27. ESP — An Expert System for Property Revitalization

Robert E. Johnson

College of Architecture and Urban Planning
The University of Michigan
Ann Arbor, Michigan 48109

This paper reports on the development of a knowledge based system that can help to assess the reuse potential of idle industrial property. It does not take the place of the architect or engineer, but allows for strategic design factors to be considered in very early and important property redesign and revitalization decisions. The idea is predicated on the judgment that there is a relatively systematic approach to evaluating the reuse potential of vacant property. A frame based approach together with a series of "if-then" rules are used to represent the knowledge domain and procedures required to perform a feasibility analysis. Rules for assessing the impact of the regional economy, industrial market trends, building configuration, building design strategies and the impact of building codes are included in this manner. A prototype of this system has been implemented on both an Apple Macintosh computer using AAIS Prolog and an IBM AT compatible using Arity/Prolog.

Introduction

Between 1982 and 1987 over 350 factories closed in the State of Michigan (Molnar and Kahana, 1989). An earlier study found that manufacturing plants in the nation's older industrial areas closed at the rate of over 3,000 per year during the 1970s. Vacant, obsolete industrial buildings are a significant problem for local communities that result in a loss of jobs, a decrease in the tax base, and cause significant urban decay of the surrounding neighborhood. Communities in the United States often do not have the resources or expertise to develop appropriate alternative strategies for the redesign and revitalization of these facilities. As a consequence, vacant industrial property sometimes sits idle for excessive periods of time or is disposed of in such a way that the potential value of the property is not realized.

Plant closing and abandonment are often the final result of a systematic process of disinvestment. Disinvestment (sometimes referred to as deferred investment) is the prolonged postponement of investment in plant and equipment. Strategies of deferred investment are typical when firms face a shortage of operating capital. Deferred investment in buildings has become, until recently, a standard way that universities in the United States have used to cope with budget shortages (Johnson et al. 1987). However, while disinvestment may be a viable strategy for the private sector, it is often a disaster and very uneconomic when viewed from the perspective of the public sector. The subject of how to most effectively revitalize abandoned industrial facilities has been the subject of multi-disciplinary research at the University of Michigan for over a decade. This research "...shows clearly that annual community economic losses exceed comparable benefits to the abandoning firm. Thus, if the community costs of abandonment were a consideration of the firm, the economics of the move decision might be altered" (Industrial Development Division 1981).

The research reported here is set in this context, but has as its specific focus the role of the physical environment in this disinvestment process and subsequent revitalization efforts. The perspective in this paper advocates an integrative approach to this issue, where design decisions can only be evaluated sensibly within the larger socioeconomic and political context.

The overall goal of this research is to promote a more reasonable approach to decisions concerning the reuse of existing building infrastructure in order to help reverse the process of urban decay and shorten the time necessary to readjust buildings to changes in the market. In particular, the first objective of this research is to develop a systematic decision-making approach to assist in the redesign and economic revitalization of abandoned property. The second objective is to introduce a prototype expert system that implements this decision-making approach and that can be used by the non-expert to assist in making crucial early strategic decisions about what can be done to improve the economic viability of underutilized property. The initial data for this expert system was obtained from a study to revitalize a large number of obsolete industrial facilities in South Bend, Indiana, that were originally the central manufacturing facilities for Studebaker automobiles (Johnson et al. Sept 1987).

A Conceptual Approach to Economic Revitalization

There are many potential reasons why disinvestment occurs and plants close. These reasons include obsolete production technology, lack of sales, price competition from other companies, high labor rates, and inadequate facilities. The revitalization process is characterized by a complex range of problems requiring a range of solution approaches and strategies. An assessment of the issues associated with revitalization is a first step necessary to form a basis for an evaluation of the decision process.

Conceptually, the redesign and revitalization of an obsolete building can be considered a type of search problem (for a discussion of finding alternatives, see Simon 1981). In contrast to a more typical design problem, an existing state is already clearly identified. That state consists of the obsolete building and the social, economic and political context within which it exists. The goal is to change the existing state so as to reach a more satisfactory benefit/cost situation. Because the social, economic and political context are not generally open to manipulation by the decision maker these factors become constraints to the search process. The goal, therefore, may be defined more precisely as searching for a building reuse alternative that will represent a better "fit" within the existing socioeconomic context. Figure 1 illustrates the range of use alternatives that define the search space. It is, of course, always a possibility that the best alternative is the current state, i.e., do nothing.

Another way to conceptualize this problem is to think of it as a type of capital planning and budgeting decision process (Johnson 1990). As is the case with design, capital budgeting is an ill-structured problem that combines characteristics of both problem solving and strategic planning. Capital budgeting provides for the systematic review of a large number of possible alternatives. The output of this process is the determination of a cost-benefit ratio that results from each capital investment proposal. Within the context of building revitalization, the cost-benefit ratio provides one of the key factors that influences the final decision.

However, political and social factors are also important in finalizing decisions. Therefore, the result of a systematic analysis of alternatives can only be advisory. In the public sector, revitalization decisions are strongly influenced by perceptions of community priorities.

