A PC-BASED SYSTEM FOR MAINTENANCE MANAGEMENT OF BUILDINGS: GENERAL DESCRIPTION

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ABSTRACT

Europe's rich culture in wooden buildings are rapidly degrading due to environmental impact, wrong conservation techniques and lack of resources and technological tools for appropriate conservation. These issues were addressed in the former EU-project ENV4-CT95-0110 Wood-Assess , which has been finalised (Haagenrud et al, 1999).

In a new EU-project MMWood (ENV4-CT-98-0796) a PC-based system for maintenance management of buildings has been developed. The project had the following objectives: To develop and validate for the SMEs an integrated Maintenance Management system for historic buildings, adapted to the needs and purposes of various user group levels. Based on the Wood-Assess concept and results the modular GIS (Geographical Information System) based system, MMWood, will specifically contain

- A documentation system for outer and inner parts of buildings and components,
- Soft- and hardware tools for the building inspection in the course of maintenance tasks,
- An environmental risk factor assessment module,
- A standardized maintenance assessment module,
- A cost and maintenance planning module.

Main developments from the Wood-Assess project are *the inclusion of the maintenance management phase*, extension of the damage atlas to include also adjoining materials in wood constructions, rendering, brick and natural stone, and a *fully integrated field inspection system*, allowing the user to import/export all background and recorded data between the field inspection and the total maintenance management system.

In this paper some of the main results of the project are given with *much of the emphasis on presenting the PC-based application, and its use in some practical examples*. Detailed results from the *environmental risk factor assessment module* and the *standardised maintenance assessment module will be given in separate papers to this Congress.*

KEYWORDS:

Maintenance management, condition surveys, environmental impact, and building documentation.

INTRODUCTION

Europe's rich culture in wooden buildings are rapidly degrading due to environmental impact, wrong conservation techniques and lack of resources and technological tools for appropriate conservation. These issues were addressed in the former EU-project ENV4-CT95-0110 Wood-Assess and a paper which summarizes objectives, strategies, work-tasks and some main results are published (Haagenrud et al, 1999)

The project has completed its tasks and achieved all its objectives, developing and validating an Assessment Protocol, methods for continuous measurements of moisture and temperature in the micro-environment, and systems for mapping environmental risk factors to wooden cultural buildings (Haagenrud et al, 2000).

The theoretical and methodological foundation for the project builds heavily on the internationally recognised methodology for prediction of durability, service life and maintenance intervals, which is now subject to standardisation by the ISO/TC59/SC14 "Service Life Planning" (ISO, 2000). As such the Wood-Assess concept for assessing environmental impact on to building facades can be directly applied to the Factorial approach in the ISO standard. This provides major new methodologies and tools for assessing the climatic risk factors for wood preservation on regional-, local and micro scale in Europe.

From synthesis and further development of the national systems and guidelines for conservation and assessment, a pilot version of a Condition Assessment Protocol has been developed and validated by assessments of pilot objects in Germany, Sweden and Norway. The PC based pilot version of the Assessment Protocol was made available on a Geographical Information System (GIS) platform that could store, integrate and further process data of all kind such as text, pictures, maps etc. A separate PC based system for field inspection and registration was developed, consisting of hand-held computer, a digital camera and bar-code reader for registration of predefined information elements from a Field Handbook.

The Assessment Protocol developed covers the five main phases of *Defining* the task (purpose, extent, costs), *Planning*, *Registration* of basic data and object condition and environmental impact, *Evaluation* and *Reporting*. It did not cover the maintenance management phase. It is adapted to different user levels and needs, and the approach is action oriented, based on registration and evaluation of damage causes and effects, consequences, risks and remedial actions.

During the pilot testing of the applications small and medium sized companies (SMEs) and clients expressed great interest and need for a potential product developed from the Wood-Assess concept. As the project also got a very high rating from the EU, a new project proposal was developed and endorsed by the EU. In this new project, ENV4-CT98-0796 MMWood "System for Maintenance Management of Historic (Wooden) buildings"(acronym MMWood), the Wood-Assess concept is further developed towards the market.

Implementation of such a system puts requirements on its users and it will require maintenance, support and further development to adapt to new technology and knowledge. These issues have been dealt with and regulated in the Consortium Agreement.

