 1 to 1.5 person hours per map and the total production costs were reduced by a factor of four. Computer-assisted mapping thus became operational at Statistics Canada.

Outcome – SNF Enhancement

20. A major outcome from the 1986 production system was the enhancement of the SNF to improve its quality and usefulness as a database for automated mapping. First, the repertoire of feature classifications was expanded to allow more flexible symbolisation on the maps to differentiate road types and to improve name placement rules (e.g. decisions to name highways but not highway ramps could be made). Secondly, since the original SNF was produced strictly for data retrievals, a minimum number of x,y point coordinates had been used in defining many of the curved features. Additional x,y points were added to some hydrographic features, highway interchanges and other curved features to improve their accuracy and cartographic appearance. In addition, new features that are important for visual identification in the field, such as railway yards and power lines, were added.

Text Placement

21. Text placement was (and continues to be) one of the single biggest problem in an automated mapping system. Custom algorithms and procedures were developed for this first automated mapping system at Statistics Canada, however, interactive editing was still required at an average of 20 minutes per census tract map. A major weakness of the name placement algorithms developed for the 1986 Census was their inability to generate curved text to follow curved features.

VII. THE 1991 CENSUS EXPERIENCE

22. It should be noted that the 1986 mapping system as well as the software used to process the SNFs were built around specialised commercial software and in-house programming systems. By early 1985, there was a wide range of commercial software packages designed to input, store, manipulate and display geographic information. During the planning for the 1991 Census, it was recognised that that this GIS technology could increase the efficiency of mapping applications as well as expand the usefulness of the SNFs into other operations. After careful analysis of current and future needs of Statistics Canada, it was decided that the ARC/INFO package from E.S.R.I. offered the processing tools and flexibility needed; ARC/INFO was acquired in 1985, too late to be used in the 1986 activities but in time for the 1991 Census.

23. The 1991 Census saw major changes in geography operations as more applications were made possible with the new GIS capabilities. The most significant enhancement to Statistics Canada's digital geographic data holdings was the creation of a digital EA boundary file for the 46,000 EAs covering Canada.

24. To ensure that the integrity of an integrated geographic base was pursued and that the boundaries aligned precisely with the SNF features for mapping and other applications, the EA boundary file was created directly from the SNF features. In areas not covered by an

SNF, the boundaries were digitised from the manual base maps. Since EAs are always delineated to respect the boundaries of all larger geostatistical areas, they could then be used as a "building block" for creating the digital boundaries for all other geostatistical areas (using a standard "dissolve" operation in GIS terminology). This ensured that all boundaries would match where they should (they were "vertically consistent").

25. In addition to digital boundaries, EA maps require the digital base map reference information, which was still lacking outside the SNF coverage in urban centres. Regardless, with the SNF and a full range of digital boundaries, large-scale collection and dissemination mapping could be automated for approximately 50% (almost 25,000) of all EAs, covering more than 60% of the population. In addition, EA dissemination maps could be designed for the particular purpose of dissemination for the first time. For EAs outside SNF coverage and for all small-scale mapping, the traditional manual methods had to be continued.

1991 EA Dissemination mapping for Large Urban Centres

26. As described earlier, urban EA dissemination maps had traditionally been created from the census tract based collection maps that were at different scales and orientations. Client feedback indicated that the inability to cut and paste the maps together was a major barrier to their effective use, particularly since clients were often interested in geographic coverages that spanned census tract boundaries.

27. With GIS capabilities, major changes could be entertained to better meet client needs and were, in fact, implemented. A few of these changes are listed below:

a) Rather than subdivide an urban centre by census tracts as used previously, a standard grid system was utilised.
b) The map sheets were produced at a consistent set of scales, depending on the density of information. This would enable the map sheets to fit together. In areas where there were pockets of dense information, insets were produced interactively.
c) The maps were sized to fit on 11 x 17 inch map sheets packaged in an "atlas-type" format by urban centre. Index maps showing census tract boundaries and the map grid were also produced to assist users in locating specific map sheets for a particular area within an urban centre.
d) For areas of an urban centre that were not covered by digital SNFs, the corresponding paper maps were photographically reduced to match the size of the automated map sheets.

28. The EA dissemination map system was implemented in ARC/INFO as a menu driven system that could be run using a production staff not expert in ARC/INFO. Interactive editing was still required to improve the automated placement of text on the maps and to create the larger scale inset maps.

29. System development started about a year before the maps were required using modules from the collection map system where possible. Production of the 1,200 automated maps took approximately 6 months using 6 production officers (with additional supervisors and management).