Problem Characteristics

As indicated previously, this research assumes that design decisions can only be made adequately by considering the larger, socioeconomic context within with the design exists. The acceptance of this view considerably increases the complexity of the decision making process. This complexity is characterized by five issues:

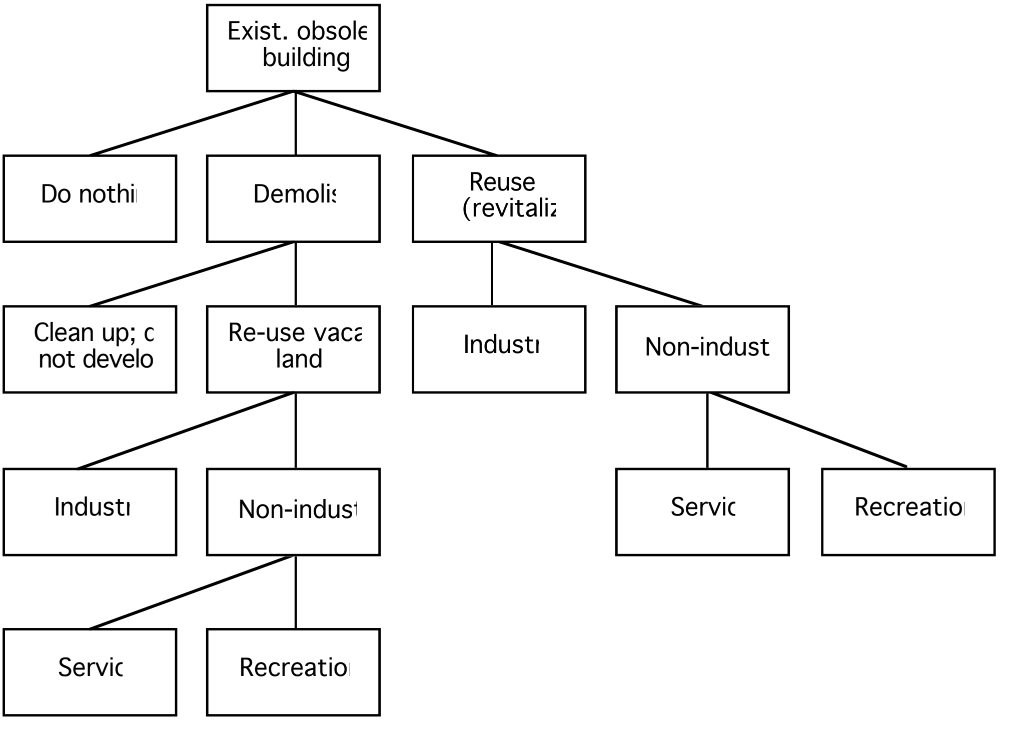

Figure 1. A Search Tree of Potential Reuse Categories for an Obsolete Building

1) Political. The revitalization of vacant industrial buildings can often be very political and highly charged with emotions of special interest groups with opposing viewpoints about the problem. Historic preservationists are concerned about maintaining the integrity of the unique, historic nature of the building. Labor groups sometimes view these buildings as symbolic of past "sweat shops." The business community generally perceives these buildings through the singular lens of economic development. Finally, there is often a group representing the interests of new development who frequently see the problem solution as a simple case of demolition and reconstruction.

2) Multi-disciplinary. The comprehensive nature of the problem requires the development of knowledge from a variety of perspectives, including historical preservation, building

design (including all disciplines), site planning, city planning, economics (city and regional), and real estate. Developing a viable revitalization strategy generally requires the participation of many different disciplines, including economists, developers, engineers, architects, and land use planners. Because of this one can expect the utilization of a variety of different types of reasoning.

3) Complexity. Complexity is related partly to the multi-disciplinary nature of revitalization problems. A variety of different perspectives must be used to evaluate the feasibility of a large number of possible reuse alternatives.

4) Cost. Regardless of the outcome, revitalization decisions typically involve millions of dollars. If the decision is to do nothing, there will be a continuing negative impact because of lost property taxes. If the decision is to renovate, taxes or other funding sources must be obtained to reinvest in the facility. Even demolition can cost millions of dollars. Therefore, it is critical to articulate a clearly thought-out plan for any final decision that is proposed.

5) Uncertainty. Although many of the issues have an "objective" basis to them (e.g., structural evaluation) others are clouded in the uncertainty that usually surrounds planning for the future. There needs to be some method for adequately assessing this uncertainty.

Research Questions

The characteristics of the problem suggest some of the questions that have been explored during the course of this research. These issues include:

1) Given complexity of choices that are available, can the design decision maker be provided reasonably robust, "expert" guidance for improving the economic performance of an obsolete building?

2) While some building problems are unique and require creative, inventive solutions, there are also many problems where proven, reliable, cost-effective solutions exist. Can knowledge-based technologies be developed that apply these well-known solutions to complex revitalization situations.

3) Can an expert system, driven by both systematic and heuristic search procedures aimed at improving economic performance, be developed and implemented within the existing framework of current cost modeling system PC-based technologies?

4) Can knowledge-based technologies help deal with the ambiguity and incompleteness of information needed to make decisions about revitalization projects?

The Revitalization Decision Process

The overall organizational approach utilized in the development and analysis of the revitalization decision may be most effectively characterized as one of conjecture and refutation (Popper, 1934) or generate and test (Simon, 1981). Redesign of the obsolete facility to improve its economic viability is conceptualized as similar to developing a testable knowledge base about the facility. Part of that knowledge base is developed in conjunction with experts, if they are available. Another part of the knowledge base is developed by obtaining information about the context; and a third is developed by asking for subjective assessments about the building.

