

GIS and logistics tool for milk transportation in dairy industries.

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Most dairy farmers in Uruguay are members of CONAPROLE (National Cooperative of Dairy Producers of Uruguay), one of the most important private companies in the country.

Fresh milk management is a key issue in dairy industry. Today CONAPROLE has more than 2.700 milk collecting points and more than 10 depots countrywide. More than 10 years ago the people involved in the daily planning of the fleet for collecting milk asked for the aid of a computer system for better planning and reducing costs. Today more than 120 trips are done daily (about 180 in peak season).

The first ideas were oriented to investigate all details of the logistics involved and the main functionalities the application should deliver. This finished in a project developed together with Universidad de la Republica (Montevideo, Uruguay) through its Engineering School (Operations Research Department) (1996 - 1998).

After two years of using the developed tools and new requirements asked by users some research was done in order to decide to buy a new tool or to extend the functionalities of the existing one. New software based in the existing tools was finally developed: GLF-Inforut II, a GIS and logistics tool to help the planning for milk tanks routing to several processing centers. Users can plan, control and evaluate past and future tours.

INFORUT II in CONAPROLE

CONAPROLE created the Fresh Milk Management (GLF) project to assure on time, fresh milk delivery. The technological solution delivers much more than a map; it also calculates dairy farmer payments, offers farmers current information, and provides information about dairy farmers and transport companies to corporate administrators. The GLF project enables data centralization and management in real time, to every user within the company, in a reasonable and suitable format and all pertinent information of the different milk management stages.

GLF is a software suite for dairy industries including specific functionalities not covered by standard ERP applications like SAP R/3 the one used in CONAPROLE. SAP R/3 and GLF are both corporate applications that must work as a unit so both applications are tightly integrated through proper data interfaces in batch and real time.

GLF-Inforut II is a module that involves all activities related to GIS's operations and it is strongly integrated with the corporate applications.

Today, Inforut II is so strongly integrated into the CONAPROLE system that the Uruguayan milk industry cannot operate without using this key GIS technological component, fully developed with ESRI software, ArcInfo 8.1 and MapObjects 2.1.

Routing problem description

The state of the art in tour routing and planning has evolved surprisingly in the last years. Once, these tasks were done by logistics departments. Existing automated tour planning systems were very difficult to generalize and apply to other situations, even being very similar to that for which they had been developed. Afterwards, as computer calculus and memory storage capacity increased, better solutions to routing problems appeared.

Today there are sophisticated tools, with varied applications and functionalities. Anyway, CONAPROLE's problem is too much complex to adapt to a standard tool.

The classic routing problem (Travel Salesman Problem) minimizes the distance visiting customers tied to several restrictions (satisfy all customers requirements, vehicle capacity cannot be exceeded, all routes start and end at the central site, etc). In CONAPROLE's particular case several issues must be added that make a more complex solution. These issues are:

- ▪ Multiple central sites (processing plants).
- ▪ Heterogeneous fleet (different tanks capacity).
- ▪ Time restrictions (specific time windows to collect milk in dairy farms).
- ▪ Dairy farmer's productivity and processing plants changes along the year (depending, for example, weather conditions, season, etc).

All these issues made CONAPROLE to make efforts to develop a specific application that delivers improved capabilities to planners to achieve their tasks.

Application main characteristics

The quality of the software for designing and optimizing routes evolved significantly in scope and functionalities, given the need of the majority of transport companies to reduce costs, both for delivery and collection. The experience in this kind of companies using automated tools reduced freight costs by 10 to 15%. High freight costs have centered the attention of managers and planners to build effective controls and continuous process improvements. Routing and planning systems are of significant help when developing these tasks.

Inforut II is an ambitious initiative, developed by CONAPROLE's software development team, based in ESRI GIS solutions, which main goal is to deliver users the best support possible in tasks involving route creation, control, evaluation and planning for milk collection. Is not the idea the planning to be made by the software, it is to give the planning users as many tools as possible. The key concept in developing Inforut II is to deliver a tool that works satisfactory in real situations and in simulation, enabling to work with fictitious scenarios where some parameters could be changed in the system and observe possible influences in costs, collecting times, etc.

