Organic Process Research & Development **2004**, *8,* 965–969

Technology Reports

ChemProject: A Valuable, Easy-To-Use Tool for COGS Calculations in Chemical Process Research and Development

Michel Guillaume* and Jef Cuypers

Chemical Process Research, Johnson & Johnson Pharmaceutical Research and Development, Turnhoutseweg, 30, 2340 Beerse, Belgium

Abstract:

In this paper, we describe the software "ChemProject" which is used to perform cost of goods (COGS) calculations. Then, we exemplify its use by comparing the COGS of a synthesis before and after process development.

Introduction

Determining the cost of goods[1] (COGS) for an API (Active Pharmaceutical Ingredient) or a synthesis intermediate thereof is of crucial importance to a pharmaceutical company:

(i) COGS can be a determining factor for the viability of a project.

(ii) Within the chemical development department, it is an important tool not only to compare different synthetic routes but also to track the progress of the optimization work.

In this paper, we explain how we use ChemProject, a rather recent software, to perform this task. After a brief historical survey, we also give an example of cost calculation using ChemProject.

Results and Discussion

In the 1980s, cost calculations were performed with an APL-based program[2] used on an IBM terminal (more recently emulated on a PC). Although very powerful in performing the required task, it suffered from several drawbacks associated with ancient platforms: it was not user-friendly, mistakes were sometimes difficult to track and to correct, and there was no possibility to save, print, or export data into a windows environment. An even more serious drawback was a continuity issue for APL support within the company (Figure 1).

In the mid-1990s, we decided to look for a new software package which would meet the following criteria:[3] (i) compatible with our operating system (Windows), (ii) user-friendly, (iii) suitable not only for linear but also for branched syntheses, and (iv) making use of a standard-formatted database (Filemaker Pro, Access, Oracle, etc.).

To our great delight, we found a very promising shareware called ChemProject, at that time running on the Apple Macintosh platform (Figure 2).[4] Although quite basic in functionality, the software already contained many of the features required by us. ChemProject then evolved into a Windows application, which subsequently was completely rewritten and significantly extended in functionality by its author Dr. S. Abrecht[5] towards a fully featured application. When the final version became available after an extensive beta testing phase, we acquired a number of licenses (version 1.2) for our Process Research department. Currently, the software is being further developed for the Microsoft.NET framework, which will result in a new interface and even more extended functionality.

ChemProject organizes a chemical synthesis into separate branches, steps, and unit operations (Figure 3). It allows the calculation of required material amounts and their costs for a given amount of final product, based on the known bill of materials per step. Interactive 2D- and 3D-charts allow the quick location of problematic spots of a synthesis, such as unusually high unit operation volumes (Figure 4) or cost driving materials, thus providing valuable starting points for process optimisation. Simulations of the impact of optimisation scenarios on the synthesis cost and volume can be performed, and different syntheses can be compared by adding their files to a comparison chart (Figure 5). Last but not least, material prices of previously calculated syntheses can be synchronized with updated price lists by clicking a button, thus easily providing up-to-date synthesis costs.

We mention however a couple of shortcomings of the program: we cannot introduce quantities as equivalents; only weights and volumes can be entered. The software cannot process cost reduction associated with recycling of an

* E-mail: mguillau@prdbe.jnj.com.

(1) We should mention that the COGS does not cover completely the actual price of a compound; the financial department has more elaborated tools to take other parameters into account: manwork, plant occupation, energy requirements, difficulties in some steps, etc..

(2) APL is the abbreviation of "A Programming Language".

(3) Several companies also use spreadsheets, which suffer from several drawbacks, namely the difficulty to insert new steps in the middle of the synthesis and the difficulty to handle branched syntheses.

(4) We recently successfully tested the software on an Apple Macintosh system (OS 9.0.4). However, this Macintosh version of ChemProject is no longer supported and might be difficult to find for download.

(5) See www.chembytes.com, containing detailed background information and demo downloads. Accessed in December 2003.

