KITCHEN DESIGN TOOL –
AN INTEGRATED ENVIRONMENT FOR LAYOUT AND VENTILATION DESIGN

Tuomas Laine
Olof Granlund Oy
P.O.Box 59, 00701 Helsinki, Finland
Risto Kosonen and Eliott Gordon
Halton Group Ltd
Niittyvillankuja 4, 01510 Vantaa, Finland

ABSTRACT

Currently used design tools for kitchen design are often complicated, have poor interfaces and limited capabilities to exchange data between different applications. No integrated kitchen design environment is available although kitchen design requires the expertise of many different specialists and the decisions of various designers strongly affect each other.

The complex design, build, maintain and retrofit process has been mapped in order to provide a logical structure and flow for the kitchen design system. The developed prototype kitchen design tool demonstrates the capabilities and requirements of a truely integrated and efficient design process.

INTRODUCTION

Kitchen design requires the expertise of many different specialists to produce designs that meet the requirements of productive and cost-effective working environments. The decisions of various designers strongly affect each other. Owners and end users are important players in design process as well as cooking and ventilation equipment manufacturers. Due to the variety of key players and the wide diversity of their expertise, a common language (design tool) is needed to facilitate, modernise and accelerate the process. Currently used design tools are often complicated, have poor interfaces and limited capabilities to exchange data between different applications. No integrated kitchen design environment is available.

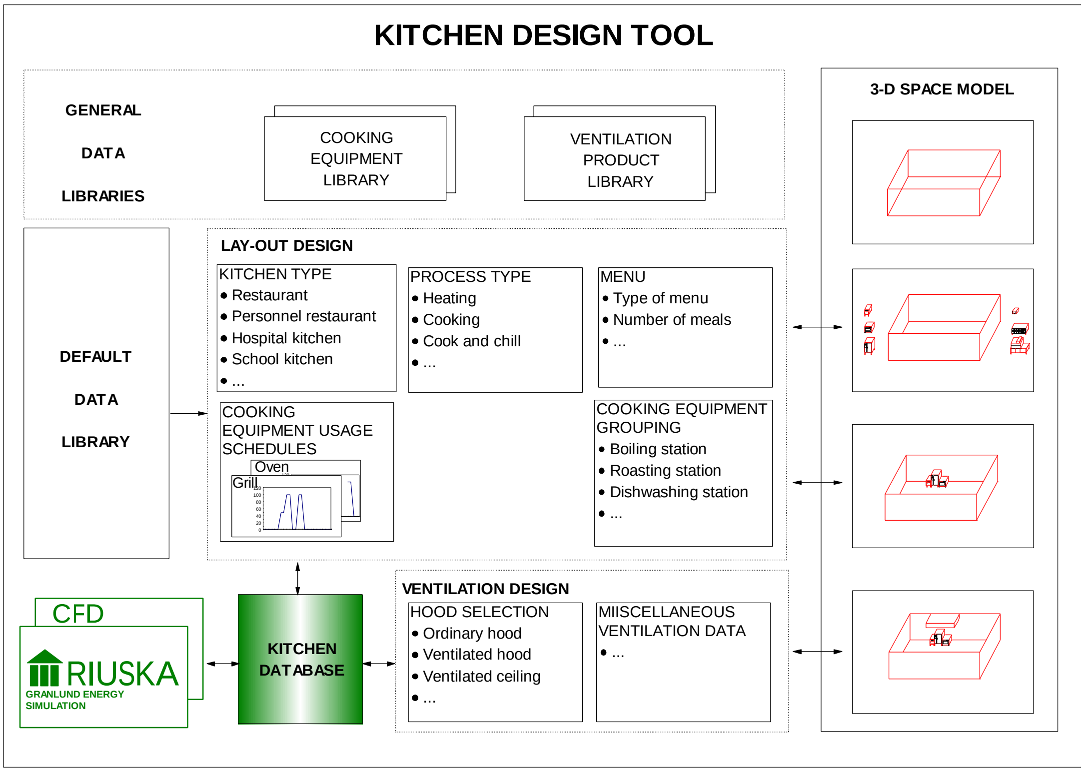

Figure 1. System structure of the prototype kitchen design tool.

Olof Granlund Oy, a kitchen layout, electrical and ventilation design company and Halton Group, a ventilation equipment manufacturer, have worked on mapping the kitchen design process. A prototype software for integrated kitchen design (Fig. 1) was developed for demonstration and proof-of-concept purposes. The system supports the entire kitchen design process. In the beginning only a few parameters are needed to gain preliminary design data. During the process it is possible to specify more detailed data. The same data, created during the design process, can also be used in facilities management.

