

# MAINTENANCE SUPPORT MODEL WORKING ON HALL FOR WORKSHOP OF META-SYNTHETIC ENGINEERING

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This paper proposed a method of researching maintenance support with hall for workshop of meta-synthetic engineering (HWMSE), set up a HWMSE framework of equipment maintenance support and researched maintenance support model system of HWMSE. Then the maintenance support model based on ExSpec was presented, application of the model based on COM component technology in HWMSE was studied.

Key Words: Hall for workshop of meta-synthetic engineering, Equipment maintenance support, simulation model

## 1 INTRODUCTION

Equipment maintenance support is an important part of equipment construction, which is the base of equipment combat readiness and mission sustainability. Equipment maintenance support is a complex system engineering influenced by multi-factor, which is difficulty to solve by quantitatively method alone. Meta-synthetic engineering and the 'Hall for workshop of meta-synthetic engineering' (HWMSE) provides methodology to solve it.

Hall for workshop of meta-synthetic engineering is a super decision-making technique engineering which integrates human knowledge and all kinds of information. Essential method of HWMSE is that experiential hypothesis and qualitative description of judgment are proposed from qualitative meta-synthetic view, then quantitative description is gained by qualitative and quantitative meta-synthesis, at last quantitative scientific conclusion is got through meta-synthesis from qualitatively to quantitatively. This realizes advancement from experiential qualitative knowledge to scientific quantitative knowledge.

In this process, system modelling must be based on theoretic methodology, experiential knowledge, data and information; quantitative results got through simulation and optimization must be discussed and judged together by expert group with their rational and intuitive knowledge of science and experience, and then model and parameters are revised; at last calculation process is repeated again and again until credible result is gained by expert group. This result, which combines qualitative with quantitative descriptions of expert group, has enough scientific bases and can be conclusion and policy for decision-support. This kind of methodology, abstracted from many practices, must be integrated with expert group, data and information, knowledge and theory of relative subjects, especially human experience and wisdom. Several above-mentioned aspects make up of an organic integer, capability of problem settlement comes from sufficient exertion of integrated advantage every element. Obviously human-machine cooperation is to exert human-machine brainpower in complex intelligent problem.

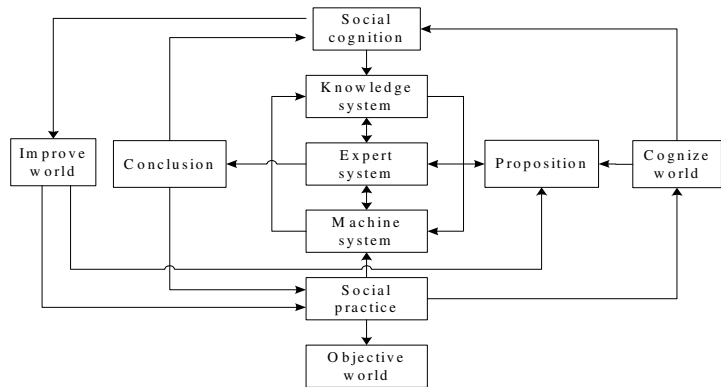


Fig.1 Concept structure of HWMSE

HWMSE is composed of three parts: machine system, expert system and knowledge system, machine system and expert system are the carrier of knowledge system. All the three parts are synthesized and integrated by modern high and new technology with computer as its core. Concept structure of HWMSE is given like Fig.1.

Essentially speaking, HWSME is a new decision-support system. It mainly has following three characteristics: (1) HWSME is a support tool of researching problem through democratic centralized mode; (2) HWSME is a human-machine system, which exerts not only human subjective activity but also function of machine; (3) HWSME is a synthetic application of many technologies.

## 2 STRUCTURE OF HWMSE FOR EQUIPMENT MAINTENANCE SUPPORT

Problem domain of equipment maintenance support includes characteristic demonstration, concept working-out and resources deployment of equipment support.

Characteristic of equipment support is a general designation of attribute and element related with support in equipment system. Support characteristic, relative not only to design characteristic but also to supportability level, reflects whether equipment needs support or not, whether equipment is easy to be supported, whether equipment can get support or not. It is extremely important for equipment support to demonstrate and analyze equipment support characteristic, to normalize demonstration process and to manage and control demonstration work.