10.1021/op049933w CCC: $27.50 © 2004 American Chemical Society
Published on Web 08/12/2004

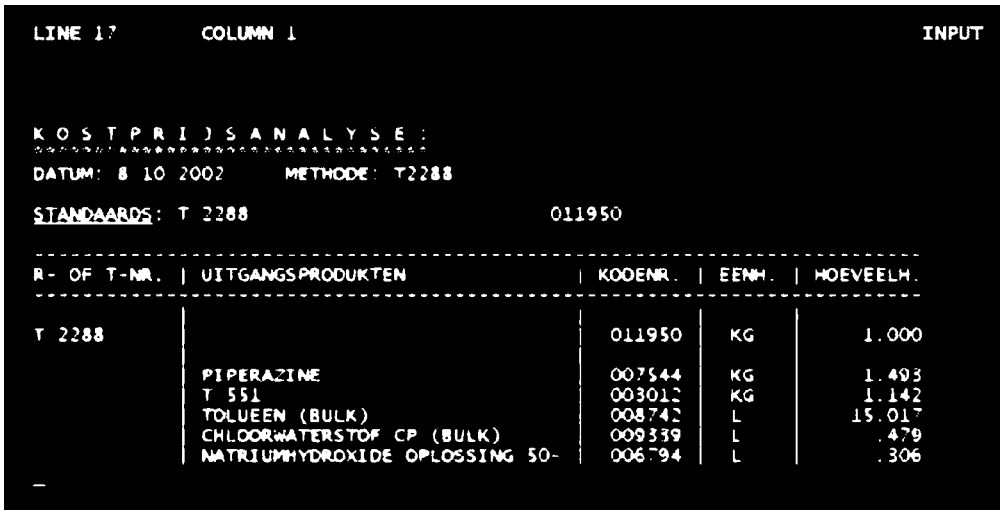


Figure 1. **Screenshot of APL-based software for COGS calculation on IBM terminal.**

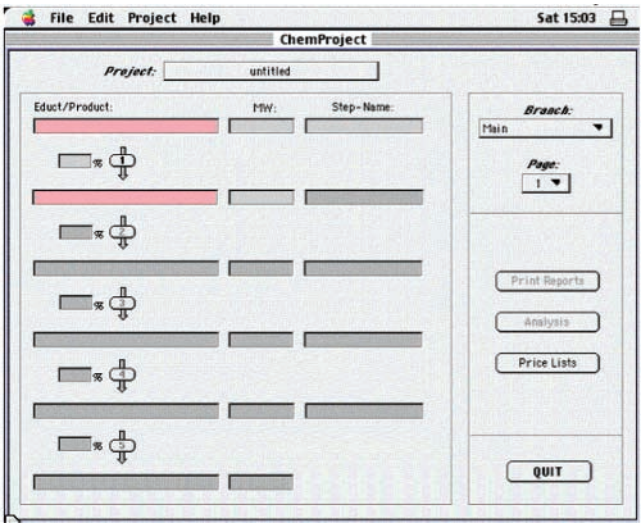


Figure 2. **Screenshot of the first developed ChemProject on Apple Macintosh platform.**

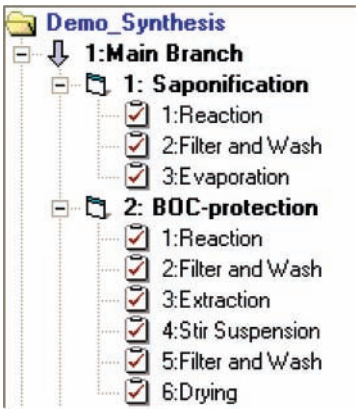


Figure 3. **Synthesis tree.**

intermediate or cost increase due to waste. It is also impossible to export report data to, e.g., a Word document.

ChemProject can manage as much as 25 synthesis branches nested to any level; the linear synthesis we describe here is therefore far under the capabilities of this tool.

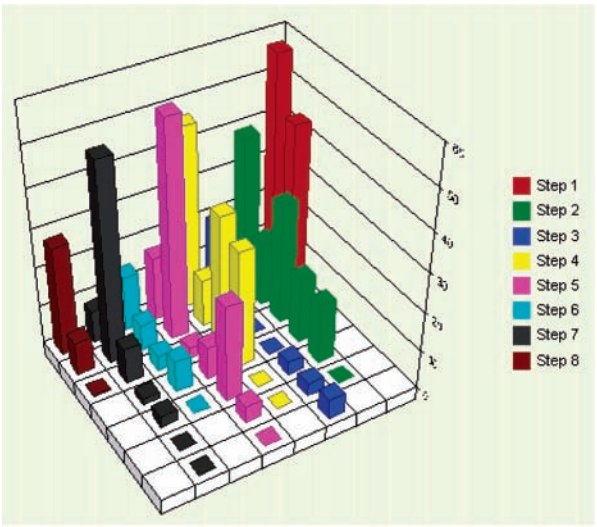


Figure 4. **Operation volume distribution.**

For confidentiality reasons, we are unable to disclose COGS details of elaborated syntheses performed in our company.[6] Rather, we compare the price of a recently published straightforward synthesis[7] by us of **1** (route 2) to the previously existing one (route 1). Although obvious, this case clearly exemplifies the use of ChemProject. Scheme 1 depicts an overview of both syntheses.