30. Problems with input data, hardware and software plagued the production of these maps from the start and time ran short. Data quality measures were compromised near the end to keep the growing cost over-runs in check and to get the maps completed in a reasonable time frame with respect to the release of the 1991 Census data.

Client Reaction

31. Client reaction to the 1991 Large Urban EA Dissemination maps was almost immediate as errors on the maps were identified and reported back to Statistics Canada. One case involved feature names that were scrambled and displayed on the wrong features for an entire urban centre. In addition, the grid system was difficult for some clients to grasp and required a 3-hour training session to understand the concepts and how to use the maps. Because a grid system was used for the 1991 maps, many EAs spanned map sheets and clients were forced to cut and paste maps together to view complete EAs and census tracts. The manual maps which covered the non-SNF portion of the large urban centres and which were photographically reduced were in some cases reduced too much making the feature names illegible. Since these manual maps were created by census tract, it was difficult for clients to fit them with the grid-based maps.

What was learned from the 1991 Experience

32. Statistics Canada's first major experience with using a commercial GIS for automated dissemination maps was a valuable one with many lessons learned.

a) Since it was determined that a number of the errors found on the maps were caused by the interactive work to improve text placement or create inset, take particular care with interactive work. Minimise the amount of interactive edits required with more up-front systems development; use production staff better trained in the GIS package; and, build in sufficient safeguards to control errors that are invariably introduced by human intervention.
b) Design the production system to re-run easily with updated inputs for a single centre or for a single map.
c) When conducting consultations on prototypes, ensure the prototype demonstrates the final look and feel of the proposed maps as well as their usability. Consultations on the 1991 computer generated maps demonstrated only a few maps, and these were well received. However, problems with the usability and content of the maps surfaced when the final package of maps covering an entire urban centre was delivered. The prototypes were not adequate for the clients to differentiate what they wanted versus what they could actually use.
d) Don't force-fit maps from two processes (automated and manual) into one package unless they have the same "look and feel".
e) Perform extensive system and volume testing using both valid and invalid data inputs prior to production.
f) Document all of the transactions during the production to use for analysing problems. Pre-plan how the production will be logged.
g) Finalise the map specifications prior to production. Minor map specification changes that occurred during the production of the 1991 dissemination maps caused havoc with system development and production tracking.
h) Build in extensive quality control procedures.

VIII. THE 1996 CENSUS EXPERIENCE

33, The use of GIS had expanded in Statistics Canada since the 1991 Census activities. The SNFs had been moved into an ARC/INFO environment and all geographic operations covering SNF areas were now automated, including the delineation of enumeration areas.

34. The main objective for the Dissemination Mapping Program in 1996 was to learn from the 1991 experience by producing a more user-friendly and better quality product, with an extensively tested production system. The concept of an 11 x 17 inch atlas-type map package

that covered a complete urban centre was still attractive since many clients purchased their data in that form. The design of the 1996 EA maps was derived through extensive consultations. Conflicting requirements were analysed and compromises reached. The final design is a major departure from the 1991 maps and a return to the look of the 1986 census tract based maps. A major improvement of the 1986 map which depicted only a single census tract, is the inclusion of a buffer of adjacent street network and boundaries to assist in locating map sheets for adjacent census tracts. However, since the maps are scaled to show the census tract as large as possible in the map window, the scale of each map varies thus cannot be cut and pasted together.

35. The SNFs and the digital boundaries were the essential inputs to an automated map production. Although there was complete coverage of the digital boundaries for the 1996 systems, SNFs covered, either wholly or in part, 39 of the 43 major urban centres in Canada. Of the 39, only seven urban centres were completely covered by SNFs.

36. To meet the 1996 objective, the 1996 automated mapping system was to create a consistent set of EA maps for complete urban centres. This would eliminate the need to supplement the automated system with a manual process for the non-SNF portions of the urban centres. However, to accomplish this, digital files were necessary to complete the digital street network coverage for the 32 partially covered urban centres and to build the four centres that had no digital coverage. It was considered too expensive to digitise the required data from scratch, and other opportunities were investigated.

Opportunity to Expand SNF Coverage

37. In parallel with the 1996 dissemination product development, work was already underway within Statistics Canada to develop a national street network base for use in the 2001 Census. This work involved a partnership between Statistics Canada and Elections Canada (responsible for Canada's federal elections) since both departments required up-to-date street networks for their massive field operations. Both departments had agreed to share information to extend the SNFs using data from a third department, Natural Resources Canada (source of Canada’s National Topographic Data Base, NTDB, a national digital base of topographic features similar to those shown on their NTS map sheets).