Equipment maintenance support concept is a summary explanation about equipment maintenance support work and a general layout about equipment maintenance support. Support concept optimization is an important guarantee to achieve equipment operational readiness and reduce life cycle costs. Working out support concept, which is a very complex process, commonly passes through three phases: original support concept, prepared support concept confirmation and optimization. Evaluation and balance analysis of prepared support concept, which is most complex in supportability analysis, is to optimize support concept and influence equipment design in order to achieve best balance among cost, speed, operational performance, operational readiness and supportability.

Support resources are not only material basis of operational capability and supportability but also precondition of effective equipment support. Modern wars require equipment support should be swift, accurate and low-cost. In the war equipment support resources are not unlimited. Therefore it is required that all the support resources needed in the current mission should be forecast scientifically, variety and amount of resources should be confirmed in every mission phase, support concept should be worked out and evaluated reasonably under restriction of operational readiness and mission sustainability in order to make support system run harmoniously and effectively, to exert support benefit farthest and to advance supportability.

To solve the problem equipment maintenance support, a hall for workshop of meta-synthetic engineering is provided is as fig. 2.

In the system application level, there define the problems of maintenance support domain, which including maintenance support concept research, support attribute argument and support resource deployment etc.

Resource level is used to restore and manage many kinds of information, mainly including data library, knowledge library and simulation model library.

Resource management level includes data library management system, model library management system, knowledge library management system and so on.

Conference service level, an interaction environment between system and expert, provides conference flow, decision support service and conference display and supplies integrated service of all kinds of requirement, including information service and simulation service.

A flexible mechanism is designed between the conference service level and resource management level, which is called simulation or attaining knowledge for needed.

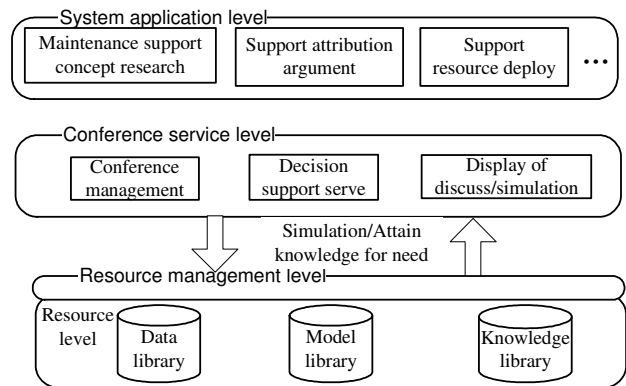


Fig.2 structure of hall for workshop of meta-synthetic engineering for Equipment maintenance support

## 3 MAINTENANCE SUPPORT SIMULATION MODEL

Modelling and simulation is the major quantitative analysis method of system. The modelling elements include equipment management office, maintenance department, spare stock, transport team and so on. To reflect the equipment state and produce the maintenance demand, it needs to model the equipment usage process, including the reliability modelling and combat process model. Based on it, the evaluation model is constructed to analysis the equipment combat readiness and mission

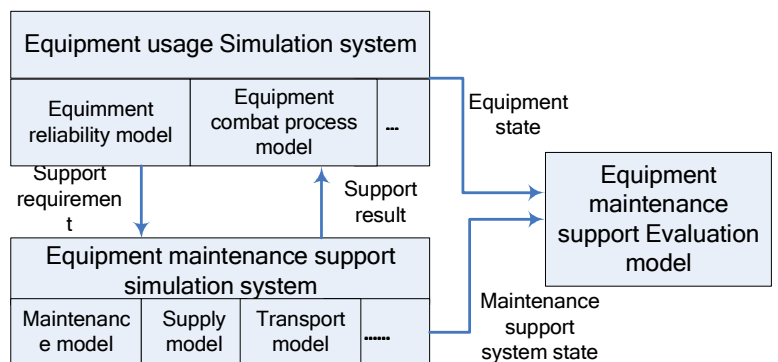


Fig.3 maintenance support model architecture

sustainability. The model architecture is as fig.3.