When we create a new synthesis, a first dialogue box appears (Figure 6a) in which we indicate the main characteristics of the first step (reagent and product name, MWs, and yield). In the subsequent dialogue box (Figure 6b), the type of unit operation can be chosen. We normally select the first icon ("reaction") to proceed.[9] Now the ChemProject main screen appears (Figure 7), where we introduce all

(6) We have introduced syntheses with three branches, always without problem.
(7) Guillaume, M.; Cuypers, J.; Vervest, I.; De Smaele, D.; Leurs, S. *Org. Process Res. Dev.* **2003**, *7*, 939.
(8) It is interesting to notice that either "virtual" quantities or "real" quantities can be introduced for the calculation. In the former case (cf route 1), one starts always with 1 mol at each step, and solvents are indicated in L/mol; in the latter case (cf route 2), effectively used or obtained quantities are introduced.

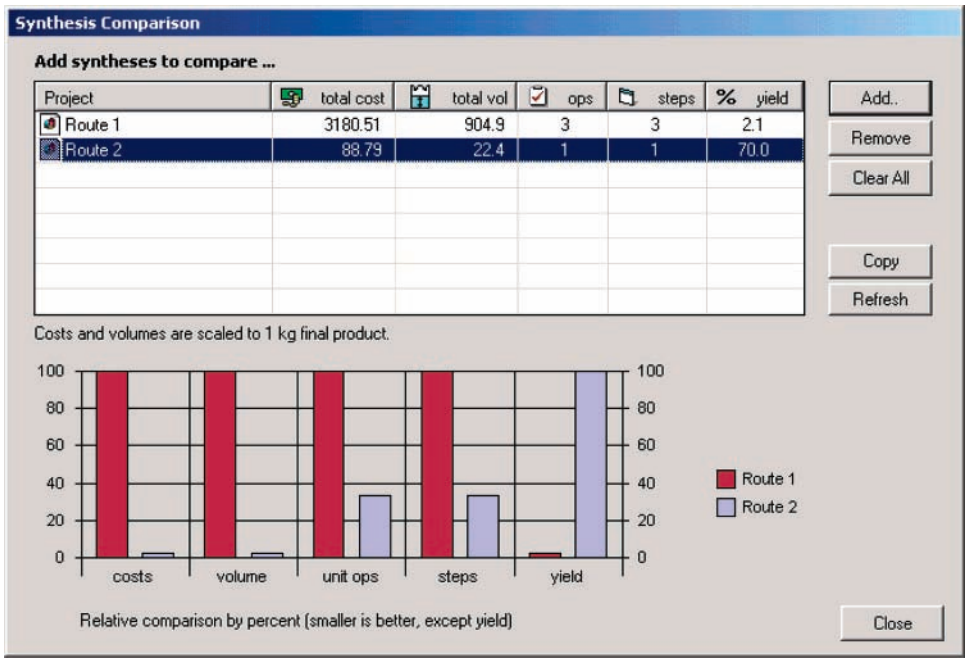
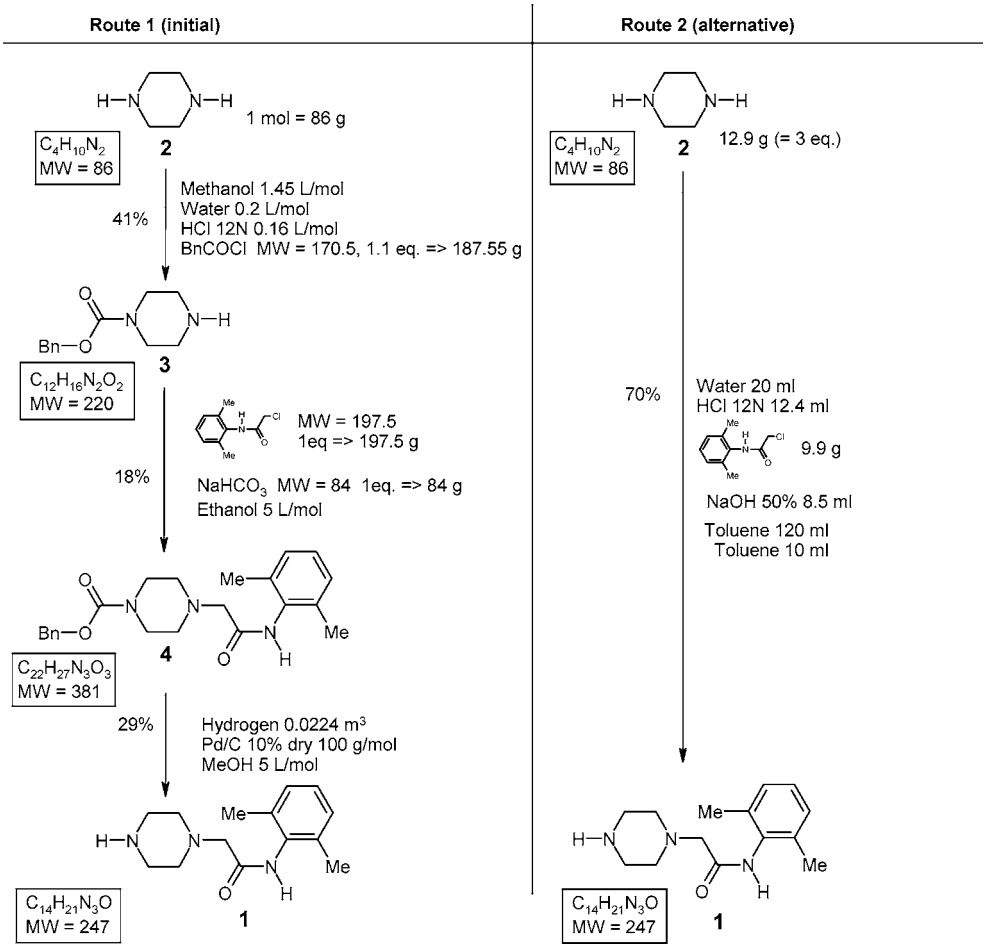