The MMWood system will bridge a gap between facility management, geographic information systems, expert systems and co-ordination of restoration experts. It will link data, of different geometric scales, of different aspects, of different user levels and time scales.

OBJECTIVES AND WORK PLAN OF MMWOOD

Objectives

The new project that started in January 1999 and runs for two years comprise the following main tasks:

> To develop and validate for the SMEs an integrated Maintenance Management system for historic (wooden) buildings adapted to the needs and purposes of various user group levels. Based on the *Wood-Assess* concept and results the modular GIS (Geographic Information System) based system, MMWood, will specifically contain
> - A documentation system for outer and inner parts of historic (wooden) buildings and components.
> - Soft- and hardware tools for the building inspection in the course of maintenance tasks.
> - An environmental risk factor assessment module.
> - A standardised maintenance assessment module based on complementation of the Wood-Assess process of assessing the symptoms, causes, effects, consequences, risks and remedial actions for environmental damages to the historic buildings.
>
> A cost and maintenance planning module.

Work-plan

The MMWood project consists of five Work Packages (WP*). WP1-Application Development and Testing* deals with developing and validating the MM system, together with different user groups, at pilot objects. Thus WP1 is the main aspect of this report.

WP 2 – Assessment of environmental damages to buildings deals with extending the Damage Atlas from wood to include also materials like Rendering, Brick and Natural Stone. It is based on the Wood-Assess protocol of assessing the symptoms, causes, effects, consequences, risks and remedial actions for environmental damages to historic buildings consisting of those materials. This Damage Atlas, which is a module in the MM system, is reported in another paper to this Congress (Eriksson et al, 2001)

WP3 - Object documentation, regulations and management- aims to identify, develop and establish documentation requirements, regulations and management performance for the application of MMS at pilot objects in each of the participating countries.

WP 4 – Environmental risk factor module provides
- dose response and damage functions for the ingoing materials,
- synthesise the necessary environmental data for exploiting the methods and models developed in Wood-Assess to map the environmental risk factors and resulting service lives for the materials at the chosen locations in the participating countries Italy, Germany, Sweden and Norway. The results are reported in another paper to this Congress (Krigsvoll et al, 2001)

GIS BASED MAINTENANCE MANAGEMENT SYSTEM (MMS)

The main focus in this report is to give an overview of the MM System. The system developed and tested in the Wood-Assess project needed further development in terms of user friendliness, integration between main system and field inspection part, new technology, more building components and materials, a maintenance management module, etc.

The system developed consists of two modules; the MMS main module and the field inspection module MMInsp. They are supposed to run on two different computers and then each of them has their own database (on Oracle platform). For convenience the inspection module is often run on a laptop suited for fieldwork. The information needed for field inspection is exported from the main to

the inspection module, and afterwards inspection data are imported into the main application for analysing and decisions. The two modules can also be run on the same computer, for instance on the same laptop used for fieldwork, in which case no export import function is needed. The MMS covers the entire work process from generation and storing of all documentation and basic data of an object, reading in inspection data and photos from the MMInsp, reworking and analysing, print out of work-card to following up of maintenance work with reports and statistics.

In the following a somewhat more detailed description of the new MMS application is given.

User administration
Each user will have a separate username and password, and all users are required to log on to the application. The users are divided in two different classes, users and administrators. The possibility to configure the system will only be available for the administrators. All inspections and decisions will be linked to the user.

The application will be oriented towards the objects, meaning that the user will have few options available until he has chosen an object to work with.