A general approach to the revitalization of vacant industrial buildings is outlined in figure 2. A use is proposed (conjectured) and efforts are made to test its viability. A failure to satisfy any of the major issues will result in a failure of the proposed use. Assuming that all of the rules are satisfactorily concluded, the financial feasibility of the proposed use is determined and compared with the prevailing market rate of return as well as with the rates of return for other proposed uses.

Problem Classification

The characteristics of the problem also suggest that a variety of reasoning approaches will be necessary to evaluate effectively the reuse potential of a vacant facility. Table 1 is a classification of the alternative reasoning types that are necessary for each major decision in the redesign of an obsolete facility.

Table 1. Problem Reasoning Classification

Problem	**Discipline**	**Reasoning type**	**Uncertainty**
1) Is proposed use legal (zoning)?	Land use planning	rule-based	No
2) Is a zoning variance possible?	Political, legal	case-based	Yes
3) Is proposed use acceptable to historic preservationists?	Architecture, History	rule-based	Yes
4) Is the proposed use in demand in this economic context?	Real estate economics	rule-based or model-based	Yes
5) Is the building supply enough to meet market demand?	Real estate economics	model-based	Yes
6) Is the building condition acceptable?	Architecture, Engineering	rule-based	Yes
7) Is the building configuration acceptable?	Architecture, Industrial engineering	rule-based	Yes
8) Is proposed occupancy financially feasible?	Real estate economics	model-based	Yes

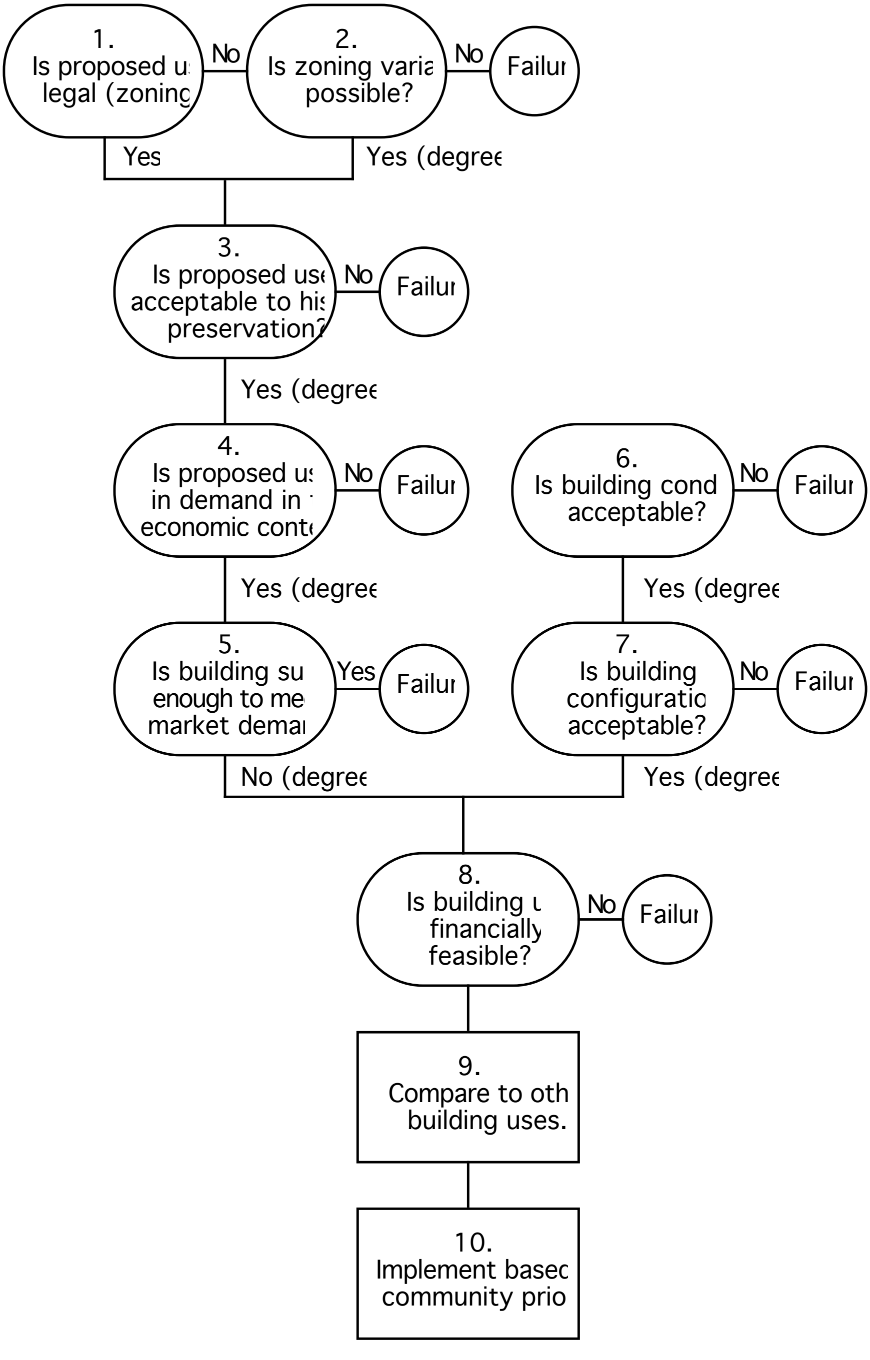

Figure 2. Decision Flow Chart

Design and Implementation of the Expert System

The evaluation of underutilized industrial facilities can be a complicated, time consuming process. However, experience gained from research on this issue suggested that even though the process was complex, a relatively systematic approach to evaluating the reuse potential of surplus property could be identified. This previous research developed an understanding of the relative importance of major project variables and the degree to which these variables can be modified. As can be see in figure 3, there is a similarity between the thinking that is involved with reuse evaluation and that of expert systems. The rules and facts associated with the general procedures of feasibility analysis are combined with the specific facts relating to a building and its context in order to assess the feasibility of reusing that building.

