Minicode Generator: A Methodology to Extract Generic Building Codes

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This paper describes work in progress. It summarizes the methodology for analyzing building codes and isolating generic building characteristics. These characteristics can be used by building code experts to markup code documents and subsequently by building code users to extract code provisions that apply to their projects. Although this methodology has been developed for the National Building Code of Canada, it can be applied to any model code and implemented on most computer platforms using off-the-shelf software. The paper outlines the scope of the research, the historical development, the problems encountered, and paradigms for markup and extraction of code provisions.

Keywords: building codes, architecture, engineering, cassification, indexing.

1 Introduction

This paper describes work in progress. The Minicode Generator is being developed to assist plan examiners, building officials responsible for plan verification prior to issuance of the building permit. The Minicode Generator quickly and efficiently finds provisions related to generic types of buildings; with some modification, this methodology could be used by the design community. The research for the Minicode Generator forms part of a larger project dealing with the classification of building attributes related to building codes, specifically the National Building Code of Canada (NBCC, 1990; Vanier, 1991a). The Minicode project was initiated to address a number of problems encountered by plan examiners in their evaluation of design submissions. It neither attempts to solve all building code problems, nor to be the final solution for plan examiners; it is one more step in the direction of providing tools to the construction industry to increase productivity and efficiency.

2 Problems Related to Building Codes

2.1 Identification of Relevant Provisions

Designers, building inspectors, plan examiners, and building owners require expert knowledge of building codes in their day-to-day operations (Mackinder, 1982). Normally

U. Flemming and S. Van Wyk (eds.), ***CAAD Futures '93****, pp. 225-239.*

this knowledge is obtained through years of experience with the documents. Finding building code provisions dealing with one building attribute, feature or concept is a long, tedious task for the novice building code user and quite simple for the experienced user. However, finding *everything* relating to that building attribute, feature or concept can be difficult for both. How can the users be certain that they have checked everywhere in a document with 4000 tightly-woven provisions or rules?

2.2 Sequencing of Provisions

Building codes are developed by committee consensus; they typically “grow’d like Topsy”[1] evolving over time rather than adhering to a rigorous implementation plan. As new materials are developed or new hazards are encountered, building codes are modified. Typically the new provisions are appended or inserted into the existing linear structure in the most expeditious fashion by the code writing bodies. Only a few building codes have been completely rewritten in the past to harmonize years of editions or directional changes (Blackmore, 1992). In the case of the National Building Code of Canada (NBCC), the order and the location of the provisions can be adjusted every five years to reduce this problem but it is impossible to address all anomalies as some provisions could logically be in two locations. In addition, this reshuffling is annoying to building code users because changes to sequencing or numbering are an additional administrative burden.

As a result, it is difficult to find all the provisions relating to a specific type of building or building feature, which can be scattered throughout the document. This is typical with any paper publication as there can only be a limited number of indices available to assist the users.

2.3 Indexing of Keywords

Permuted indices or conventional back-of-the-book indices assist users by listing the cross-references together, but place the onus on users to locate them. So the user can always find where a concept has been referenced, providing the indexing has been done properly or has been kept up to date after numerous code modifications. Some indices even list a string of references to a specific keyword such as “exits” and do not provide any context for individual references.

As a partial solution, computer-assisted indexing solves many of these problems by providing Boolean search capabilities on the inverted indices of full-text documents (Vanier, 1991b); but still many false hits will occur because of lack of vocabulary control in the writing of these documents. Even conventional manual indexing of provisions using library methods will result in questionable retrieval. It is because building codes are not written in conventional prose; they are written as a combination of engineering principles and legal documents. This makes it extremely difficult to index using current solutions. For example, examination of the complexity of building codes will quickly show how implicit information, alternate terms or faceted attributes would be extremely difficult to index using conventional methods or inverted indices.

Implicit information is predominant in building codes, Article 3.23.18.1. of the NBCC states:

> (1) Except as provided in Sentence (2), each exterior wall in each *story* shall be braced with not less than one diagonal brace conforming to 9.23.18.1.

[1] From a memorable line in the book, *Uncle Tom’s Cabin* [1852, ch 20], where Topsy, when asked “who was your mother?,” answered: “Never was born ... I ‘spect I grow’d” (Oxford Dictionary of Quotations).

An experienced code user automatically knows this applies to wood-frame construction because it is in a section with that heading, even though the heading is located 19 pages earlier. Another example of this type is a cross-reference, where conditions and requirements of applicability are referenced at another location, as in the case of Article 2.1.1.1. where:

> 2.1.1.1. Scope. Except as provided in Subsection 2.1.5., Parts 1, 2, 7, and 8 apply to all *buildings.*

Alternate terms are used throughout code documents; in the NBCC there are 12 major occupancies: A1, A2, A3, A4, B1, B2, C, D, E, F1, F2, or F3. These are also referenced in the NBCC by terms such as assembly, institutional, residential, business and personal services, mercantile, and industrial occupancies or by more specific terms such as high hazard industrial occupancy.

The reason this is an indexing nightmare is because discrete attributes and values exist and there is a need for faceted indexing. That is, it is not a simple case of one index term or NOT that index term for a provision, but any number of a discrete selection of values could be possible for the same provision.