Choosing an object
Choosing an object can be made from
- map- GIS based (see Fig 1)
- list of objects
- by searching
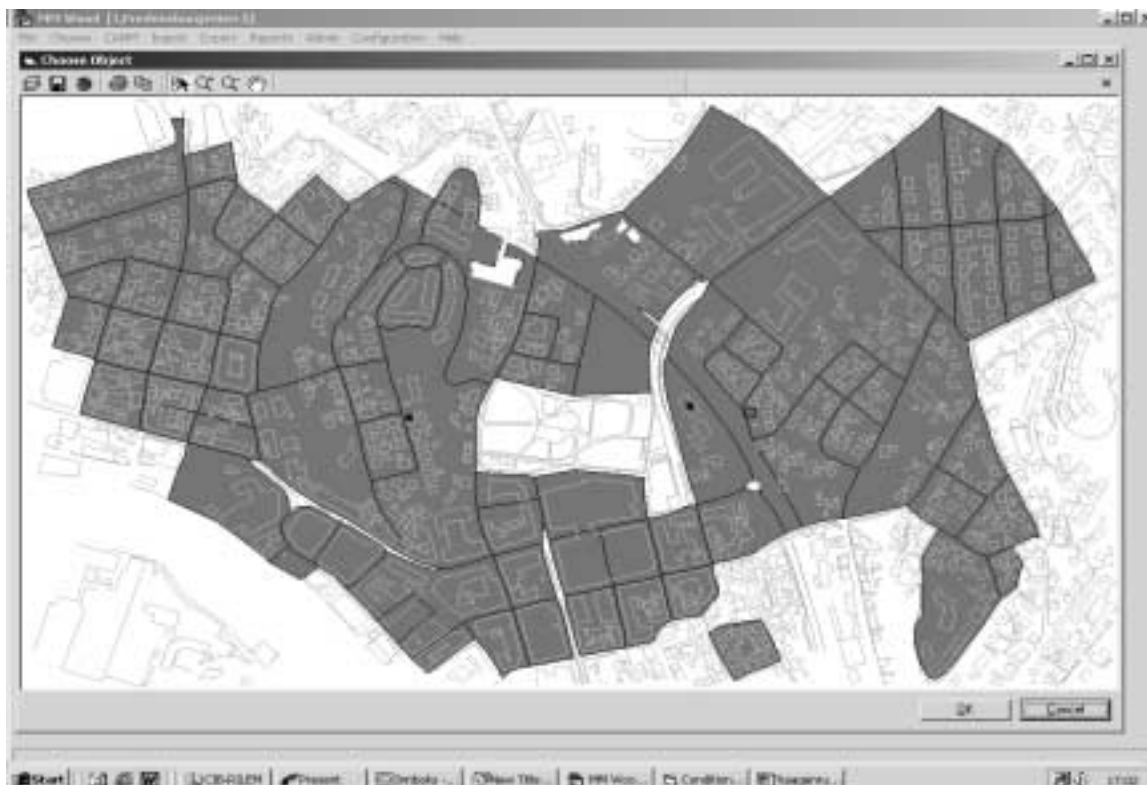- objects unique number

Fig 1 Chosen object from map

Information menu
After the user has chosen an object, this object becomes the active object. At the same time the Information menu becomes active, giving the following options for viewing further information on the object:

- Building and Building parts
- General info
- Specific info
- Map
- Images
- Inspections, including observations
- Damages
- Drawings linked to the object and its building parts
- Documents/any information connected

The Information menu will contain paths to all the different groups of information that are available regarding the chosen object, see Fig 2. This means that each of the partners in this project can specify information that is only relevant to their country/customers.