The complex design, build, maintain and retrofit process has been mapped in order to provide a logical structure and flow for the kitchen design system. In turn, the kitchen design tool demonstrates the capabilities and requirements of a truely integrated and therefore efficient design process.

GENERAL CONCEPT

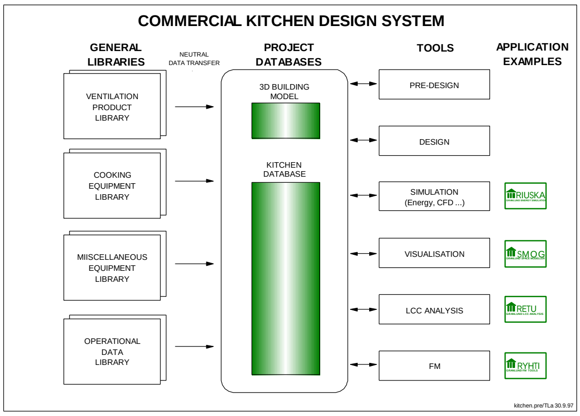

Figure 2. General concept for kitchen design system.

The system consists of a kitchen layout and ventilation design tool and a group of auxiliary design tools such as 3D space modeller, energy simulation and visualisation tools. In the future additional applications (e.g. CFD simulations and LCC calculations) can be linked to the system. The design tool utilises product data libraries, produced by cooking and ventilation equipment manufacturers. Default data from libraries can be used in early phases of design.

The general concept of the kitchen design system is shown in figure 2. The objective is that all design data (which affects to each other and affects energy consumption and comfort conditions of the space under construction) is produced in a form that during kitchen design project designers can utilise in their design applications.

The project databases contain 3D models of the building and kitchen design database. Tools and libraries are needed to construct and update project databases during the kitchen design process.

The system supports the entire kitchen design process. The same model, created during the project, might also be used in facilities management. In the beginning of the kitchen design process, when accurate data is not available, the designer needs to define only a few parameters to gain preliminary design data. Later on the design process data will be specified according to the information known. For example, in the beginning of the kitchen design process the menu, which aids the whole design process, is not always known. By defining kitchen type and process type the designer can determine the typical menu according to parameters defined.

KITCHEN LAYOUT DESIGN

The basic assumption in developing the kitchen layout design tool was that there exists common operational features in the kitchens of same type and same cooking process. To utilise these common features it is necessary to examine and divide these features into smaller parts and form a default data library. The basic menu offerings, serving times, size and number of portions and necessary sections with sufficient space requirements are all characteristics of the kitchen type. The process type, in turn, determines the space and equipment requirements for the facility.

In the beginning of the kitchen design process the designer defines kitchen type and process type as an input. The layout design tool utilises the default data library and gives preliminary information regarding the type of menu, number of meals to produce in a day divided to different serving periods and size of portions. All default data library values are alterable if needed. In that way it is possible to specify preliminary values to get more detailed information.

The menu (Fig. 3) serves as the source of information for the various food items to be prepared. The menu will guide the further design process. Default data libraries will facilitate developing the menu and also facilitates assessing the impacts of menu.

After editing the library values characteristic to the kitchen and process type, the layout design application produces a list of cooking equipment required and performs preliminary space dimensioning. Equipment requirements will be determined from a complete analysis of typical menu. For each food item on the menu, information regarding anticipated number of portions to be