Crucial in the indexing is the NULL set. In building codes, if nothing is mentioned regarding the type of building or building feature, then the provision applies to *all* buildings; this is contrary to conventional indexing.

To add more complexity to the indexing dilemma, any provision can contain a number of conditions coupled with AND and OR, as in the case of Article 2.1.3.1.

> (1) ... Part 9 applies to *buildings* of 3 *Stories* or less in *building height,* having a *building area* not exceeding 600 m^2 and used for *major occupancies* classified as ... Group C, ...Group D, ...Group E, ... or ... Group F, Division 2 and 3 ...

2.4 Minicode Generator Solution

The idea behind the Minicode Generator is to identify provisions that relate to a specific attribute, such as occupancy and to electronically tag those provisions with that attribute; thus, to allow the automated generation of abridged versions of building codes that are building type-specific and based on associated attributes.

This solution addresses the three following problems. The Minicode generates only information pertaining to a generic or specific building type such as townhouses or small commercial buildings; thereby eliminating irrelevant sections and reducing the volume of text to verify. The Minicode attributes form part of the absolute location of the provisions; this makes the sequence of provisions as they appear in the text irrelevant. The attributes and values are well-defined and the tagging is done by building code experts; this provides a degree of confidence for users of the Minicode Generator.

3 History of Minicode

The concept of a Minicode was proposed in Target (1988) as one of two options in a study entitled *Target System: An Information System for MiniCode Preparation* commissioned by Alberta Labour, the authority having jurisdiction for building codes in that province. The Alberta Research Council's (ARC) feasibility study proposed a classification of building attributes, the creation of a database for individual projects, and the preparation of user-described building attributes for building code provisions. The Target System was originally intended to assist plans examination operations, whereby only provisions on the culled building code would be checked. The other option proposed in the feasibility study concentrated on developing an expert system for the Alberta Building Code using the same building attribute concept.

Interest in the development of a Minicode Generator resurfaced in 1990 when a number of building code writing bodies jointly agreed on collaborative research in the field of electronic building codes. Funds were secured in 1991 from the National Research Council Code Development Fund, the Office of the Fire Commissioner of Canada, Alberta Labour, and the Ontario Building Standards Branch to develop the Minicode Generator and the more detailed NBCC Classification System.

4 Description of the Project

The objective of the research project is to develop a Minicode Generator to increase the efficiency of the plans examination process for checking design compliance with the appropriate building code. The task description of the project is as follows:

1. Elicit attributes and attribute values in cooperation with Alberta Labour and the Canadian Fire Commissioner. This task will involve the generation of a list of attributes and associated attribute values (called Attributes List) which will be used to classify or tag the individual provisions.
2. Design and develop input interface to a project database to facilitate the tagging operations (called Minicode Tagging Interface).
3. Systematically tag every provision in the NBCC (called Minicode Tags) with the appropriate selection from the Attributes List. This would be carried out by building code experts from the research consortium.
4. Create the computer software to generate the Minicode (called Minicode Generator Software).
5. Create user software for designers, plan examiners and building inspectors (called Minicode Users) to select the description of their building (Building Description) from the Attributes List and to generate the appropriate Minicode (called Minicode Generation).

Two fundamental principles are to be incorporated:

1. The Exclusion Principle, whereby only irrelevant provisions are excluded from the Minicode, will form the basis for the search mechanism. The Exclusion Principle is explained in detail later in the paper.
2. Only the provisions at the level of an NBCC article will be tagged. For the benefit of readers not familiar with the NBCC, it contains nine parts dealing with topics such as general requirements, structural design, and small buildings. It contains 1715 articles which include 2184 sentences. Sentences, one rung down on the NBCC hierarchy from the article and denoted by the character “(1), (2), etc.,” are full provisions. Owing to the historical development of the NBCC and the breakdown of various sections and subsections, it can be assumed there are 3899 standalone provisions in the NBCC, this equals the sum of the number of articles and sentences.

5 Evolution of the Minicode Generator

Four groups are working cooperatively on this project. Group 1, at the Institute for Research in Construction (IRC), is responsible for the creation of the Attributes List, the development of the database for recording the tags, and design of the Minicode Tagging Interface. Group 2, the Advanced Construction Technology Laboratory of the IRC, is responsible for the development of the Minicode Generator Software. Group 3, at the Fire Commissioner of Canada, is responsible for testing the validity of the model and assisting in creating the Minicode Tags of Part 3 (large construction) of the NBCC. Group 4, at Alberta Labour, is responsible for creating the Minicode Tags of the NBCC.

Specifically, the elicitation of the Attributes List is done in *a posteriori* fashion. A number of attributes and attribute values (See Table 1) were identified in earlier research projects (Vanier, 1991a;Vanier, 1992) and were used initially for tagging the articles. As this tagging proceeds, new attributes are identified and incorporated into the evolving Attributes List.