The building is constructed from a Building-parts library. Several drawings may be linked to the object. Here a drawing of the main floor shows a graphical presentation of the ground floor of the object. On the drawings there will be marks showing different building parts and/or where the different observations and situated. Different types of information linked to the drawing are showed by separate types of symbols. The user can zoom in and out, and pan in the form. The user can filter which marks are to be shown by using the Filter-button. Images may be linked to the object, to building parts, or to the observations.
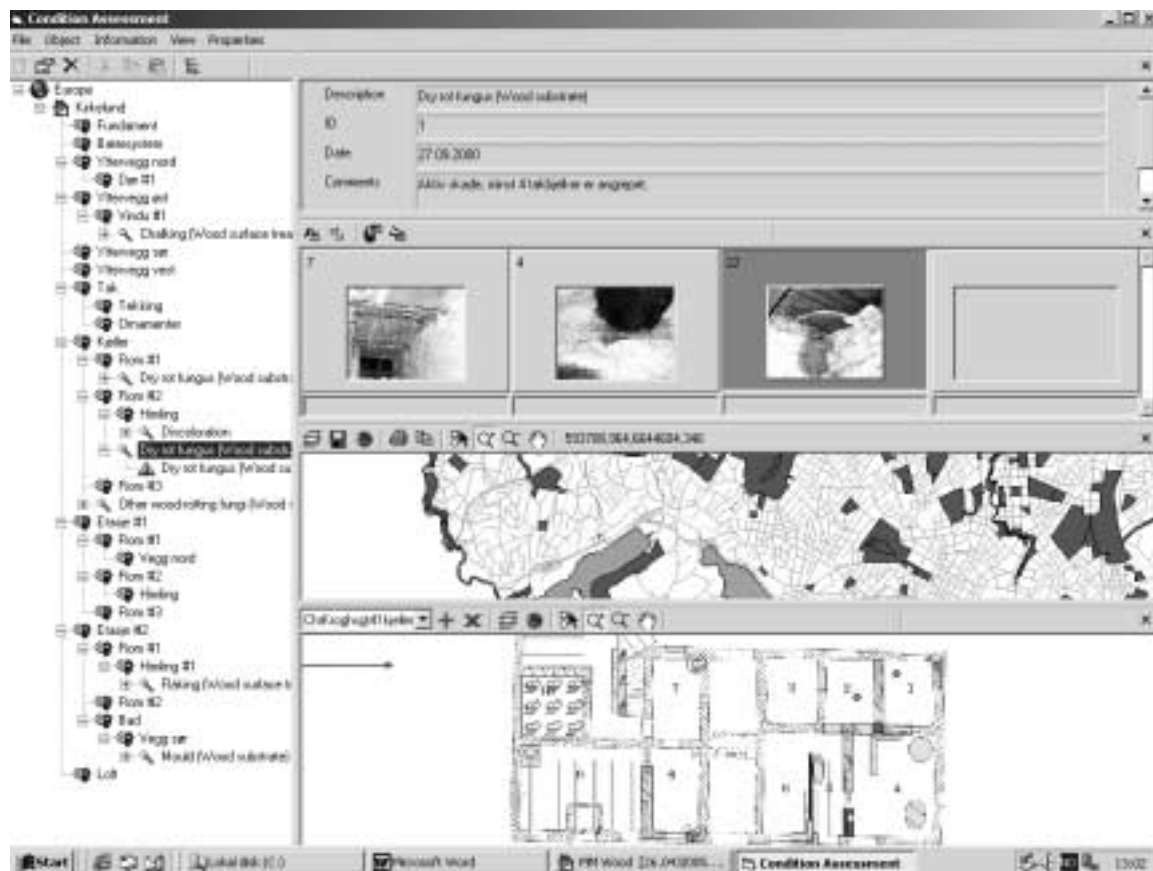

Fig 2 Chosen object (Kirkelund) showing linked information with pictures, maps and drawings

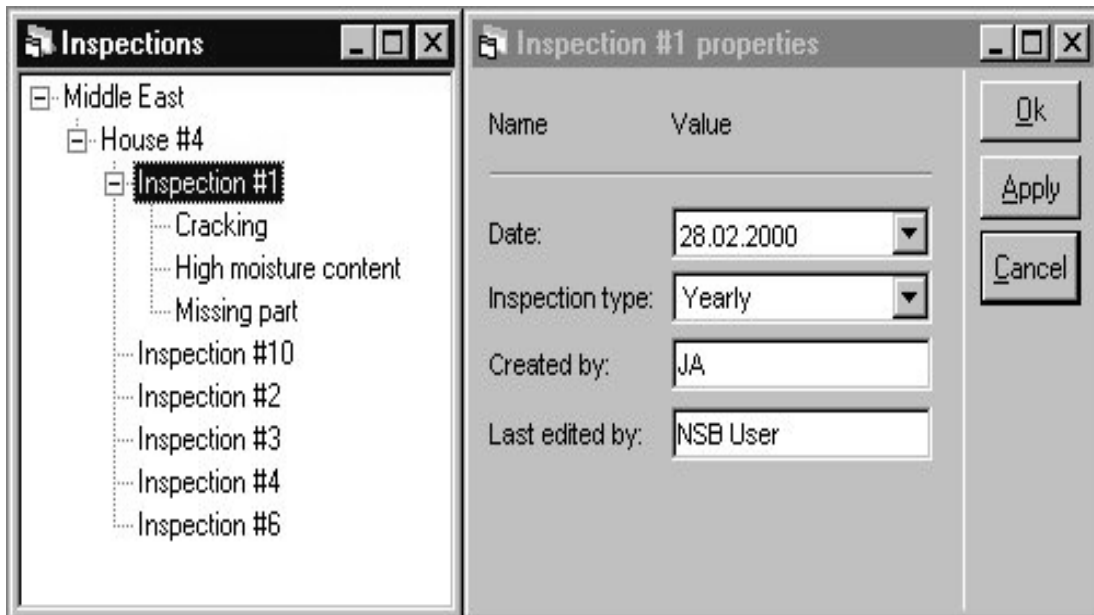The inspections included observations form shows a list of the inspections performed on the object, see Fig 3.