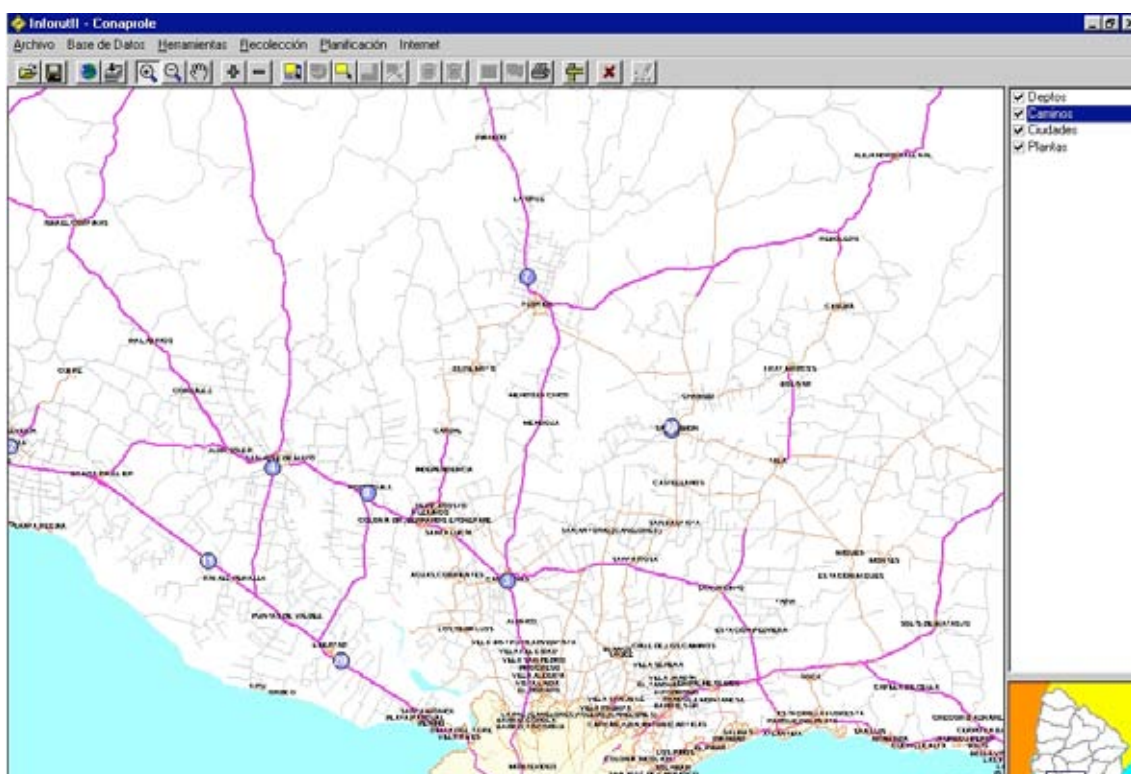
Inforut II integrates friendly window interfaces with ESRI MapObjects 2.1 controls where users can:

- Modify geographic routes and transport costs per kilometer.
- Simulate open and close of processing plants.
- Add new transports companies or join existing transport companies
- Make milk collect planning for a specific day.
- Compare calculated results with real results
- Redesign routes assigned to each tank,
- Create tours passing by processing plants, dairy farms or desired points.
- Make new planning for 24 or 48 hours.

These tasks aid the planning user to improve evolutionarily the costs involved in the collection, based in his know how.