Table 1. Preliminary Attributes List

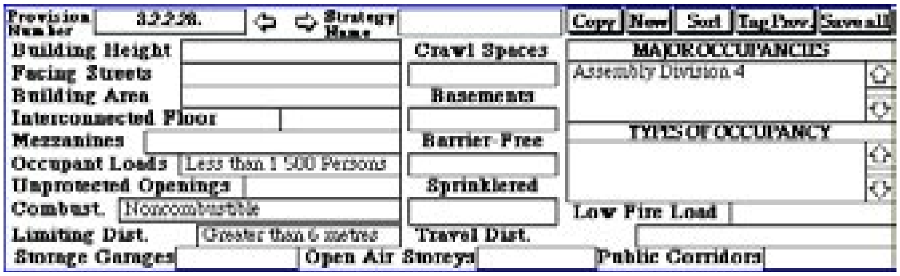
Attribute	Attribute Value
Barrier-Free:=	True, False
Basements:=	True, False
Building Area:=	< 600 m^2, > 600 m^2, area in m^2
Building Height:=	< 3, 1, 2, 3, 4, 5, 6, 7 Stories, and > 7 Stories
Combustible Construction:=	True, False
Crawl Spaces:=	True, False
Facing Streets:=	One, Two, Three Streets, or more
Interconnected Floor:=	True, False
Low Fire Load:=	True, False
Major Occupancy:=	A1,A2,A3,B,C,D,E,F1,F2,F3
Mezzanines:=	True, False
Occupant Loads:=	Number of Persons
Part 3 Building:= (Large Construction)	True, False
Sprinklered:=	True, False
Type of Occupancy:=	List of ~ 100 choices--i.e., Gymnasia, Flour Mills, and Warehouses, etc.
Unprotected Openings:=	True, False

5.1 *Prototype I*

The initial database and user interface software provided to Groups 3 and 4 also included a hypertext version of the NBCC, similar to NBCCard (Vanier, 1991b). It permits the experts performing the tagging operations to move quickly back and forth from an electronic code to the Minicode. It was felt that this would increase their efficiency and allow them to search for related NBCC references.

The task at hand is to systematically and sequentially tag each provision in the NBCC. A user-friendly interface with pull-down menus and point and click buttons was developed to tag the provisions (See Figure 1). Provision numbers are automatically generated for each new Minicode Tag and templates can be created for common tagging strategies. Other functions include sorting the Minicode Tags, copying existing tags, and saving a backup to a text file.

In the example in Figure 1, the upper portion displays the Minicode Tags for Article 3.2.2.28 and the bottom displays the article. The expert selects the attribute values for each tag from a pop-up menu that appears when the cursor enters a field.



Provision Number: 3.2.2.28.
Strategy Name:
Building Height:
Facing Streets:
Building Area:
Interconnected Floor:
Mezzanines:
Occupant Loads: Less than 1 500 Persons
Unprotected Openings:
Combust.: Noncombustible
Limiting Dist.: Greater than 6 metres
Storage Garages:
Crawl Spaces:
Basements:
Barrier-Free:
Sprinklered:
Travel Dist.:
Open Air Storeys:
MAJOR OCCUPANCIES: Assembly Division 4
TYPES OF OCCUPANCY:
Low Fire Load:
Public Corridors:

(1) A building classified as Group A, Division 4 shall conform to Sentence (2).
(2) The building shall be of *noncombustible construction*, except that
(a) the roof assemblies are permitted to be of *heavy timber construction*
(b) the *building* is permitted to be of *combustible constructio*n provided
(i) the *occupant load* is less than 1,500 persons, and
(ii) the *building* has a *limiting distance* of not less than 6 m.

Figure 1. Prototype I database and electronic code for Article 3.2.2.28, showing the exact display that the user sees while entering tagging data.

The original software design permitted only one Minicode Tag per article. A multiple Minicode Tag feature was implemented during the initial phase of the project when it was discovered that complex articles could have a number of different tags, some of them conflicting with each other.