Fig 3 List of inspections and properties of the inspection

The damage form shows a list of all the damages linked to the object, see Fig 4.

Fig 4 List of the damages linked to the object

Included in the list are the name of the damage, the date it was discovered, and the name of the person discovering it. This form will be the basis for analysing the damages.

Configuration menu
The Configuration menu will only be available to the Administrator-class of users, and consists mainly of options for maintenance of the database and the libraries in it.
This includes the following options:
- Users
- Library of building-parts
- Library of observations/damages (Damage atlas)

- Library of work-types
- Library of responsible
- Library of questions (Fig 6)
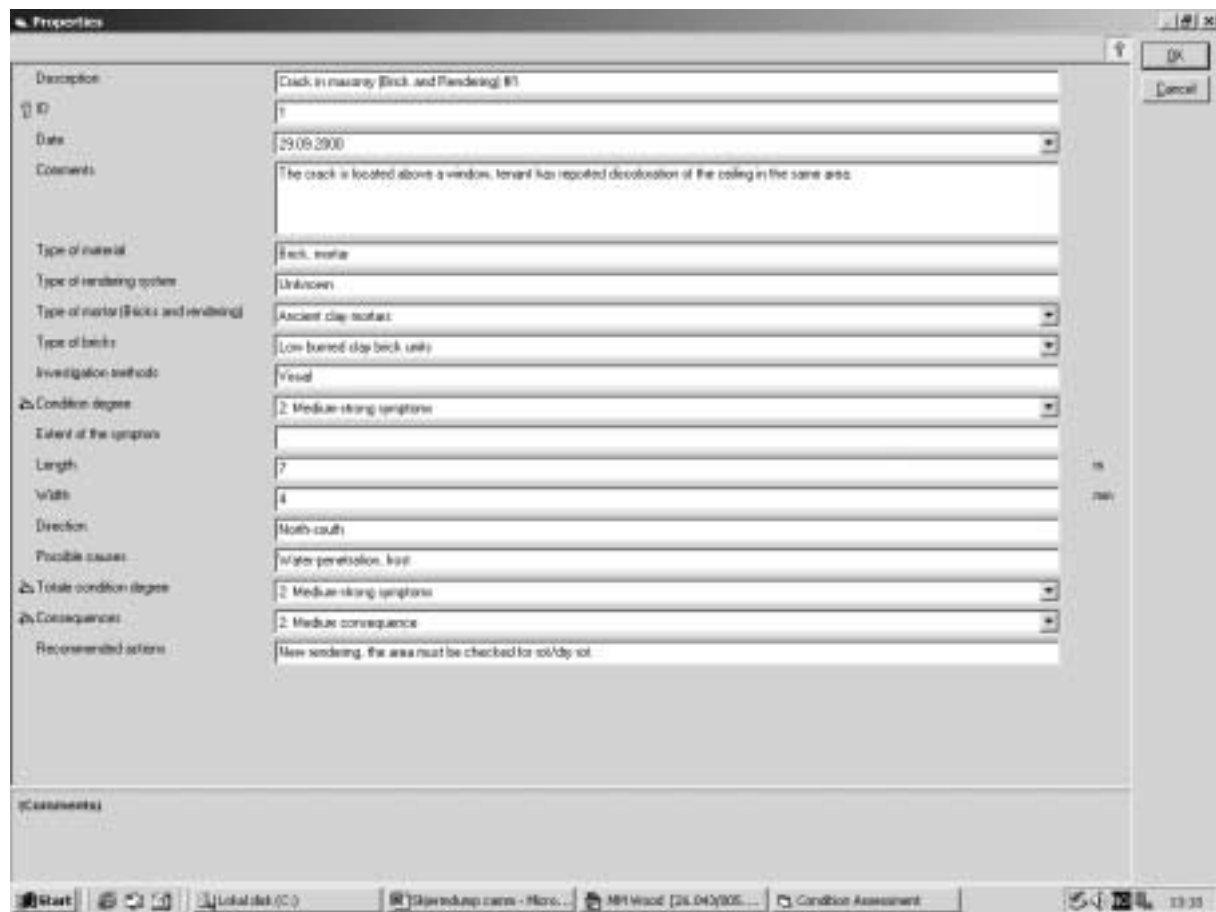
Fig 6 List of defined observations