Figure 5. **Synthesis comparison chart.**

Scheme 1. **Overview of the two synthetic routes[8]**



materials required for the unit operation, assisted by a context-sensitive popup menu (Figure 8) connected to our custom product price database (.mdb format[10]). This popup menu allows a very rapid materials entry. If an ingredient is

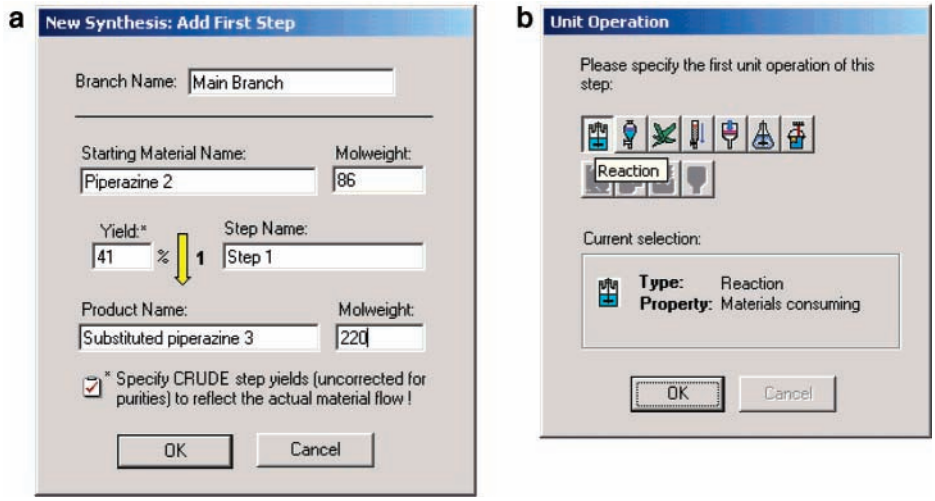


Figure 6. **(a) New synthesis dialogue. (b) Unit operation selection.**

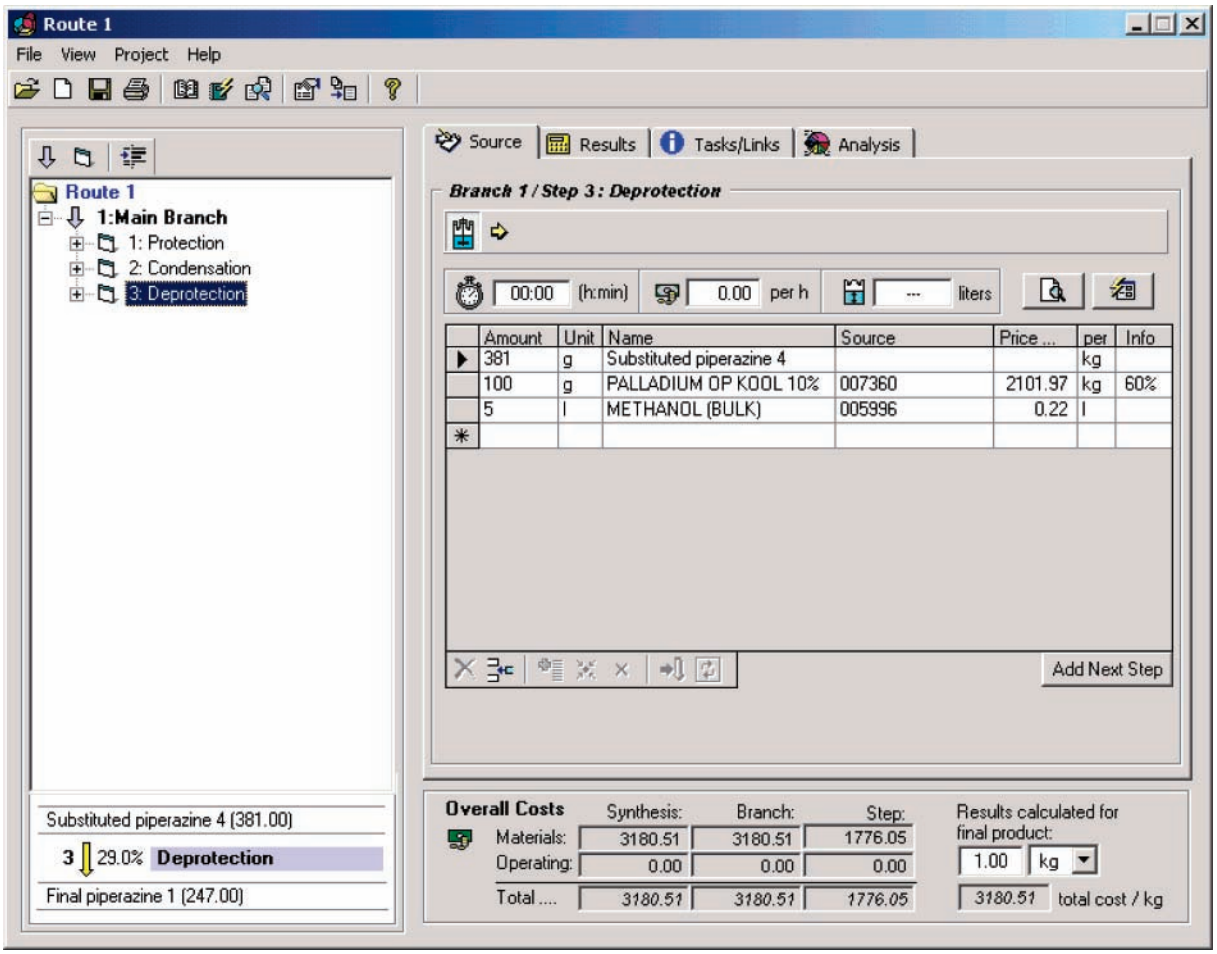


Figure 7. **ChemProject main screen.[11]**

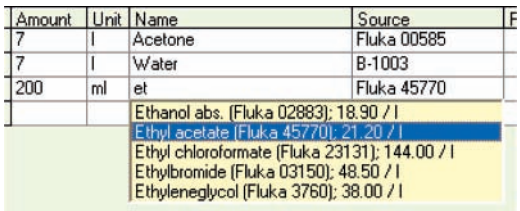


Figure 8. **Context-sensitive material entry.**

not present in the database, we easily introduce it manually. When ingredients of the first step have been added, the button "add next step" is clicked and the same procedure is repeated until the last step.

It does not take more than 30 min to learn the main functions of this software, and when all required data (original step material amounts, MWs, and yield) are at hand, it takes 5−10 min to enter all the data.

Unsurprisingly, the thus calculated difference in COGS in our example is rather impressive: 3180.51 EUR/kg for route 1 as described in the literature vs 88.79 EUR/kg for the optimised route 2! This 40-fold improvement can be

explained by the fact that three steps were originally necessary (2.1% overall yield), whereas one step is sufficient in the synthesis we devised (70% yield).

We conclude that ChemProject[5] can easily and efficiently be used to calculate COGS in a chemical synthesis. We showed its applicability by comparing a recently published process with the formerly described synthesis.

(9) Other unit operations can be chosen as well if separate cost calculations are useful: extraction, crystallization, filtration/washing, chromatography, stirring or cleaning the reactor. For each of these operations, ingredients can be added the same way as for the reaction. Also operating hours can be attributed to each of these unit operations.

(10) This corresponds to a Microsoft Access database format. Our database contains a list of the different products, their code number, price per unit (kg or L), and density.

(11) In the second line, a 60% effective cost of Pd is assumed, due to recovery.

Received for review April 1, 2004.

OP049933W