Information layer management

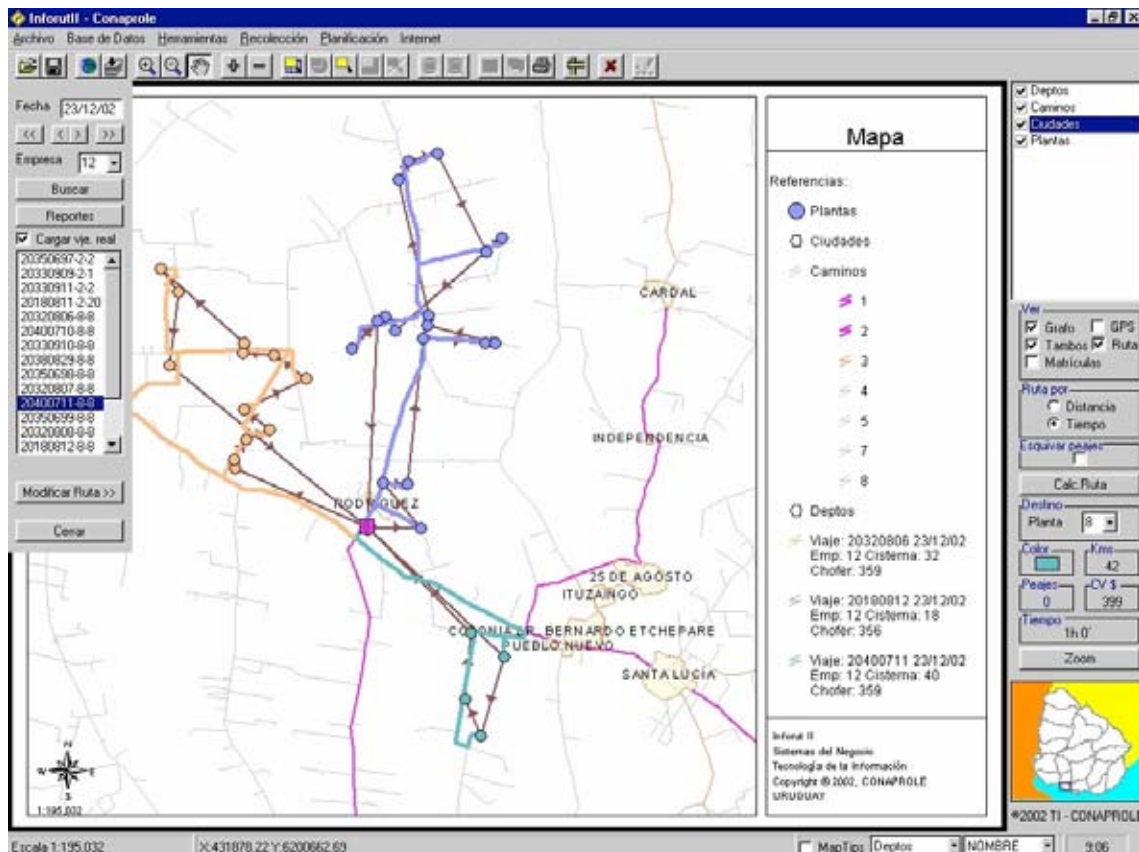
Several information layers can be loaded / unloaded, while showing or hiding as user convenience. Also zoom in / out are available to see maps at the desired detail level. Minimum and maximum scales can be set for a specific layer to enable points appear only when are appreciated by the user.