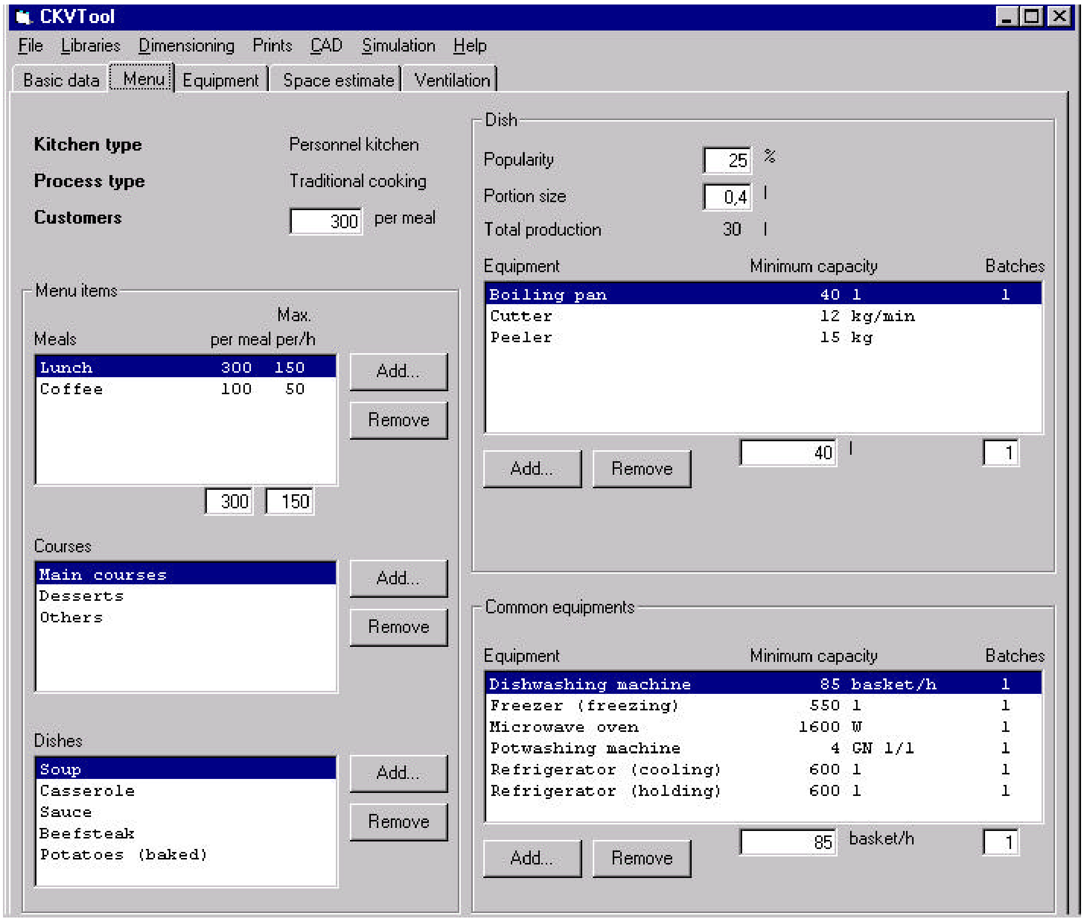

Figure 3. Menu selection in the kitchen layout design tool.

prepared, portion sizes, main ingredients, and the process to be performed are indicated. The total time that the equipment will be used for each process is evaluated. After this is done for each process, the equipment usage is evaluated and final equipment capacity will be determined by the system. At this point in the design process, it may be found desirable to add, delete, or change some of the menu items or processing methods in order to achieve greater equipment utilisation.

The preliminary space dimensioning includes room estimates for all functional areas, such as receiving, storage, preparation, cooking, and dishwashing, that are required to produce the menu items. The space required for each functional area of the facility is dependent upon many factors. The factors involved include the number of meals to be prepared, the functions and tasks to be performed, the equipment requirements and the suitable space for traffic and movement. Preliminary space dimensioning is also performed by the system in order to facilitate the layout designers detailed operational and workplace design. Accurate space dimensioning will be performed by the layout designer when the functions and tasks have been evaluated and grouping of equipment, including auxiliary equipment and material, tool and utensils storages, needed to perform the desired task has been done.

To facilitate configuration and visualisation of the layout, the system utilises a general data library (3D-models of equipment) and as the final product of layout design process user will gain 3D-modelled layout solution. The 3D-model of the facility is valuable when visualising (Fig. 4) the layout solution to the owner or user of the facility. In addition, the 3D-model will be employed by auxiliary design solutions. For example, as an input data of building or kitchen geometry for energy- and CFD-simulation tools.

Figure 4. Visualisation example of a kitchen workplace.

KITCHEN VENTILATION DESIGN

The HVAC designer receives layout of the kitchen from other designers in a compatible form to ventilation design tools and general databases produced by manufacturers. This means that HVAC design engineer has an opportunity to perform various tests while selecting and dimensioning the ventilation system.

Selecting, dimensioning and placing hoods and supply air devices could be performed by tools, such as energy analysis and CFD-simulation tools. This useful possibility to test and compare different solution strategies enables designer to ”select” (together with the owner and end user of the kitchen) the quality of the design. In ventilation design it means evaluation of indoor climate including target value adjustment for temperature, humidity and air movement. It would be useful to classify indoor climate requirements in every section of the kitchen, to facilitate target value adjustment. Classification may consist of three categories: basic, good and demanding.

Results of the indoor climate selection would act as a guideline for further design process. Indoor climate class selected gives the first idea of the system to the designer. Whether mechanical cooling is needed or not? Is the use of special hoods required?

