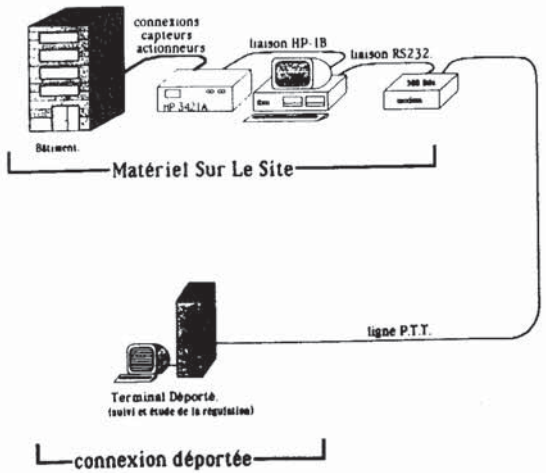
TABLEAU I. Résultats de simulation pour le projet-pilote

Lois de commande	EBASE kWh	ETOT kWh	EBASE ETOT	CBASE FF	CTOT FF	CBASE CTOT	CUNI F/kWh	TINT °C	TRS °C	PMV	PPD %
Régulation sur température extérieure	16467	17899	92%	4022	4677	86%	0.261	19.5	19.8	-0.3	8.9
Intégration des bilans	16986	18126	94%	4122	4364	88%	0.270	18.8	19.0	-0.4	9.1
Commande optimale déterministe	15421	16490	94%	3924	4589	87%	0.270	19.0	19.2	-0.4	8.8

ETOT : Consommation électrique totale(kWh)
EBASE : Consommation électrique de la base (kWh)
CTOT : Coût d'exploitation total hors abonnement (Francs)
CBASE : Coût d'exploitation de la base hors abonnement (Francs)
CUNI : Coût unitaire, base + appoint confondus (Francs/kWh)
TINT : Température d'air (°C)
TRS : Température résultante sèche (°C)
PMV : Predicted Mean Vote
PPD : Predicted Percentage of Dissatisfied (%)

Tableau I : Résultats de simulation pour le projet-pilote

Figure 1 : Configuration du système



Le calculateur :
- IBM-PC (unité centrale, clavier, terminal)
- Coprocesseur mathématique 8087
- Carte d'interface IEEE-488 <-> PC
- Carte Quadram (Super Quadboard) :
  Port série, port parallèle, horloge calendrier, extension mémoire (384 Koctets)

La centrale d'acquisition :
- HP 3421A avec :
  2 modules multiplexeurs 10 voies
  1 module d'E/S numérique 8 bits
  1 interface HPIB

Le système d'exploitation : Unix-like sur PC

Figure 1 : Configuration du système

The Smart House

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KEY WORDS

Cooperative R&D, Electrical Safety, Home Function Control, Integrated Energy/Communication Wiring, New Product Opportunities

ABSTRACT

The Smart House is a new approach to power and communications systems for buildings. It is a basic rethinking and redesign of power and communications systems within an integrated framework. The developers of the Smart House feel that this technology is the most significant innovation in power and communications systems in at least sixty years. The Smart House concept encompasses distribution of power, distribution of telephone and other communications and entertainment services, and intelligent control. Power circuits are centrally controlled and are energized only where the attached appliance is requesting power. A complete new line of compatible appliances is planned. The Smart House Venture was founded by NAHB Research Foundation, Inc., and now includes over thirty-five leading industrial firms manufacturing basic electrical wiring and devices, appliances, and electronic subsystems. Initial marketing of the complete system will begin in 1988.

La "Maison Intelligente"

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MOTS CLEFS

Recherche et Développement Coopératifs, Sûreté Électrique, Contrôle Fonctionnel de la Maison, Câblage Intégré d'Énergie et de Communication, Occasions pour de Nouveaux Produits

SOMMAIRE

La "Maison Intelligente" (Smart House) constitue une nouvelle approche en matière de systèmes de puissance et de communications pour des bâtiments. Les systèmes de puissance et de communications ont été repensés et reconçus en profondeur dans un cadre intégré. Les personnes à l'origine de la Maison Intelligente sont d'avis que cette technologie est l'innovation la plus importante en matière de systèmes de puissance et de communications des soixante dernières années. Le concept de la Maison Intelligente comprend des systèmes de distribution de la puissance, des services téléphoniques et de communication, en général, et de divertissements ainsi que contrôle intelligent. Les circuits de puissance ont une commande centralisée et ils ne sont activés que lorsque l'appareil qui y est relié demande de la puissance. Une gamme nouvelle et complète d'appareils compatibles est en voie d'élaboration. Le projet de Maison Intelligente a été conçu par la Fondation de Recherche de NAHB et il regroupe maintenant plus de trente-cinq importantes sociétés industrielles fabriquant le câblage et les dispositifs électriques de base, les appareils et les sous-systèmes électroniques. Le marketing initial du système complet débutera en 1988.