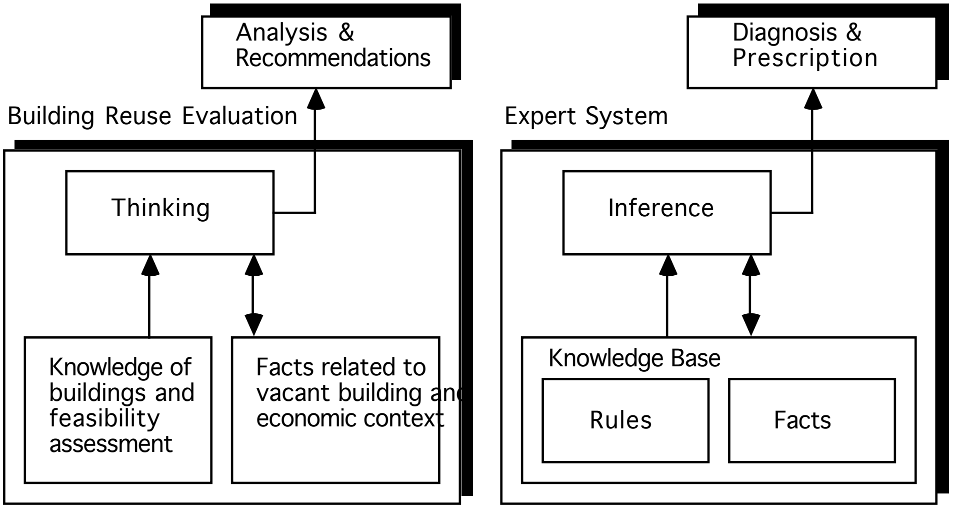

Figure 3. Comparing the Building Reuse Evaluation Process and Expert Systems

Knowledge Representation: Hierarchical Decomposition

Figure 4 illustrates how building and community factors are arranged as objects (O), an attribute of the object (A) or a value of the attribute (V). Every object has at least one attribute and every attribute has one value. The objects are organized in a hierarchical fashion (e.g., the building object is a part of the project object). There may be more than one attribute associated with each object. For example, demand for a particular building use may be determined by either the absorption rate for that use or the employment rate associated with that use. Finally, values may either be numbers (e.g., the percent absorption rate) or one of a list of possible values (e.g., type of zoning use that is permitted). Both this basic structure and the rules that define the feasibility process are used to help organize the building reuse evaluation process.

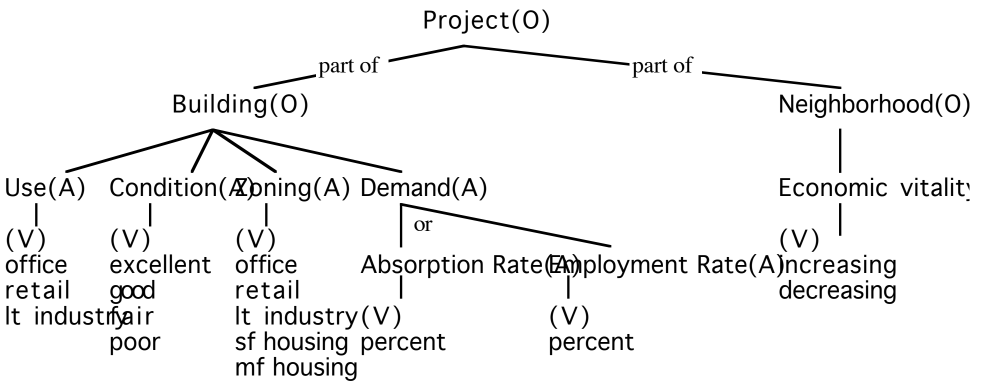

Figure 4. Hierarchical Organization of Rules and Facts

Frame-Based Knowledge Representation

Knowledge is represented as frames (Winston, 1984) within the hierarchical organization previously described. Frames are used in two ways. First, frames are used to represent information concerning the hierarchy of objects that combine to make up the building. An instance of this use of a frame is indicated in table 2.

Table 2. Frames Used to Represent Building Objects

```
1) AN ABSTRACT REPRESENTATION OF THE ELEVATED-FLOOR FRAME
<Frame name>:  elevated-floor
     <Slot-name>:           part-of
          <Facet-name>:     value super-structure
     <Slot-name>:           load-capacity
          <Facet-name>:     value *undefined*
          <Facet-name>:     if-needed  ask_integer
     <Slot-name>:           type
          <Facet-name>:     value *undefined*
          <Facet-name>:     if-needed  ask_ako

2) A PSEUDO-REPRESENTATION OF AN INSTANCE
     elevated-floor
          part-of
               value        super-structure
          load-capacity
               value        200
          type
               value        wood floor

3) THE PROLOG REPRESENTATION OF AN INSTANCE
     oav(elevated-floor,part-of,super-structure).
     oav(elevated-floor,load-capacity,value,200).
     oav(elevated-floor,type,value,'wood floor').
```

The second use of the frame structure is to compare prototypes of prior situations (cases) that may assist in understanding the viability of reusing the vacant building (table 3). This type of representation is particularly useful in helping to determine if a zoning variance is possible for the proposed building use. The example below illustrates how the knowledge about cases can be packaged for use within the inference mechanism. This part of the knowledge base will be augmented as we increase our knowledge about situations in which zoning variances have been successful.