The total design result with selected ventilation equipment can be again visualised to the client (Fig. 5). Visualisation gives the required information for decision making.

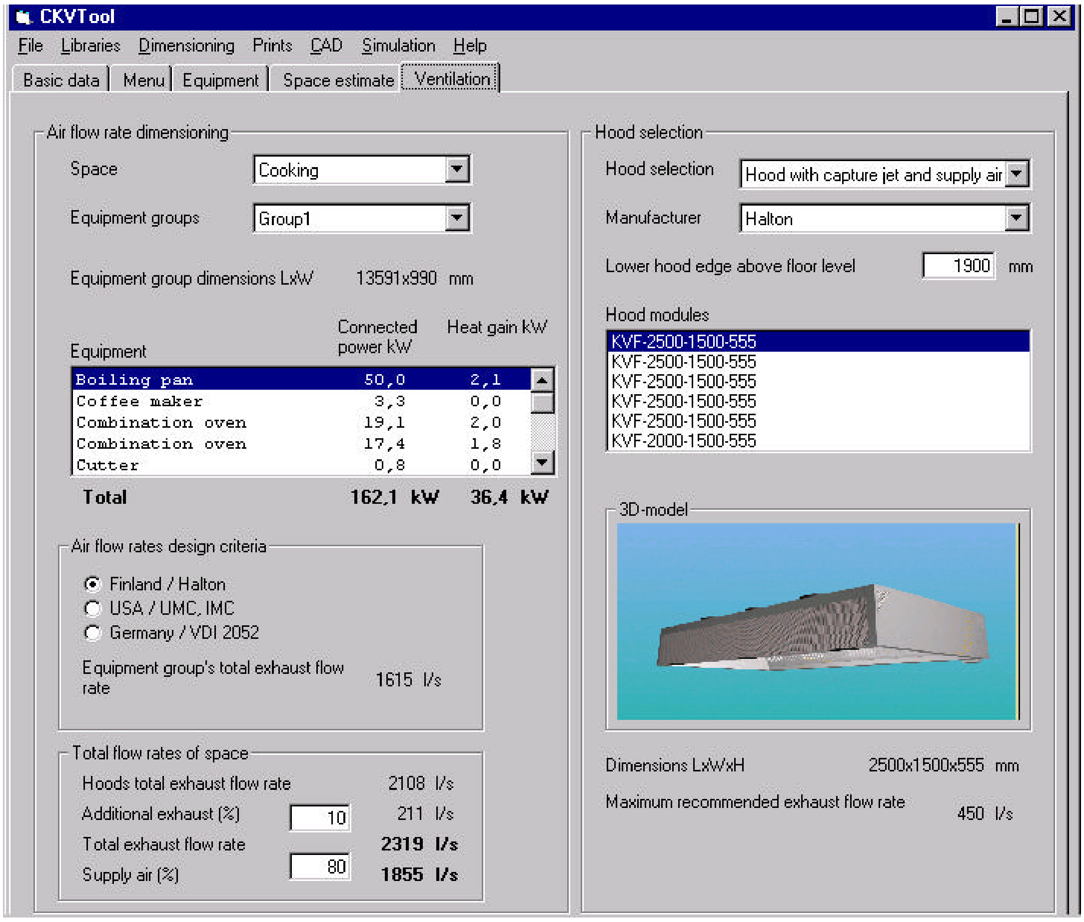

Figure 5. Hood selection in the kitchen ventilation design tool.

LIBRARIES

The default data library consists of operational information characteristics of the kitchen type and process used.

Information characteristic of the kitchen type: typical menu offerings, typical serving times, typical peak conditions, size of portions, number of portions and section space requirements.

Information characteristic to the process type: equipment requirements and section space requirements.

Default data library information related to ventilation design: indoor climate library for all areas or sections related to foodservice facility, area or section specific heat load library including heat loads of equipment (in cooking, baking and dishwashing areas the system utilises general data library), people and lighting and case library to facilitate ventilation system evaluation and design.

Default data library information related to electrical design: area or section specific lighting requirement library.

Default data library information related to building construction design: construction material library for walls, windows and so forth.

General data libraries should contain all essential information (including 3D-model) of cooking equipment and ventilation products. At the moment it seems that all information needed is not included in manufacturers databases. For example heat gains of cooking equipment are typically not available. Therefore it is useful to integrate utilisation rate factors and heat load factors of all commonly used equipment to the cooking equipment library (Fig. 6).