38. A review of the state of this 2001 initiative revealed that it was not possible to move timeframes to have final files early enough for the map production. However, an interim database, developed especially for the production of the large-scale dissemination maps, could be undertaken within the time available to satisfy the 1996 dissemination map requirements. This database would involve the integration of spatial databases from the three federal government departments. Even though the integrated (interim) database had essentially a one-time use, the benefits in terms of a single map production system and client satisfaction were deemed to outweigh the costs associated with the integration process.

39. The National Topographic DataBase (NTDB) produced by Natural Resources Canada covers the entire Canadian landmass and is organised by the National Topographic System (NTS), where each data set corresponds to one NTS map-sheet. The NTDB contains the features normally found on topographic maps at the scales of 1:50,000 and 1:250,000. Each type of feature (such as roads, hydrography, contours, vegetation, etc.) is provided as a separate layer (or theme). Both Statistics Canada and Elections Canada were involved in updating the street features in the road layer of the NTDB. Since street names on the maps were essential, and the NTDB model did not link feature names directly to the street features, both departments had also tagged street features with their street names.

The Challenges of Data Integration

40. The objective was to integrate the SNF and the enhanced NTDB to create an integrated and consistent digital coverage for complete urban centres. This would enable a single map production system to produce the 4,200 dissemination maps required for 1996 (approximately 20% of the maps would utilise the NTDB data).

41. The differences in content, positional accuracy and data structure between the SNF and NTDB were to make the integration of these data a challenge. Differences in feature attributes, classification and coding were essentially resolved with automated solutions.

42. In terms of content, the prominent features in the SNFs are the street network, hydrography, railways, and transmission lines all integrated into one network layer. The NTDB provides a much richer feature set in many separate layers and often the density of features was greater than those represented in the SNF. This issue was partially resolved by removing features in the NTDB portion that were not consistent with those in the SNF portion. Although some of this could be programmed automatically, interactive work was required to verify the outcome and resolve difficulties.

43. The difference in positional accuracy between the SNF and the NTDB caused difficulties in edge-matching ("joining") the features across the boundary of the two data sets. The NTDB was created from a scale of 1:50,000 and the positional accuracy standards of this data set are well known and quantified. The SNF features, on the other hand, come from a variety of sources: municipal maps, field updates captured during the census, and even digital sources, thus positional accuracy within the SNF is variable and not measured (relative accuracy and timeliness are more important for SNFs). The two data sets were first automatically "joined" and then interactive work was required to verify the results and make adjustments where necessary.

44. Finally, the other major data components -- the geostatistical boundaries -- were vertically integrated with the SNF (that is, boundaries coincide with features where appropriate), but not necessarily with reference to the NTDB. In order to depict the correct location for the boundaries, a reconciliation process was required which involved both automated and interactive procedures.

45. Details of the steps performed to complete the integration of the SNF and NTDB databases are the subject of another more technical paper. All of the work was performed in a production environment in ARC/INFO and resulted in an integrated database covering the 43 urban centres in Canada that could be used in a single production process for the 1996 Large Urban EA dissemination maps. Compromises were made in order to keep within budgets and timeframes. These compromises (e.g. edge matching roads and only those other features that formed EA boundaries) were considered acceptable since the objective was a cartographic base for dissemination mapping.

The 1996 Automated Mapping System

46. Similar to the 1991 system, systems specifications called for a turnkey operation enabling operators, with no ARC/INFO experience, to generate the maps. However, there was to be no facility for interactive edits to improve the placement of text on individual map sheets or to create insets since interactive editing was deemed to be a major source of errors in the 1991 maps. This meant that more system development was required to improve the automation in these areas. In particular, the default text placement in ARC/INFO was not sufficient to produce acceptable maps and a number of custom processes were built to improve ARC/INFO's functionality using both ARC/INFO and 'C' programs.

47. Since interactive editing was eliminated, production staff identified maps with pockets of illegible map detail caused by dense information. These maps were then automatically split into large scale maps of two or four parts which could be pasted together to create a complete census tract.

48. The project to design and produce the 1996 automated EA dissemination maps started approximately 2 years prior to the delivery date for the maps (one year earlier than in 1991). Although the boundary reconciliation with the NTDB features was performed in a separate step, the integration of the SNF and NTDB data sources was built into the map production system. The main portion of the map specifications and system development was essentially complete within the 12 to 15 months. The second year included extensive volume testing, fine-tuning and final production. The main problems identified throughout the production process were caused by unexpected data inputs (often caused by conflicts in the two data sources). The complete set of EA maps was actually produced three times, however, these were done within the original budget and time. Production throughput (including a manual data quality check) started at approximately 700 maps per month in a shared workstation environment. For the last round of map production that was performed on a single-use workstation, throughput increased to 2,100 maps per month and the 4,200 maps were complete within 2 months with 4 production officers.