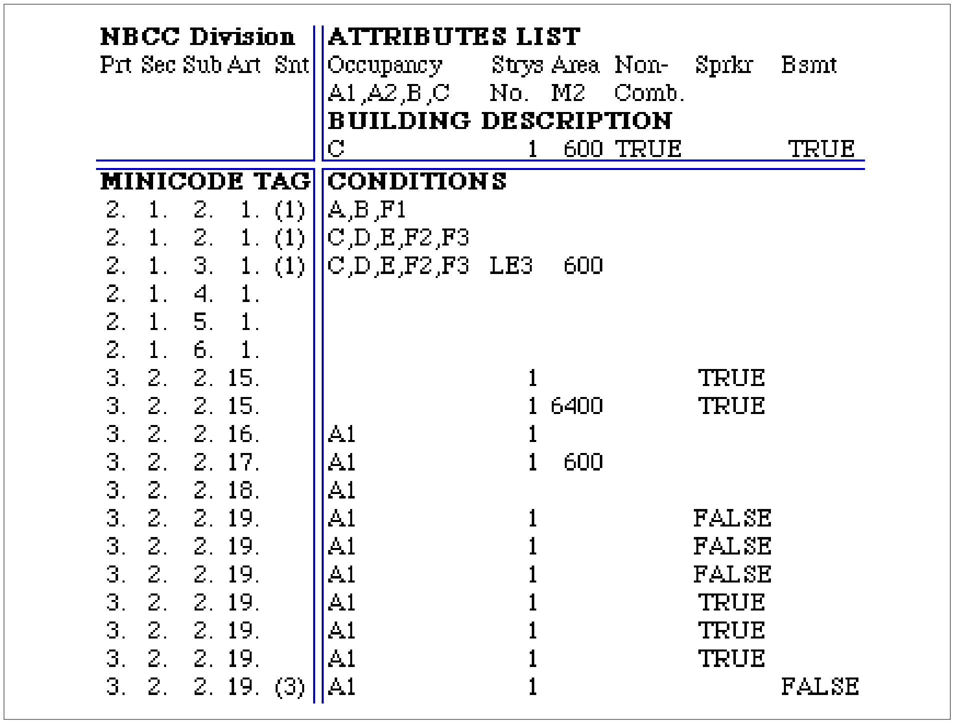
5.2 *Problems with Prototype I*

It was discovered early in the project that: (a) maintenance of the system with four different, independent groups was difficult; (b) updating the software to include new attributes was laborious; (c) providing the software on two computer platforms was time-consuming; and (d) verifying the model during tagging was impossible.

It was also decided that a one-line summary of all tags was needed to allow the users to view the tags for similar provisions at the same time. It was discovered that the integrated electronic code was rarely used and could be omitted, thus reducing considerable programming overhead. As a result, a new database and new interface were developed to overcome these unexpected problems and to reduce the time required for data input.

5.3 Prototype II

This version presented the information (see Figure 2) on a line-by-line summary.



NBCC Division					ATTRIBUTES LIST					
Prt	Sec	Sub	Art	Snt	Occupancy	Strys	Area	Non-	Sprkr	Bsmt
					A1,A2,B,C	No.	M2	Comb.		
					BUILDING DESCRIPTION					
					C	1	600	TRUE		TRUE
MINICODE TAG					CONDITIONS					
2.	1.	2.	1.	(1)	A,B,F1					
2.	1.	2.	1.	(1)	C,D,E,F2,F3					
2.	1.	3.	1.	(1)	C,D,E,F2,F3	LE3	600			
2.	1.	4.	1.							
2.	1.	5.	1.							
2.	1.	6.	1.							
3.	2.	2.	15.			1			TRUE	
3.	2.	2.	15.			1	6400		TRUE	
3.	2.	2.	16.		A1	1				
3.	2.	2.	17.		A1	1	600			
3.	2.	2.	18.		A1					
3.	2.	2.	19.		A1	1			FALSE	
3.	2.	2.	19.		A1	1			FALSE	
3.	2.	2.	19.		A1	1			FALSE	
3.	2.	2.	19.		A1	1			TRUE	
3.	2.	2.	19.		A1	1			TRUE	
3.	2.	2.	19.		A1	1			TRUE	
3.	2.	2.	19.	(3)	A1	1				FALSE

Figure 2. Prototype II, showing representative provisions on the left with Minicode Tags on the right. The Building Description at the top is provided by the user.

6 Minicode Generator Features and Functionality

The following items describe the features and the functionality of the Minicode Generator.

6.1 Minicode Tags

The Minicode Tags for the provisions form the rows of Figure 2, whereas the columns are the applicable attributes. The original intention of the project was to tag only at the article level of the NBCC, for administrative and control reasons; but Prototype II provides greater flexibility and control, and as can be seen in the first 3 Minicode Tags in Figure 2, even the NBCC sentences can be independently tagged.

The top right quadrant of Figure 2 contains a representative sample of the Attributes List and a Building Description. The Building Description entered by the Minicode User in this example describes a Group C Occupancy, one story, 600 m^2, noncombustible building containing a basement. The bottom portion of Figure 2. contains the Minicode Tags for a number of provisions; the provision numbers on the left, and the provision conditions on the right. For example, the Minicode Tag on the second row for

Sentence 2.1.2.1.(1) indicates that it is applicable for Groups C, D, E, F2, or F3 Occupancy; in the following row, Sentence 2.1.3.1(1) is applicable for the same Occupancies but restricted to buildings less than or equal to 3 story (LE3), or less than 600 m^2; and Articles 2.1.4.1 through 2.1.6.1. are applicable for all types of buildings.

6.2 *Multiple Tags*

As can be seen in Figure 2, a provision can have any number of Minicode Tags. Sentence 2.1.2.1.(1) has two, one for Groups A, B, or F1 Occupancy and another for Groups C, D, E, F2, or F3 Occupancy. This example also shows that even an NBCC sentence can have multiple tags.

6.3 *Hierarchy of Attribute Values*

By definition each attribute has a discrete number of attribute values, as can be seen in Figure 2. For the attributes identified to date, they always fall in a spectrum ranging from least restrictive to more restrictive conditions. For example, a “sprinklered” condition is more restrictive than a “non-sprinklered” condition; an “occupant load” of 300 people is more restrictive than 100 people; and “one facing street” is more restrictive than “three facing streets.”

Some attributes have an unlimited number of attribute values, as in the case of building area, occupant load and building height. In these cases, the building code experts who are performing the tagging operations will enter the appropriate value from the building code (i.e., 1225 m^2) in all the Minicode Tags; these will be analyzed after the tagging of the entire NBCC is complete and a limited number of representative attribute values will be selected for the final Minicode Generator.

6.4 *Boolean “AND” and “OR"“*

The Boolean “AND” conditions in the Minicode Generator are intuitive; if any condition for a single tag is not applicable then the provision will be excluded. The Boolean “OR” tags are more complex, as multiple tags have to be created for the same provision, for example, see Sentence 2.1.2.1(1) or Article 3.2.2.19. in Figure 2. In these cases the provision may be applicable via any one of the tags.