Table 3. Frames Used to Represent Cases.

```
1) AN ABSTRACT REPRESENTATION OF THE ZONING-VARIANCE FRAME
<Frame name>:  similar-use-case
     <Slot-name>:          ako
          <Facet-name>:    value zoning-variance-case
     <Slot-name>:          surrounding-land-use
          <Facet-name>:    value *undefined*
          <Facet-name>:    if-needed  ask_ako
     <Slot-name>:          economic-impact
          <Facet-name>:    value *undefined*
          <Facet-name>:    if-needed  ask_ako
     <Slot-name>:          economic-impact
          <Facet-name>:    value *undefined*
          <Facet-name>:    if-needed  frame-get
     <Slot-name>:          case-law-reference
          <Facet-name>:    value *undefined*
          <Facet-name>:    if-needed  frame-get

2) A PSEUDO-REPRESENTATION OF AN INSTANCE
     similar-use-case
          ako
               value      zoning-variance-case
          surrounding-land-use
               value      similar
          economic-impact
               value      moderate
          probability-of-variance
               value      likely
          case-law-reference
               value '    MICH PA 125.1045'

3) THE PROLOG REPRESENTATION OF AN INSTANCE
     oav(similar-use-case,ako,value,zoning-variance-case).
     oav(similar-use-case,surrounding-land-use,value,similar).
     oav(similar-use-case,economic-impact,value,low).
     oav(similar-use-case,probability-of-variance,value,likely).
     oav(similar-use-case,case-law-reference,value,'MICH 12.45').
```

Inference Mechanism

The inference mechanism is designed as a general purpose inference engine (see figure 5). The generate_test predicate conjectures a building use and tests that use against the knowledge base. Show_rule and show_object enable the user to query the status of the knowledge base. How and Why are standard queries to help the user assess the reasoning behind the outcome of the consultation. At present only the how predicate is implemented. The knowledge base also consists of predicates that manipulate frames and attached proce-dures. Predicates in working storage maintain the status of the knowledge base.

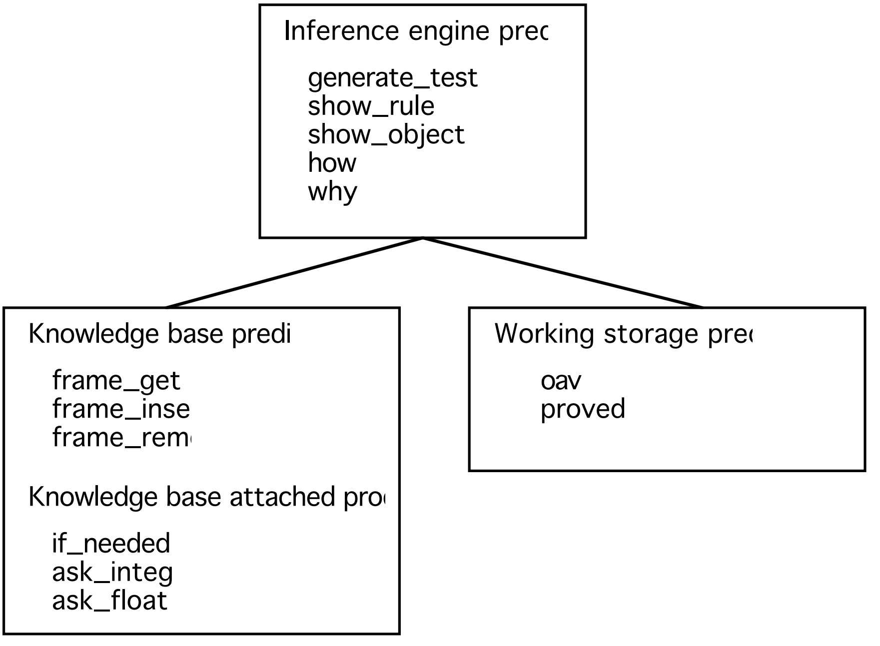

Figure 5. Architecture and Major Predicates of ESP

Inexact Reasoning

The knowledge base of this system is a collection of human knowledge. Because much human knowledge is imprecise, uncertainty is frequently associated with both rules and facts. For example, although the number of floors in a building may be known for certain, it usually will not be possible to know with absolute certainty whether or not it will be possible to obtain a desirable zoning variance. This expert system accounts for such inexact reasoning by the inclusion of certainty factors (similar to the approach outlined by Lecont and Parker 1986). Numbers are used to express the degree to which the human expert believes the rules and facts are valid. Inexact reasoning then combines these different types of uncertainty into a global uncertainty measure associated with the final conclusion. The certainty factor, or level of confidence, that is associated with each rule ranges from 1.0 (completely known) to -1.0 (completely unknown). These certainty factors will need to be modified as experience is gained with the set of rules and as new rules are added. The certainty factor phrases associated with this version of the system are defined as indicated in table 4.