49. The 1996 Large Urban EA Dissemination maps were released at the same time as the 1996 Census population and dwelling counts, the first data available from the 1996 Census, on April 15, 1997. Client reaction to the maps has not yet been measured.

50. The 1996 automated mapping system was considered a success, which can be attributed to a number of factors:

a) experience gained through the 1991 production;
b) starting the process early (consultations and planning started three years prior to the delivery data);
c) extensive testing of the system and map design specifications;
d) not-allowing interactive edits during the map production even though this meant additional up-front programming. Interactive editing was required during the edge matching of the two data sources, but was kept to a minimal. The underlying assumption was that, in order for the maps to meet client needs, they need not be perfect in a cartographic context. Compromises were made in the placement of text, and in the consistency of the content and edge matching of the two data sources (e.g. a lake that in reality spanned an area part SNF and part NTDB but only appeared in the NTDB was left in the final data set). Consultations with Statistics Canada's Regional sales offices were held throughout the process to ensure that the compromises made were acceptable;
e) 100% volume testing which identified all possible problems before final production.;
f) a turnkey system that could process a full centre or a single census tract (important if a map were lost or ruined by a printer malfunction).

IX. SUMMARY OF GIS IMPLEMENTATION

51. The following table summarises the number of maps produced using automated mapping, and some associated costs and throughput, over the past four censuses. The 1986 prototype system gave Statistics Canada the initial experience in automating a traditional labour-intensive map production system. The introduction of a commercial GIS for the 1991 maps was a difficult lesson learned, but benefited the 1996 production that in turn paves the way for 2001.

Average cost to produce an automated Large Urban EA reference Map

a.

	b. Number of maps	***c.Cost 1996 $Can***	***d.Person-hours***	***e.Through-put f.#maps per month***
g. Prototype system (1980) (by census tract)	***h.32***	***i.$225***	***j.9***	***k.***
l. Automated (1986) (by census tract)	***m.1,200***	***n.$58***	***o.1 to 1.5***	***p.75 – 100***
q. Automated 1991 (by map grid)	***r.1,200***	***s.$120-$140***	***t.4 to 6***	***u.200***
v. Automated 1996 (by census tract)	***w.4,200***	***x.$15***	***y.0.5***	***z.700 for the first 2 rounds, 2,100 in the last round.***

aa.

X. CONSIDERATIONS FOR THE 2001 CENSUS

52. Statistics Canada is working towards having a national digital network base for most of its geographic processing for the 2001 Census. For the Dissemination Map Program, this will permit the development of automated EA dissemination maps covering both the urban and rural parts of Canada. Experience with using automation for urban mapping has now been gained over 3 censuses, using GIS for urban mapping over two censuses, and integrating different data sources over one census. GIS has allowed Statistics Canada to focus on building its geographic databases and production applications rather than spending time and resources on systems to store and manipulate the geographic data. Using a commercial GIS has also allowed Statistics Canada to benefit from the latest GIS technology via software upgrades rather than building that technology. GIS, however, does not mean that standard systems analysis, design and testing can be compromised. GIS comes with its own price in terms of specialised training requirements for staff. The number of clerical and drafting staff working on manual geographic operations has reduced from an average of 40 persons per year, to about 10. This is expected to drop even further by 2001. However, the number of technical staff has probably increased by the same numbers. As the requirement for staff to do manual work has reduced, the availability of their expertise is being lost as these employees pursue other career opportunities. In fact, there may be no manual drafting expertise left in Statistics Canada by 2001 to keep as a contingency for mapping if required.

53. The 1996 large-scale mapping program has opened a new dimension of automated cartography – that is allowing us to accept compromises in the final map design that would not have been required with manual cartography. The objective of an “automated push-button” approach without human intervention to improve the automated process was met. Although this increased the up-front programming and testing, it saved time and resources on the actual production process. We won’t know the consequences from a client perspective until feedback is received and analysed which will determine if the consultation process was adequate and the compromises made acceptable to the full user community.

54. Experience in mapping urban areas in Canada may not imply expertise in mapping rural EAs. Automating rural areas in Canada will present its own challenges, which cannot be addressed until a digital database in these areas is established for testing and prototyping.

55. Specifications for the 2001 EA collection maps are being developed now. A national digital base will allow maps designed specifically for dissemination. Rather than build

separate collection and dissemination map systems, the benefits of building one mapping system that will accommodate different sets of specifications for producing both the collection and dissemination maps should be considered. We also need to consider if paper maps will be required in 2001 or will it be sufficient to deliver them in electronic format with viewing software. Perhaps the national digital databases will provide an option to produce customised maps for individual clients, as they are required. These considerations and many others will have to be addressed over the next year.

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