6.5 *Multiple Conditions*

To limit the number of Minicode Tags for a specific article, multiple conditions are possible. The software is programmed to allow this variation without having to add additional Minicode Tags for each one of the OR conditions; that is, Group A or Group B or Group F1 Occupancy in the case of Sentence 2.1.2.1.(1). in Figure 2.

6.6 *Exclusion Principle*

The principle search mechanism for the Minicode Generation is an Exclusion Principle; meaning, provisions that are not relevant to the Building Description are excluded from the final selection of applicable provisions.

The Exclusion Principle assists the Minicode User when entering the Building Description. The user can enter as little or as much information as is known at the time. For example, if the user does not know whether the building will contain a basement, that attribute can be left empty. However, if the user specifies that the building does not have a basement, then the Minicode Generator software will exclude those provisions concerning buildings with basements. This implies that, the more the user knows about the building, the smaller the Minicode will be.

The Exclusion Principle also implies that if no Building Description is provided by the user, then all provisions in the building code are applicable. In retrospect, the selection of this methodology was fortuitous, as the NBCC is written with the Exclusion Principle in mind. That is, if the building is described in any one of the provisions, then the regulation must be abided by; if it is not described anywhere, then no provisions apply. However, all types of buildings are covered in the NBCC and every building has a relevant series of provisions. Take, for example, Sentence 2.1.2.1.(1). in Figure 2; by NBCC definition all buildings must fall into one of the 12 Occupancy Groups and Divisions, therefore this article is applicable in all cases. Cursory analysis of model codes from the United States indicates this is the form of their documents also.

This harmony of the Exclusion Principle used in writing code documents and the Exclusion Principle in the Minicode Generator is the most important contributing factor to the functionality of the Minicode Generator. This led to the development of provision conditions and provision requirements and to the use of truth tables for the Minicode Generator (Fenves, 1987).

7 Provision Conditions: Requirements and Truth Tables

7.1 Provision Conditions

Every provision stipulates conditions for applicability. This is similar to the concept of Decision Tables described by Fenves (1987). For example, Article 3.2.2.28. states:

(1) A *building* classified as Group A, Division 4 shall conform to Sentence (2).

7.2 Provision Requirements

If the provision conditions are applicable, then specific requirements must be met for the building to comply to the provision. The corresponding requirements for Article 3.2.2.28 (See Figure 3for the 2 Minicode Tags) are:

(2) The building shall be of noncombustible construction, except that:
- (a) the roof assemblies are permitted to be of *heavy timber construction*
- (b) the *building* is permitted to be of *combustible construction*, provided that
  - (i) the *occupant load* is less than 1,500 persons, and
  - (ii) the *building* has a *limiting distance* of not less than 6m.

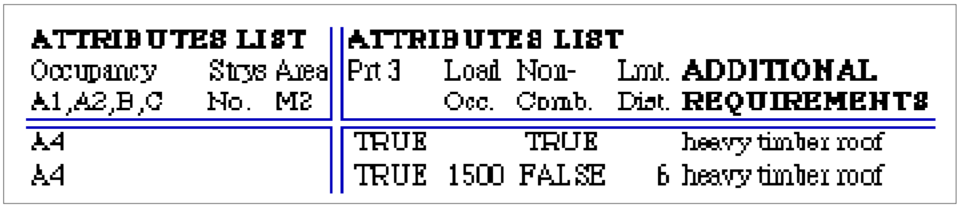
Categories of additional conditions and additional requirements have been established to cover building attributes not included in the Attributes List. These are normally entered as free text during the tagging. They are automatically returned to the user if that provision is applicable. The Additional Requirements are shown at the extreme right of Figure 3.

7.3 Condition Truth Tables

These tables are normally hidden from the user and operate completely in background, even in the tagging operations. They establish whether the provision conditions match the Building Description for the Minicode Tag. Article 3.2.2.19. states the conditions of applicability of a type of building:

(a) is not more than 1 *story* in *building height*

(b) if unsprinklered, has a *building area* not more than

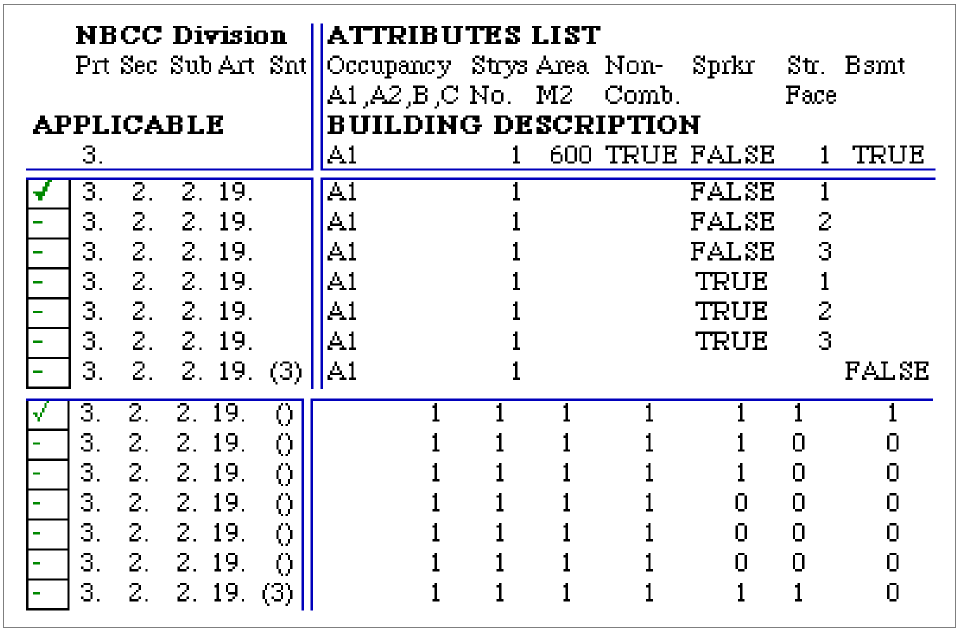


ATTRIBUTES LIST Occupancy A1,A2,B,C	Strys No.	Area M2	**ATTRIBUTES LIST** Prt 3	Load Occ.	Non- Comb.	Lmt. Dist.	**ADDITIONAL** **REQUIREMENTS**
A4			TRUE		TRUE		heavy timber roof
A4			TRUE	1500	FALSE	6	heavy timber roof

Figure 3. Provision Conditions and Requirements for Article 3.2.2.28. The Conditions on the left indicate that the Minicode Tag applies to A4 Occupancy. The Requirements for the two Minicode Tags for this article are shown on the right.

(i) 400 m^2 if facing 1 *street*,
(ii) 500 m^2 if facing 2 *streets*, or
(iii) 600 m^2 if facing 3 *streets*, and
(c) if *sprinklered*, is not more than twice the area limits of Clause (b).

Notice how the conditions and requirements are intertwined in the description of Article 3.2.2.19. In fact, the building areas in Clause (b) are requirements and the remainder are conditions.



	NBCC Division Prt	Sec	Sub	Art	Snt	**ATTRIBUTES LIST** Occupancy A1,A2,B,C	Strys No.	Area M2	Non- Comb.	Sprkr	Str. Face	Bsmt
APPLICABLE	3.					**BUILDING DESCRIPTION** A1	1	600	TRUE	FALSE	1	TRUE
✓	3.	2.	2.	19.		A1	1			FALSE	1	
-	3.	2.	2.	19.		A1	1			FALSE	2	
-	3.	2.	2.	19.		A1	1			FALSE	3	
-	3.	2.	2.	19.		A1	1			TRUE	1	
-	3.	2.	2.	19.		A1	1			TRUE	2	
-	3.	2.	2.	19.		A1	1			TRUE	3	
-	3.	2.	2.	19.	(3)	A1	1					FALSE
✓	3.	2.	2.	19.	()	1	1	1	1	1	1	1
-	3.	2.	2.	19.	()	1	1	1	1	1	0	0
-	3.	2.	2.	19.	()	1	1	1	1	1	0	0
-	3.	2.	2.	19.	()	1	1	1	1	0	0	0
-	3.	2.	2.	19.	()	1	1	1	1	0	0	0
-	3.	2.	2.	19.	()	1	1	1	1	0	0	0
-	3.	2.	2.	19.	(3)	1	1	1	1	1	1	0

Figure 4. Condition Truth Table for Article 3.2.2.19. The top portion is the Building Description provided by the user; the middle portion contains the Minicode Tags; and the bottom is the Truth Table for the article.

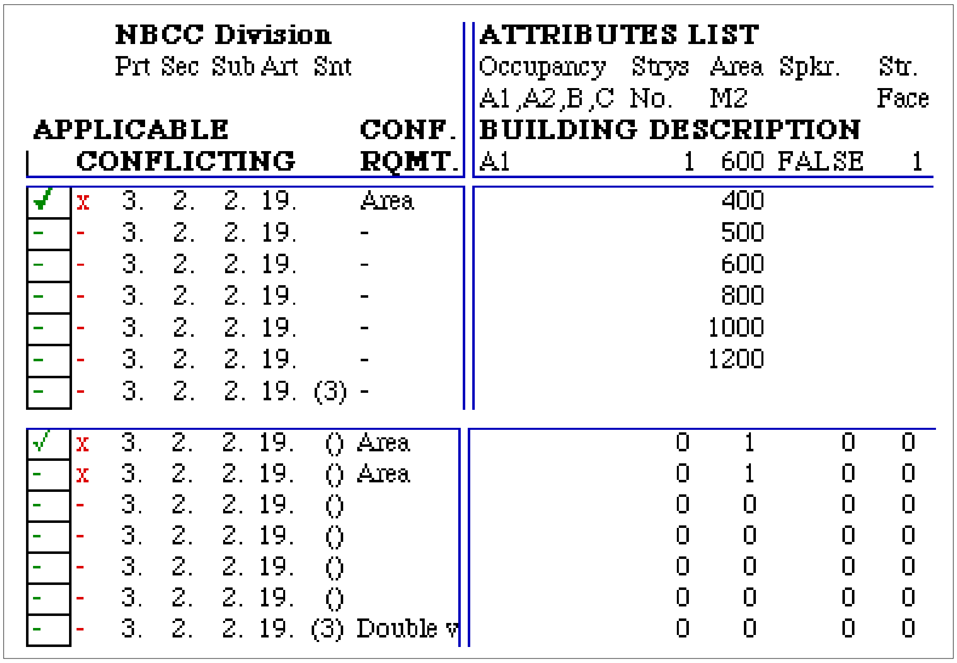
The left-hand column of Figure 4 is the summary of the results. The Building Description is a nonsprinklered Group A1 Occupancy building with a basement, one story in height, 600 m^2 in area, facing one street. Therefore only the first tag describing

Article 3.2.2.19 is applicable for this Building Description, because it is the only Minicode Tag meeting the conditions “facing 1 street” and “ non-sprinklered.”