Table 4. Certainty Factors

	Representative Cert. Fact	Low Cert. Fact	High Cert. Fact
definite	cf(1.00)	cf(1.00)	cf(1.00)
probable	cf(0.95)	cf(0.90)	cf(0.99)
likely	cf(0.75)	cf(0.60)	cf(0.89)
possible	cf(0.45)	cf(0.30)	cf(0.59)
do not know	cf(0.00)	cf(-0.29)	cf(0.29)
questionable	cf(-0.45)	cf(-0.59)	cf(-0.30)
unlikely	cf(-0.75)	cf(-0.89)	cf(-0.60)
not probable	cf(-0.95)	cf(-0.99)	cf(-0.90)
definitely not	cf(-1.00)	cf(-1.00)	cf(-1.00)

Prolog User Interface

The user interface has been developed to meet two objectives: 1) to facilitate ease of use and 2) to insure that the system is transportable among the widest number of computer systems (hardware and software). An example of the user interface is indicated in table 6. Although these goals are somewhat incompatible, a number of mechanisms have been adapted to enhance the ease of use. For example, in order to minimize the need for typing users select from a list of choices by entering the number of the item in the list. In addition, certainty factors are represented by more easily interpreted English text and are converted into numbers internally. The version of ESP that uses the Prolog user interface has been tested on both Macintosh (AAIS Prolog) and IBM compatible workstations (Arity/Prolog).

Table 6. Example of Prolog User Interface

```
What is the exterior construction condition
      1. very good
      2. good
      3. fair
      4. poor
   >> 2.

   What is the certainty factor
      1. definite
      2. probable
      3. likely
      4. possible
      5. do not know
      6. questionable
      7. unlikely
      8. not probable
      9. definitely not
   >> 1.
```

HyperCard Front-End

The weaknesses of a text-oriented, sequential question and answer interface become apparent when compared to generally available commercial software. A substantial amount of data entry is involved which can become tedious to enter. In addition, with the Prolog interface is not possible to correct easily items that were entered erroneously. Finally, the entry of information is easier to understand if the items are clustered together on a single screen.

The cost of developing a custom user-friendly interface can be considerable. Therefore, it was decided to experiment with HyperCard as a front-end to the ESP system. The HyperCard interface handles all data entry in a manner consistent with generally recognized user interface guidelines for Macintosh computers. Selections are provided through pop-up menus (figure 6), explanatory information is readily available (figure 7), and all parameters that are similar can be grouped within the contents of a single card to provide a better overview of the status of the object or attribute being addressed. Information collected through this manner is reformatted by a HyperCard script into Prolog predicates which are then written to a file. The ESP Prolog inference engine is automatically executed directly from a button located on a card.

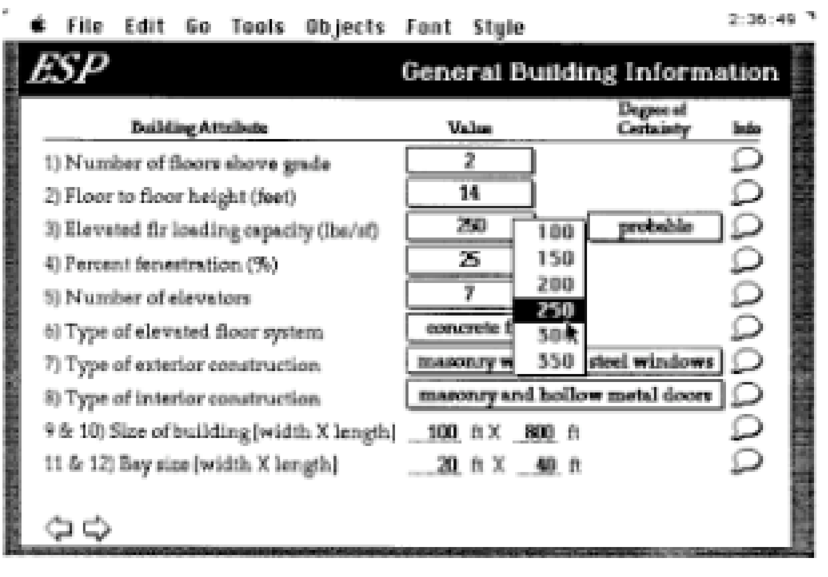

Figure 6. Example of HyperCard Pop-up Menus

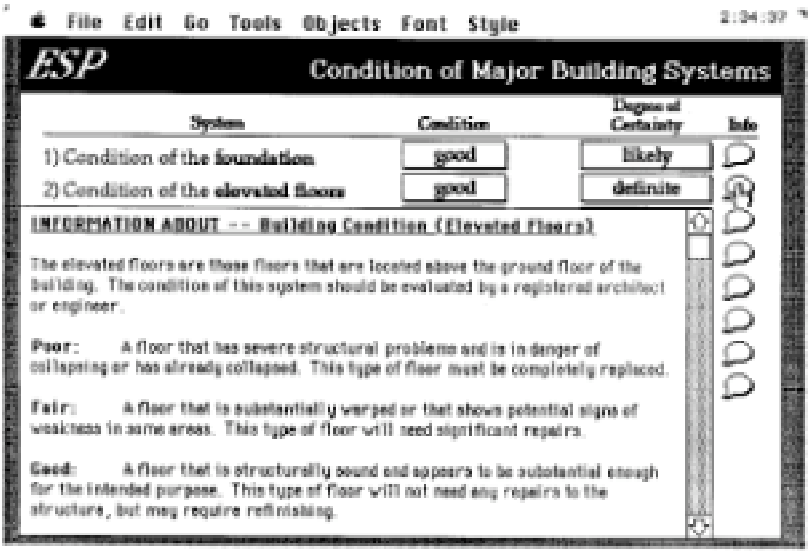

Figure 7. Example of Help Using "Tell About" Buttons

Introduction to the Knowledge Base Rules and Facts

The knowledge base of the system contains the rules listed below. Internally, these rules are represented as Prolog predicates. In order to obtain an English-like listing it is necessary to use the predicate show_all_rules to display all the rules or show_rule to display only one of the rules. The sections below explain each the rules that exist in the knowledge base. The certainty factor, or level of confidence, that is associated with each rule ranges from 1.0 (completely known) to -1.0 (completely unknown). These certainty factors will need to be modified as experience is gained with the set of rules and as new rules are added.