Route management utilities

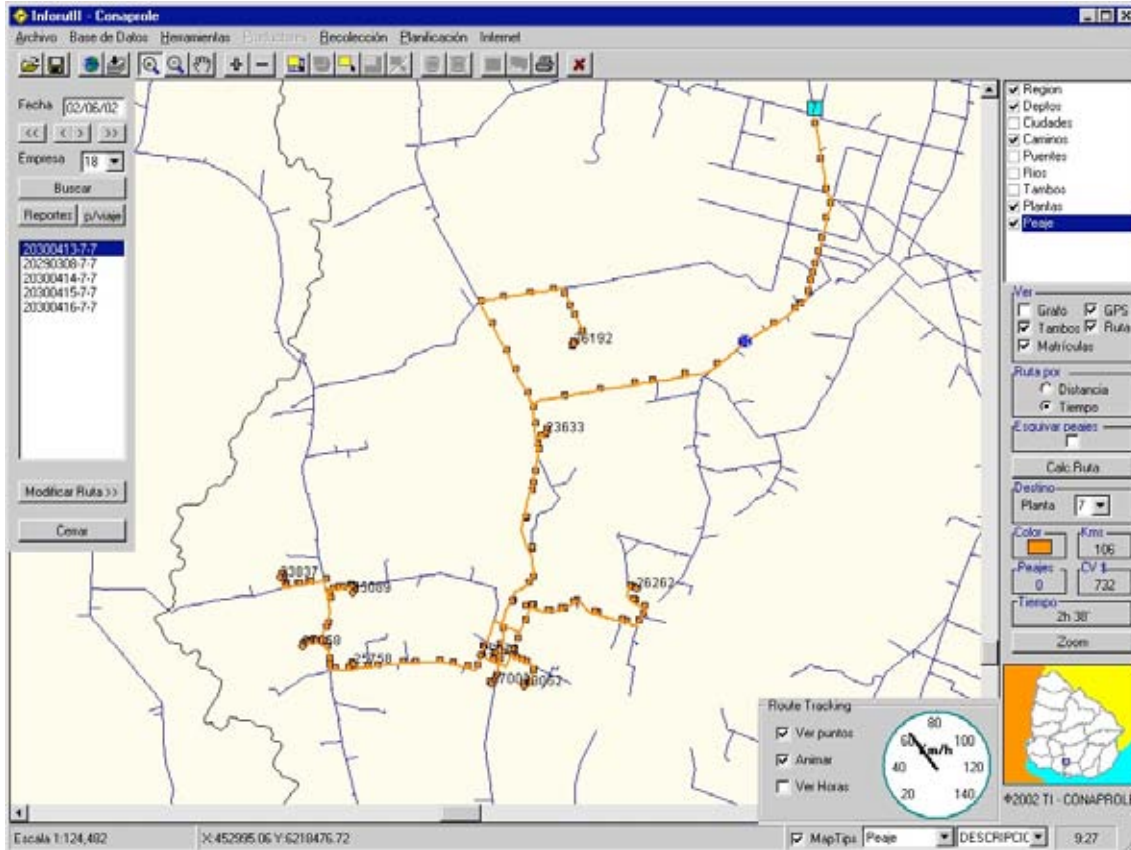
With Inforut II you can create routes and evaluate the associated cost, efficient and easily, just with some minutes of work.

Real routes can be modified to evaluate costs involved in the change. Updates can add or delete dairy farms, geographic points, tolls points for paid routes, change of destiny plant, etc.