7.4 Requirement Truth Table

These tables in Figure 5 are normally hidden from the user and operate completely in background, even in the tagging operations. They establish which requirements in the Minicode Tags conflict with the Building Description provided by the user.

The first line of Figure 5 indicates that one Minicode Tag for Article 3.2.2.19. is applicable, but there is a conflict between the provision requirement and the Building Description. The central column, entitled Conflicting Attribute, indicates this conflict is the building area. Looking at the Building Description at the top right quadrant of Figure 5, the user has selected a building area of 600 m^2 and this conflicts with the 400 m^2 requirement in that Minicode Tag (remember, only that Minicode Tag is applicable).



		NBCC Division						ATTRIBUTES LIST				
		Prt	Sec	Sub	Art	Snt		Occupancy A1,A2,B,C	Strys No.	Area M2	Spkr.	Str. Face
APPLICABLE	CONFLICTING						CONF. RQMT.	BUILDING DESCRIPTION				
								A1	1	600	FALSE	1
✓	x	3.	2.	2.	19.		Area			400		
-	-	3.	2.	2.	19.		-			500		
-	-	3.	2.	2.	19.		-			600		
-	-	3.	2.	2.	19.		-			800		
-	-	3.	2.	2.	19.		-			1000		
-	-	3.	2.	2.	19.		-			1200		
-	-	3.	2.	2.	19.	(3)	-					
✓	x	3.	2.	2.	19.	()	Area		0	1	0	0
-	x	3.	2.	2.	19.	()	Area		0	1	0	0
-	-	3.	2.	2.	19.	()			0	0	0	0
-	-	3.	2.	2.	19.	()			0	0	0	0
-	-	3.	2.	2.	19.	()			0	0	0	0
-	-	3.	2.	2.	19.	()			0	0	0	0
-	-	3.	2.	2.	19.	(3)	Double v		0	0	0	0

Figure 5. Provision Requirements for Article 3.2.2.19.

8 Development of Minicode Generator

A straight-forward methodology has been identified for the development of this and other Minicode Generators. However, building codes are complex documents and some provisions can require considerable analysis before tagging. The steps in the procedure are as follows:

1. As described in the research papers on Decision Tables (Fenves, 1987), the code provisions must be analyzed first, and then normally reworked into conditions and

requirements, before classification can take place.

Example (Original)

2.1.2.1.Scope

(1) Except as provided in Subsection 2.1.5., Parts 3, 4, 5 and 6 apply to

(a) all *buildings* used for *major occupancies* classified as
   - (i) Group A, *assembly occupancies*,
   - (ii) Group B, *institutional occupancies*, or
   - (iii) Group F, Division 1, *high hazard industrial occupancies*, and

(b) all buildings exceeding 600 m^2 in *building area* or exceeding 3 *Stories* in *building height* used for *major occupancies* classified as
   - (i) Group C, *residential occupancies*,
   - (ii) Group D, *business and personal services occupancies*,
   - (iii) Group E, *mercantile occupancies*, or
   - (iv) Group F, Division 2 and 3, *medium* and *low hazard industrial occupancies*.

Example (Revised)

(1) Parts 3, 4, 5 and 6 apply to

(a) Except Farm Building, all *buildings* used for *major occupancies* classified as
   - (i) Group A
   - (ii) Group B or
   - (iii) Group F, Division 1

OR

(b) Except Farm Building, all *buildings* exceeding 600 m^2 in *building area* for *major occupancies* classified as
   - (i) Group C
   - (ii) Group D
   - (iii) Group E
   - (iv) Group F, Division 2 and 3

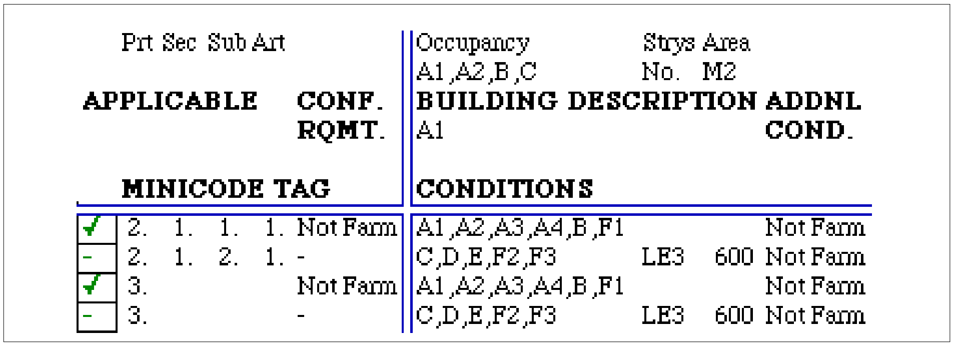
OR

(b) Except Farm Building, all *buildings* exceeding 3 *Stories* in *building height* used for *major occupancies* classified as
   - (i) Group C
   - (ii) Group D
   - (iii) Group E, or
   - (iv) Group F, Division 2 and 3

Although Figure 6 is a markup for Article 2.1.2.1., this markup also has to be duplicated in the Minicode Tags for Parts 3, 4, 5, and 6.