In some cases these rules appear to be overly simplistic. There is a trade-off between developing an overly complex, but accurate set of rules and making a system that may be less accurate, but easier and quicker to use and to understand. The intent at this point in time is to develop a reasonable, comprehensive but still easy to understand set of rules for feasibility analysis.

Rule Set 1. Determine the Feasibility of the Proposed Building

```
RULE: feasibility of proposed building :
       if   building condition is acceptable
       and   building zoning is legal
       and   building market is exists
       and   building financing is feasible
       then it is likely (0.950000) that building proposal is possible
```

Expresses the fact that the building use that is proposed is possible if the building condition is acceptable; building zoning is legal; a market for the building exists, and that the results of a financial feasibility analysis are positive.

Rule Set 2. Assess the Overall Condition of the Building

```
RULE: building condition :
    if  foundation condition is very good, good, fair, or poor
    and  elevated floor condition is very good, good, fair, or poor
    and  roof condition is very good, good, fair, or poor
    and  exterior construction condition is very good, good, fair, or poor
    and  interior construction condition is very good, good, fair, or poor
    and  elevator condition is very good, good, fair, or poor
    and  mechanical system condition is very good, good, fair, or poor
    and  electrical system condition is very good, good, fair, or poor
    and  building structure is acceptable
    then it is likely (0.950000) that building condition is acceptable
```

The building condition is a function of all the condition of all of the major systems in the building as well as the basic configuration of the building. This rule indicates that the building system may be acceptable even when one or more building systems is determined to be in "poor" condition. This reflects that fact that the decision to reuse a building is primarily an economic decision, not a technical decision. This rule also indicates that rules may be inter-related with other rules. In this example, the building configuration is determined from a subsequent series of four rules (see Rule Set 3).

Within the system, the definition of "very good, good, fair, or poor" is mapped directly to the maintenance or renovation task ("min maint cost, avg maint cost, avg repair cost, max repair cost") needed to bring that building system up to its proper condition. A different maintenance or renovation cost is associated with each of these tasks. The items below are presented in order to facilitate the understanding of these judgments.

Rule Set 3. Evaluate Elevated Floor Load Capacity

```
RULE: office floor load capacity-wood floor :
      if   building use is office
      and   elevated floor type is wood floor
      and   elevated floor load capacity is greater than or equal to 150
      then it is definite (1.0) that building structure is acceptable

RULE: office floor load capacity-concrete floor :
      if   building use is office
      and   elevated floor type is concrete floor
      and   elevated floor load capacity is greater than or equal to 250
      then it is definite (1.0) that building structure is acceptable

RULE: retail floor load capacity-wood floor :
      if   building use is retail
      and   elevated floor type is wood floor
      and   elevated floor load capacity is greater than or equal to 200
      then it is definite (1.0) that building structure is acceptable

RULE: retail floor load capacity-concrete floor :
      if   building use is retail
      and   elevated floor type is concrete floor
      and   elevated floor load capacity is greater than or equal to 300
      then it is definite (1.0) that building structure is acceptable
```

This series of rules indicates the acceptability of the estimated floor loading capacity of the building. The required floor loading varies, depending on the live load (occupancy of the building) and the dead load (type of elevated floor system).

Rule Set 4. Compliance with Existing Zoning of the Property

```
RULE: compliance with current zoning-office use :
       if   building use is office compatible uses
       then it is definite (1.0) that building zoning is legal
RULE: compliance with current zoning -retail use:
       if   building use is retail compatible uses
       then it is definite (1.0) that building zoning is legal
RULE: possibility for obtaining a zoning variance :
       if   zoning variance is probable
       then it is likely (0.950000) that building zoning is legal
```

These rules govern whether or not the property meets existing zoning requirements. If the building use is compatible with current allowed uses, then there is a high degree of certainty that the zoning requirements have been met. However, if the proposed building use is not in compliance with zoning requirements, then a zoning variance must be obtained. The list of compatible uses will change, depending on the proposed use of the building.

Rule Set 5. Possibility for Obtaining a Zoning Variance

```
RULE: compatibility of proposed zoning with adjacent zoning :
       if   adjacent building use is building use
       then it is likely (0.95000) that zoning variance is probable

RULE: compatibility of planned use with surrounding use :
       if   adjacent building planned use is building use
       then it is possible (0.85000) that zoning variance is probable

RULE: impact on economic vitality of neighborhood :
       if   neighborhood vitality impact is positive
       then it is possible (0.85000) that zoning variance is probable
```

The probability that a zoning variance can be obtained is defined in these three rules. These rules indicate that a zoning variance is likely (but not definite) if the use of the surrounding buildings is the same as that of the building being analyzed. The probability of a zoning change is less (possible) if the planned, future use of surrounding buildings is the same as that of the building being analyzed and if it can be argued that the proposed building would have a positive impact on the economic vitality of the neighborhood.