Cooking equipment information: 3D-model, capacity information, maximum heat gain (sensible/latent) or utilisation rate factors of all commonly used cooking equipment, maximum electrical input power, surface temperatures and technical requirements required e.g. for water, gas, ventilation and drain connections.

Ventilation product information: 3D-model, noise and pressure loss information, average capture efficiencies of hoods for energy simulation purposes and appropriate flow parameters for CFD case library.

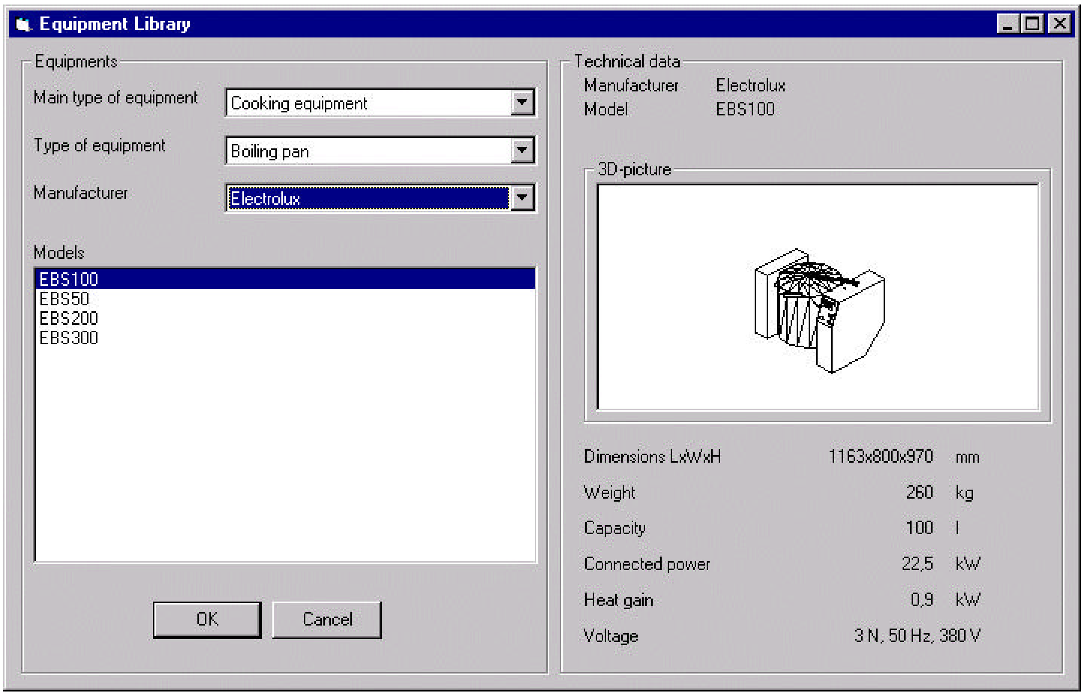

Figure 6. An example of the product data library of cooking equipment.

CONCLUSIONS

Kitchen is very important part of the foodservice facility. Kitchen floor plan, selected cooking equipment as well as indoor climate affects a lot to productivity of the whole foodservice facility. The problems related to kitchen layout, equipment selections, ventilation and lighting conditions require the expertise of many specialists.

Especially ventilation design is a very challenging task. High cooling loads and air flow rates demand accurate design. In commercial kitchens it is useful to keep heat gains as low level as possible, because heat gains have an immediate effect on air flow rates, ventilation system requirements, thermal conditions and energy economy.

Kitchen design system presented in this paper demonstrates the solution to facilitate and integrate separate design areas. Integration means that all design data is produced in a form that various designers can utilise in their design applications. In practice this means system assisted producing of design data and 3D-model of the kitchen as numeric and geometric input for various design tools and creation of data links between design system and tools. In this way comparisons and evaluations of alternative design solutions are easy to make.

Preliminary testing of this demonstration tool has pointed out that system works. The 3D-model of the kitchen has been formed out during the project. Menu creation, equipment selection, layout configuration and preliminary ventilation designs have accomplished aided by the system. Today manufacturers equipment and fixture databases seldom contain real 3D-models but the development is making progress rapidly.

REFERENCES

Riskala, K. and Heinonen J., „Commercial Kitchen and Restaurant Ventilation Pre-Study Project“, CD-ROM, Helsinki University of Technology, HVAC-laboratory, Espoo Finland, 1998.

Laine T., Hänninen M., „Restaurant Ventilation Technology Assessment Project: Kitchen Design System“, Olof Granlund Oy, Helsinki Finland, 1998.