In order to work on the hall for workshop of meta-synthetic engineering, the model needs more flexibility to be organized according as expert idea and be simulated and re-organized. To improve the flexibility, the general entity model is constructed by abstract of the entity attribute.

Maintenance organization is taken for example to illuminate the method. Supported by resources of manpower, equipments, spares etc., Maintenance organization transforms the fault equipment to healthy states by a series of business process and maintenance process; meanwhile, ask for support of supper organization for beyond capability.

We use Executable specification tool—ExSpect to model the maintenance support, which is based on colored timed Petri net. The language ExSpect consists of two parts: a functional part and a dynamic part. The functional part is used to define types and functions needed to describe the operations on the value of a token. The dynamic part of ExSpect is used to specify a network of transitions and places, and therefore, the interaction structure of a system. The behaviour of a transition, i.e. the number of tokens produced and their values, is described by functions. The language also has a hierarchical construct called system. A system is a subnet, i.e. an aggregate of places and transitions and (perhaps) subsystems. The system concept supports both top-down and bottom-up design. A system can have a number of parameters. As a result, a system can be customized or fine-tuned for a specific situation. This way it is possible to define generic system specifications, which are easy to reuse.

Used executable specification tool-ExSpect, the maintenance organization can be defined as tab.1, which graphical interface in ExSpect is as fig. 4. In the system definitions, the parameter *in* represents the system input, the parameter *out* represents the system output and the parameter *val* is the system attribution value. The *fun* means function, which can calculate some value by the parameter. In the System maintenance organization, the repair time is the function of equipment-fault model and can be calculate.

The bad equipment arrives in channel *taskin* and leaves at channel finished by repair process defined as *repairtaskprocess* which can be outspread to describe the process logic. The store *sysinf* define the system attribute of level, local etc., the store *rsconfig* define the resources deployment, and the store *taskinf* defines the maintenance task information, which is the repository of maintenance organization model.

Tab 1 maintenance organization definition

```

sys maintenance-organization [
  in taskin: task,
  out wput: task,
  out needsupport: task,
  store rsconfig: rs,
  store taskinf: muti_taskinf,
  store sysinf: systeminformation,
  val: team_number,
  fun:repair_time[equipment-fault model],
  fun:request_spare_rate[equipment-fault model]
]

```

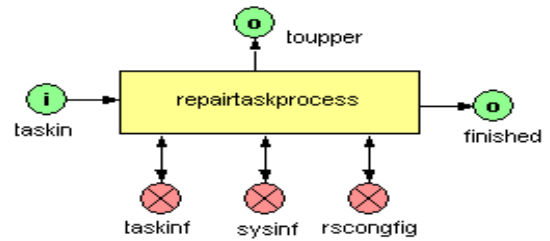


Fig.4 maintenance organization model

Graphical interface in ExSpect

ExSpect software provides a CExServ class library based on COM, which can control model in exterior program and implement the data transfer between exterior program and ExSpect model. A simple example in VB.net is as follow, and the complex control function can be implemented by using other methods and events of class library.

```

Public WithEvents ExObj As EXSERVLib. //declare EXSERVLib. CExServ class
CExServ                               libraries

ExObj = New EXSERVLib. CExServ         //define object of class CExServ

Call ExObj. Init( PathName, Model, Sys) // initialize model

Call ExObj. ProduceToken( "placename", token- // transform information in place
information, time )

```

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```

Call ExObj.Continue()                //start simulation
Call ExObj.TracePlace(placename)    // trigger the event Present
Private Sub ExObj_Present(TokenID, Place, Time) //Present event handing grogram
Handles ExObj.Present

    User program
End Sub

```

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The maintenance support models based on ExSpect implement flexible simulation required in hall for workshop of meta-synthetic engineering, which can be re-sued by instantiation of entity attribution and be controlled by COM interface.

#### 4 CONCLUSION

Equipment maintenance support is a complex system engineering influenced by multi-factors, and the HWMSE provides methodology to solve it. In order to work on the hall for workshop of meta-synthetic engineering, the model needs more flexible to be organized according as expert idea and general entity model based on ExSpect becomes a powerful method.

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