1.0 INTRODUCTION

The Smart House is a new approach to power and communications systems for residences. It is a basic rethinking and redesign of power and communications systems within an integrated framework. The developers of the Smart House feel that this technology is the most significant innovation in residential power and communications systems in at least sixty years.

The Smart House Venture was founded by NAHB Research Foundation, Inc., and now includes over thirty-five leading industrial firms manufacturing basic electrical wiring and devices, appliances, and electronic subsystems. The Venture is one of the first applications of the National Cooperative Research Act.

In 1986, product development will begin. The Smart House Venture will contract with companies to develop specific hardware items to strict specifications. The development process will last through 1987.

Initial marketing will begin in 1988. Based on analysis of the residential electrification, home control, and entertainment markets, Smart House penetration could reach one million homes per year by 1995. This kind of major impact on the way homes are wired and controlled is the guiding plan and vision of the Smart House Venture.

2.0 THE SMART HOUSE CONCEPT

The Smart House concept encompasses distribution of power, distribution of telephone and other communications and entertainment services, and intelligent home control.

The best way to understand the Smart House is to look at its key defining features. Those features are the following:

- Integrated wiring and receptacles;
- Programmed power; and
- Flexible switching and control.

2.1 Integrated Wiring and Receptacles

A modern house requires wiring for power, telephone, cable TV, HVAC control, security, doorbell, audio speakers, and digital information. Conventionally, these functions are served by a multiplicity of separate wiring systems that must be separately installed. The Smart House replaces these separate wiring systems with a single wiring bus for all functions.

Integration of the wiring system is the foundation for all the powerful control and communications capabilities of the Smart House. The integrated wiring system also will reduce wiring installation costs and improve wiring installation quality. Builders will no longer have to deal with up to five separate wiring subcontractors performing work at varying levels of quality; instead, a single, fully-qualified contractor will install the complete wiring system.

In parallel with integrated wiring are integrated receptacles. In a conventional house, receptacles are specific to specific purposes -- power, telephone, or whatever. In the Smart House, there is only one type of multifunction receptacle. It is used for power, telephones, video, stereo speakers, or any other Smart House device. The Smart House supplies whatever service is required by the particular appliance. Equipment such as answering machines can receive both power and communications through a single plug.

The advantage of integrated receptacles is flexibility. Anything can be plugged in anywhere. Special purpose receptacles such as telephone outlets need no longer be restricted to a few special locations around the house.

2.2 Programmed Power

In a conventional house, branch circuits are always energized. In the Smart House, branch circuits are controlled and monitored by branch circuit controllers. Circuits become energized only when an appliance is plugged in and is actually requesting power. Most circuits, most of the time, are de-energized and present essentially no electrical hazard.

Further, when an appliance requests power, it requests power within a specific current range. Deviation from this current range might indicate appliance malfunction, or that the appliance has become unplugged. If programmed current limits are exceeded, power is immediately cut off.

The Smart House does not restrict appliances to 110 volt AC power. It also offers 48 volt DC power -- power that does not present an electrocution hazard. The outlet is supplied by a single set of power conductors; the branch circuit controller switches onto these conductors whichever type of power is requested. Forty-eight volt DC power has distinct advantages for lighting, for electronic equipment, and for many types of motorized appliances.

2.3 Flexible Switching and Control

Whereas switches in a conventional house are hardwired into the power circuits, switches in the Smart House are functionally rather than physically associated with outlets and appliances; and switching functions may involve sensors and other information inputs as well as switches of the conventional kind. Switches are low-voltage signalling devices; actual power switching occurs only at central controllers within the wiring system. Each switch and sensor can be programmed and reprogrammed to control any outlet or group of outlets within any part of the house.

When combined with modern communication and control technology the possibilities for flexible switching are almost endless. Functional capability is maximized because the intelligence of the system is built in, not added on. All Smart House components and appliances are designed to easily interface to the control system and work naturally with it.

3.0 IMPLICATIONS OF THE SMART HOUSE

3.1 Safety

Programmed power control in the Smart House means that receptacles are normally de-energized; are continuously monitored for correct operation; and are capable of distributing safe low-voltage DC power on request. The safety implications are very evident.

Many of the Smart House flexible control and sensing features serve to increase safety and improve home security at the same time they increase convenience. Particularly important are benefits to children, the elderly, and the handicapped:

- Parents can restrict children left alone at home from using dangerous appliances.
- For the elderly, a Smart House can be programmed to summon aid on voice request or if there has been no input to the system after a designated time delay.
- For a blind person, the Smart House can tell the person the status of various appliances around the house via voice synthesis. For example, it can warn that a stove burner was left turned on.