Fig 6 shows an example from the list of observations. There is also a list of damages, and a relation between observations and damages. The system has a library containing possible question, and there is a relation between observation and questions. There is a Damage Atlas containing a list of pre-defined damages, showing which questions are linked to the observation, , and which questions requires an answer , see Fig 6 (Eriksson, 2001).

It will be possible to add new records, edit records, and delete records (provided they are not in use).

The administrator will be able to add and remove questions, and change their order, as well as editing the description of the damage. The administrator will also be able to make a link to the Damage Atlas.

Analysing damages and deciding maintenance work is another functionality.

The user will have to enter the deadline for work due, and choose a work type and responsible for fixing the damage. Work types and responsible are found in pre-defined lists, but the administrator (user) has the possibility of adding more records. The user must also give a priority for the importance of fixing the damage. Optionally, the user can add a comment (in free text).

Reports

The following reports are given
- List of objects

All

Selected in list

- One object

With static and/or dynamic information

- List of inspections

For all objects

For selected objects

For active object

- List of damages

For all, selected or one object

All, fixed/not fixed, or analyzed/not analyzed

- Damage information

- List of users

Import/Export MMInsp
Import from the inspection-module will be taken care of through the menu-choices under the File, Input-menu.

Export to the inspection-application will always include the systems users, the list of observations (and other libraries connected to the damages) and the main information for the chosen objects. The information on earlier inspections, damage atlas etc, are optional:
- earlier inspections
- damage-atlas

CONCLUSION

The paper describes objectives, strategies, work-tasks and some main results of the MMWood project. Main developments from the preceding Wood-Assess project are *the inclusion of the maintenance management phase*, *extension of the damage atlas* to include also adjoining materials in wood constructions, rendering, brick and natural stone, and a *fully integrated field inspection system*, allowing the user to import/export all background and recorded data between the field inspection and the total maintenance management system. Main functionalities of the *MMS application and the inspection module MMInsp are described*. Detailed results from the *environmental risk factor assessment module* and the standardised maintenance assessment module are given in separate papers. The theoretical and methodological foundation for the application builds heavily on the internationally recognised methodology for prediction of durability, service life and maintenance intervals, which is now subject to standardisation within ISO/TC59/SC14 "Design life of Buildings"

REFERENCES

Eriksson, B., Waldum, A., Riks, E., Andersson, T., Andersen, H., Mohn-Jenssen, K., Garofolo, I., Albatici, R., Frattari, A., Haagenrud, S. E, Krigsvoll, G. 2001. A PC-based system for maintenance management of Buildings-description of the damage atlas, This Congress

Haagenrud, S. E, Framework and Implementation of Performance based Standards for a more Sustainable Built Environment 2000, 2nd Asia/Pacific Conf. on Durability of Building Systems: Harmonised Standards and Evaluation, Bandung, Indonesia 10-12 July, 2000.

Haagenrud, S. E, Veit, J., Eriksson, B., Henriksen, J. F., Krigsvoll, 1999 G. EU – project ENV4-CT95-0110 "Systems and Methods for assessing Conservation State and Environmental Risks for Outer Wooden parts of Cultural Buildings"- Final report in print

Haagenrud, S.E, Eriksson, B., Sjöström, C. and Skancke, T., 8th DBMC; Vancouver 1999 (Volume Three). Edited by M.A.Lacasse and D.J.Vanier, pp1602-14

International Organisation for Standardisation 1999 Service Life Planning – Part 2: Service Life prediction Methods. Geneva (ISO/DIS 15686-2).

International Organisation for Standardisation 2000 Service Life Planning – Part 1: General principles. Geneva (ISO 15686-1).

Krigsvoll, G. Henriksen, J. F., Haagenrud, S. E, Eriksson, B. A 2001.PC-based system for maintenance management of Buildings-Environmental. Risk factor module, This Congress.