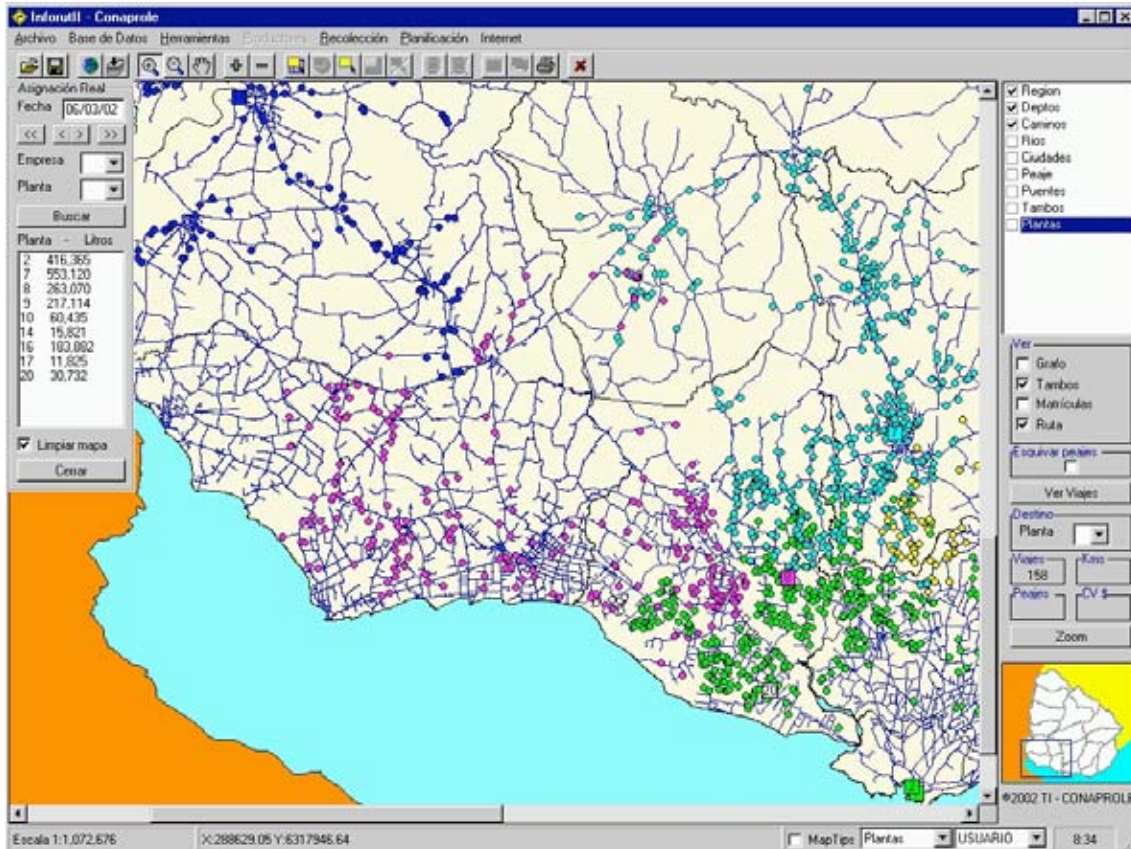
Route creation and display options

Options for Inforut II configuration to manage the planning and display it results: users have the option to display or not the graph, dairy farms, its affiliate number, GPS data and map route. With this can be displayed in the map the order where the dairy farms are inserted, their affiliate number (key identifier) and the route color highlighted in the map. Minimizing by distance or time are most common optimization situations, also asking to evaluate the possibilities of avoiding tolls points in paid routes (search for an alternative route keeping restrictions fulfillment, saving money not passing through tolls points). Another option is to change a tour destiny plant and evaluate how changes cost and collecting time. It is also shown the route color, driven kilometers, number of toll points, route cost and time involved for each route. The GPS data and the trackinglayer objects included in ESRI MapObjects 2.1 allow to check the truck movement, trucks speeds and to detect non-planned stops in the trip.