Rule Set 6. Assessment of the Building Market

```
RULE: building marketability factors :
      if  building demand is positive
      and building supply is positive
      and building demand estimate is greater than building supply estimate
      then it is definite (1.0) that building market is exists
```

The assessment of the building market is operationalized by this rule, which simply compares the demand and supply of space associated with the proposed building use. If there is no demand for a given use, or if the supply exceeds the demand, then further consideration is unwarranted for that proposed occupancy.

Rule Set 7. Assessment of Building Supply and Demand Factors

```
RULE: demand for space using absorption rate :
      if   building absorption rate is greater than 0
      then it is definite (1.0) that building demand is positive

RULE: demand for space using employment rate :
      if   building employment rate is greater than 0
      then it is likely (0.950000) that building demand is positive
```

The demand for space is estimated in two ways. The first (and preferred) method is to evaluate the prevailing demand conditions by means of a market survey. Given the total building stock that is available for the proposed use, the market survey will define an absorption rate which can be used to estimate the space that can be absorbed each year.

Employment data is the second method used for estimating demand. This calculates space needs by multiplying the total employment for a given standard industrial classification (SIC) code by the current rate at which employment is increasing (or decreasing) times an estimate of the gross square foot of space per employee that is required for the proposed use. If employment is increasing, this should translate into a greater demand for space. It has a lower level of certainty but is generally easier to obtain from state employment security records.

```
RULE: supply of space using estimate of vacant space :
      if   building avg vacant sf (market) is greater than 0
      then it is likely (0.950000) that building supply is positive

RULE: supply of space using new building permits :
      if   building avg new sf (permits) is greater than 0
      then it is likely (0.950000) that building supply is positive
```

The supply of available space is obtained either through a market survey or through a evaluation of new building permits.

Rule Set 8. Assessment of Building Financial Feasibility

```
RULE: financial feasibility :
     if building pre-tax equity rate of return is greater than or equal
to
        building pre-tax market rate of return
     then it is definite (1.0) that building financing is feasible
```

The financial feasibility of the building is calculated using a standard pre-tax cash-on-cash rate of return analysis. The calculation proceeds in four stages: 1) estimation of the cost of renovation and land, 2) calculation of the mortgage debt service, 3) estimation of Net Operating Income (Potential Gross Income minus Operating Expenses), and 4) the calculation of the rate of return.

An Example of Results

After an evaluation of the building, the user may request an explanation of the solution by asking "how." Because the explanations can be quite detailed, they typically will be written into a text file that can then be read into a word processor, formatted as desired, and printed.

```
>> how.
The hypothesis is that: ("building proposal is possible")
The following has been established:
   building proposal [possible] is possible (with certainty of 0.726750)
   BECAUSE

   building condition [acceptable] is acceptable (with certainty of 0.902500)
   BECAUSE

   foundation condition [good] is very good, good, fair, or poor (with certainty of 1.0)
   and   elevated floor condition [good] is very good, good, fair, or poor (with certainty of
          0.950000)
   and   roof condition [good] is very good, good, fair, or poor (with certainty of 0.950000)
   and   exterior construction condition [good] is very good, good, fair, or poor (with
         certainty of 1.0)
   and   interior construction condition [good] is very good, good, fair, or poor (with
         certainty of 1.0)
   and   elevator condition [good] is very good, good, fair, or poor (with certainty of
          0.950000)
   and   mechanical system condition [fair] is very good, good, fair, or poor (with certainty
          of 1.0)
   and   electrical system condition [poor] is very good, good, fair, or poor (with certainty
          of 1.0)

   building structure [acceptable] is acceptable (with certainty of 1.0)
   BECAUSE

   building use [office] is office (with certainty of 1.0)
   and   elevated floor type [wood floor] is wood floor (with certainty of 1.0)
   and   elevated floor load capacity [300] is greater than or equal to 150 (with certainty
          of 1.0)
   and   elevated floor type [concrete floor] is wood floor <RULE FAILED>

   building use [retail] is office <RULE FAILED>

   building use [retail] is office <RULE FAILED>

   building zoning [legal] is legal (with certainty of 0.807500)
   BECAUSE

   building use [office] is office compatible uses [office,retail,light industry,multi-
       family] (with certainty of 1.0)

   building use [office] is office compatible uses [office,retail,light industry,multi-
       family] (with certainty of 1.0)

   zoning variance [probable] is probable (with certainty of 0.850000)
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Conclusions and Acknowledgements

This paper has provided an interim report on the status of the ESP project. More development work needs to be conducted prior to a more comprehensive testing of the approach and additional rules need to be formulated for other building types. Rules also have to be developed for issues that have been identified but have not yet been factored into the rule base. Historic preservation is an example of one issue that still needs to be formalized in this decision process.

The primary purpose of this first phase of the project has been to demonstrate the viability of the concept and to identify areas for future research. It does appear possible to develop a systematic, knowledge-based approach to help evaluate the major options that face decision makers in the revitalization decision process. Further case studies need to be conducted in order to better understand the relative strengths and weaknesses of this approach. If this approach does turn out to be effective, then it may be possible to utilize a more generalized technique to evaluate alternative uses for a wider range of building types. The results of future research in this area may also have more direct applicability to the design of new buildings. Approaches used to improve the economic performance of an existing, underutilized building may have a direct applicability to approaches that can be used to improve the economic performance of an evolving building design.

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