2. Identify the salient attributes in the provision (i.e., farm buildings). If these attributes are used in a number of other provisions, they should be considered for inclusion in the Attribute List.

3. Enter the Minicode Tag conditions into the database (see Figure 6). The Minicode Tags for Parts 4, 5, and 6 are identical to the last two lines in the figure.
4. Enter the Minicode Tag requirements into the database.



	Prt	Sec	Sub	Art		Occupancy	Strys	Area	
						A1,A2,B,C	No.	M2	
APPLICABLE					**CONF.**	**BUILDING DESCRIPTION**			**ADDNL**
					RQMT.	A1			**COND.**
	MINICODE TAG					**CONDITIONS**			
✓	2.	1.	1.	1.	Not Farm	A1,A2,A3,A4,B,F1			Not Farm
-	2.	1.	2.	1.	-	C,D,E,F2,F3	LE3	600	Not Farm
✓	3.				Not Farm	A1,A2,A3,A4,B,F1			Not Farm
-	3.				-	C,D,E,F2,F3	LE3	600	Not Farm

Figure 6. Minicode Tags Conditions for Article 2.1.2.1.

5. Test the model using the appropriate Building Descriptions. This is normally accomplished by first deleting existing data for the Building Description, to ensure that the Minicode Tag will be included. The next step is to enter a building description identical to the Minicode Tag to validate that the provision will still be included. The third stage is to test Building Descriptions close to the conditions identified; this is not to test the software relations but is for the benefit of the person doing the Minicode Tags to understand when the provision should be excluded versus when it should be included. This is a subtle point that requires clarification. The provision should not be excluded unconditionally if a specific Building Description is not applicable; sometimes building code users are more interested in possible alternatives as in the case of the following article:

   3.2.2.12. Sprinklers in Lieu of Roof Assembly Rating

   (1) The requirements in Articles 3.2.2.16. to 3.2.2.62. for roof assemblies to have a *fire-resistance rating* are permitted to be waived provided

      (a) the building is *sprinklered*,

      ....

   In this example, the sentence should be included whether or not the conditions are satisfied, because a designer or building official should be directed to this sentence in all cases.
6. Identify potential building types or features as additional conditions or additional requirements.
7. Add new attribute to Attributes List, if warranted (i.e., if a number of provisions include the same additional condition or requirement).
8. Re-examine existing Minicode Tags to include the new attribute. This involves re-evaluating the existing Minicode Tags to identify if the new attribute has been used elsewhere as an additional condition or requirement. A more thorough analysis would involve re-examination of all of the previous provisions to see if the new attribute is included in the text of the building code. A keyword search of the document would quickly identify occurrences of the attribute.

9 Interim Report

This paper describes research in progress. As of the date of submission of the paper, the user interface for the Minicode Generator is complete and the tagging process is under way.

9.1 Problem Solving

The Minicode project addresses three problems encountered by plan examiners in their evaluation of design submissions. The Minicode Generator reduces the amount of information pertaining to a generic building type; it is independent of the relative location of the provisions; and the attributes and values are well-defined and the tagging is done by building code experts.

9.2 Speed

It now takes 10 seconds to generate calculations for the applicable provisions and the conflicting attributes from 300 provisions using a 40 MHertz microcomputer. To create a Minicode from the 3899 provisions in the NBCC, a processing time of about two minutes is estimated.

9.3 System Design

The program can be used in its current design for the tagging operations, however some restructuring is required for Minicode Generator by plan examiners and other users. Restructuring could also significantly increase the speed for extracting the desired information. One method attempted to date for increasing the speed is using bitstring encoding for the Minicode Tags, although it is only in the preliminary research stage, the processing speed could increase by two orders of magnitude (Cornick, 1992).

9.4 User Interface

A simple user interface can be seen in the previous figures, but other methods could include creating text files of the complete building codes text and extracting the results using database or hypertext technology.

10 Future Work

The Minicode Generator was developed in conjunction with a number of code writing bodies to meet their individual needs. Each partner in the consortium has expressed an interest in including the Minicode attributes and attribute values in their proprietary electronic codes. As a result, there may be a number of future products based on this Minicode methodology. The Minicode Generator could also form part of a larger, long-term project dealing with compact disk products involving all the Canadian code writing bodies.

At the time of the submission of this paper, the tagging for the Minicode was in process and it was hoped the project would be completed by April, 1993. The outcome of this project will be presented at similar symposia in the near future. The experience gained from this project will be used in the development of the NBCC Classification System described in other publications (Vanier, 1991a, 1992).

There is considerable potential for this methodology, but more experience is needed before the system design can be finalized. It has not solved all building code problems nor is it the final solution for the plan examiners, but the research to date has provided a clearer understanding of the internal structure of the NBCC and perhaps other model codes.

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