Bulk and interplant planning algorithm

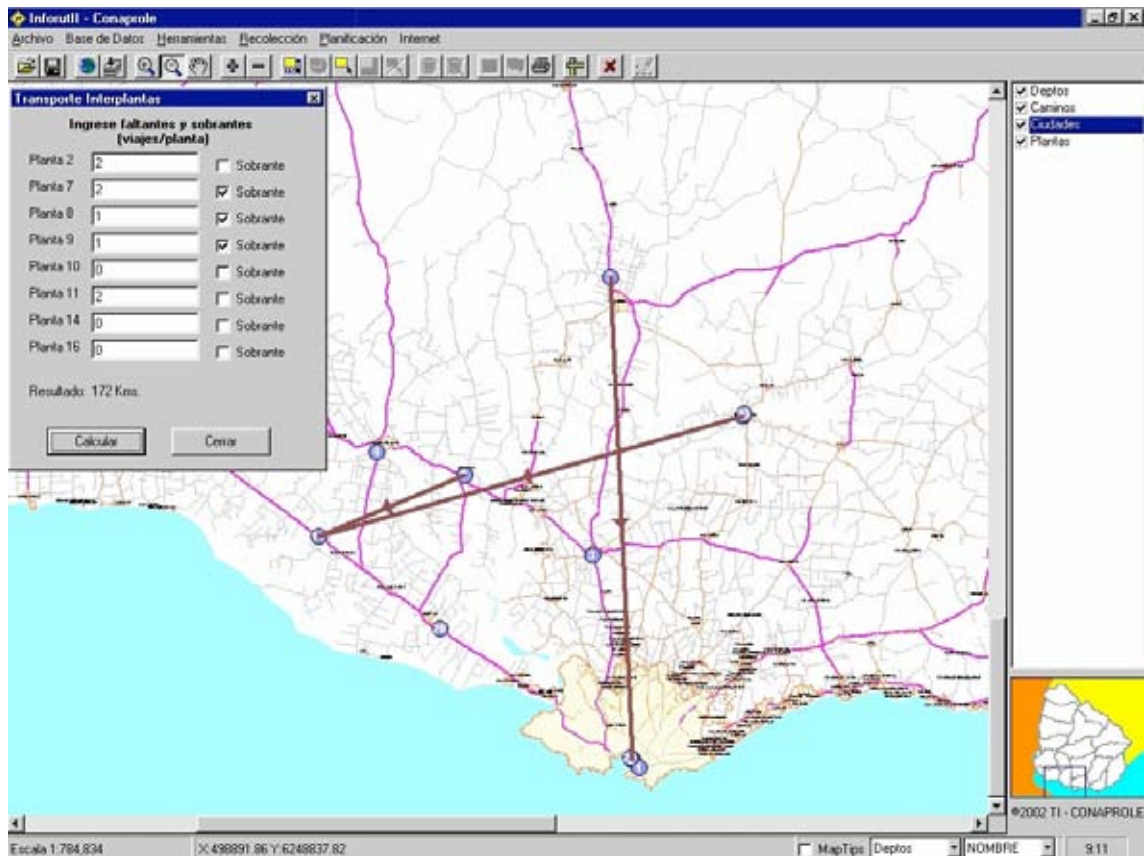
A reassignment of dairy farms to plants can be evaluated. This option does not make routes, just takes previous routes for a specific date and searches a more convenient tour with dairy farm reassignment to plants, lowering costs still satisfying plant demand. Finally it is issued a complete report showing the new assignment and comparing it with the real one. The idea is that this tool could help as experience for the team to improve future assignments. Moreover, in the map could be seen dairy farms assigned to different plants. The same query can be done for the real assignment. As both maps could be printed, could be seen the changes made by Inforut II to get the cost difference. Dairy farms which assignment is notoriously improved are marked. It is shown that Inforut II make these changes in assignment without missing the balance of milk assigned to each plant. From the real assignment, the planned one is deviated a maximum of N liters (parameter N is set by users).



Important savings are achieved just reassigning tours to plants, without changing the internal structure of each tour. Tour structure analysis and improvement is another of the strategic functionalities of Inforut II.

Interplant tour planning.

Interplant tour planning is related to dairy moves between two processing plants. Some plants receive milk in excess and another plant receives less milk than current demand. These excess and scarcity it is solved with milk moves between plants (interplant moves). The application evaluates the most economic way of milk redistribution to satisfy all plants demand. It calculates the most convenient tour between plants in order to minimize the total cost and the assignment graph in the map.



Inforut II has been developed with powerful optimization techniques such heuristics, genetic algorithms and exact procedures that require graphic interfaces and an important GIS component. To integrate GIS it was decided to use ESRI ArcInfo 8.1 and ESRI MapObjects 2.1, a product with a high integration level with visual tools such Visual Basic 6.0, easy programming, clear relations between components, objects, properties and methods. Moreover, it brings a powerful visual tool for working with maps, visualization, categorization, item and spatial selections. It is a perfect tool to monitor milk transport units that each minute send its position to the central data base. Algorithms have been developed in C++ and multiple database connectivity (Oracle, Microsoft SQL Server, etc.) is supported.

As important as the software developed, the digital cartography information is the key to get the best results, for this reason CONAPROLE is working actively since 1999 with the Uruguayan National ClearingHouse Geographic Data (NCGD www.clearinghouse.com.uy). The ClearingHouse is a government initiative and has established a computer network that can be accessed via the Internet offering digital cartography of the entire national territory. The NCGD has also developed a search engine to enable users to find pertinent geographic information with ease.

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