3.2 Switching

Smart House switches can take many forms:

- Low cost, single function wall switch: Simple momentary contact connected to the control equipment. As few as two low-voltage conductors are required. Both switch and wiring can be surface-mounted, and more switches can be added on very easily. Even the simplest switch can be programmed to perform any function.
- Programmable, multifunction wall switch: This type of Smart House wall switch is a touchpad device with, say, six programmable keys. Icons on the keys make their functions easy to identify. A high-end switch can even have programmable icons generated by a dot matrix liquid crystal display.
- Hand-held remote controller: This device is a portable form of the programmable multifunction switch. It can be carried from room to room, and even assume different functions when used in different rooms.
- Switching by voice recognition is also anticipated.
- Switching by telephone will allow the homeowner to access any function in his home from any remote location.

3.3 Sensors

Sensors in the Smart House are almost as important as switches. Smart House sensors plug in and communicate in standard ways. Sensors of any kind can be installed anywhere -- and then reinstalled somewhere else as the occupant needs change. Available sensor types will include occupancy/intrusion, temperature and humidity, light, smoke, and indoor air quality. Note that a single sensor can assume multiple functions in the Smart House. An occupancy sensor that controls room lighting becomes an intrusion sensor when the family is away. A temperature sensor that normally controls the heating system will also signal "fire!" if an abnormal temperature rise occurs.

3.4 Integrated Scheduling

The scheduling function provides further control capabilities. The power of the Smart House control system becomes most apparent when the different control modes -- switching, sensing, and scheduling -- are combined. For example, the occupancy detector will turn the light on if someone comes in the room while it is dark and someone is supposed to be home; however, if no one is supposed to be home, it will instead call a security service.

3.5 Improved Appliance Design

A complete line of Smart House compatible appliances will have reduced cost, increased safety, and improved functionality. New capabilities include:

- Reversible, variable-speed, electronically-commutated DC motors;
- Appliance safety design simplified by using low-voltage DC power that does not present electrocution hazards;
- Elimination of appliance controllers redundant with the built-in intelligence of the Smart House; and
- Sophisticated appliance diagnostics in an integrated house-wide reporting system.

3.6 Improved Lighting Design

The 48 volt DC power available in the Smart House is advantageous for lighting, too. It is easily synthesized into any waveform for dimming control and for improved fluorescent lighting. Using a 400 Hz synthesized waveform to power fluorescent lights eliminates need for a separate ballast, increases efficiency, increases bulb life, and allows flicker-free light. And, of course, lighting fixtures benefit from the inherent personnel safety of 48 volt DC power.

3.7 Energy Management

The Smart House makes practical the use of time-of-day rate structures in the residential setting. So far time-of-day rate structures have not been widely used in the residential sector because of the complexity of metering and because homeowners do not understand how to reduce their costs in response to the rate structure. The Smart House can automatically defer discretionary appliance usage to low-rate periods. In general, the Smart House can greatly assist electric and gas meter reading by allowing remote meter reading and programmable meters.

3.8 Gas Distribution

Gas distribution in the Smart House operates on the same principles as electrical power distribution. As with electrical energy, gas is distributed from a supply controller. A gas appliance requests gas at a certain flow rate. The request is validated, gas is supplied, and the flow is cut off should the requested flow rate limits be exceeded or should incorrect operation be detected at the appliance.

4.0 CONCLUSION

The Smart House is a revolutionary approach to the problem of providing integrated, safer, more flexible power, and communication systems to residences.

"HVAC-DYNAMIC" - SIMULATOR AND EMULATOR SYSTEM

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KEYWORDS

Adaptive Controller, Dynamic Simulation, Emulator System, HVAC-Plant, Model Library, PID-Controller.

ABSTRACT

HVAC-DYNAMIC is a computer program designed for simulation of dynamic behaviour in HVAC plants. The program is based on a model library, which contains models for some standard components in HVAC systems. Available models today are: pipe, valve, shunt coupling, fan, duct, damper, heat coil, heat recovery wheel, temperature sensor, controller and actuator. The library is also containing a simplified model of the building itself and its outdoor climate. The program may be used for investigation of dynamic interactions between different components in the HVAC plant, or be utilized more as a tool for designing and testing of different control strategies and algorithms. Furthermore it is possible to connect real, external controllers to the computer through appropriate interface. In this emulation mode the program will simulate the HVAC system and respond to inputs from the external controller. Commercial controller can then be tested, compared and tuned in a matter of hours instead of spending several days doing the same job in the actual plant. This paper presents a brief review of the program system together with some test results.