The American Petroleum Institute (API) Research Project 6 has been chosen as a model to study the science organization in petroleum chemistry. The quantitative analysis of scientific publications, references, citations and citation lags elucidates the cooperative nature of Project 6.

Introduction

Formal patterns of scholarly communication have been mainly studied in order to gain better understanding of the structure of scientific disciplines, to compare nations' scientific potentials and to develop evaluation techniques applicable to individual scientists and to the institutions that employ them. In this paper we attempt to complement these uses by embarking on analysis of references with the hope to elucidate a particular episode in the history of science organization. More specifically, analysis of references is to shed light on the sources of printed knowledge used in an ambitious research program on the composition of petroleum which spanned several decades of continuous efforts. After presenting a brief description of the program we shall attempt to show how analysis of references may be a useful means of understanding the program's workings.

History of API project

After years of debate, the American Petroleum Institute (API), a trade association representing America's oil companies, decided in 1926 to sponsor nearly thirty research projects connected with various aspects of the science of petroleum. One of the projects, known as API Research Project 6, was devoted to the study of the composition of petroleum and was conducted at the National Bureau of Standards (NBS) in Washington and, since 1950, till its termination a decade later at the Carnegie Institute of Technology in Pittsburgh. The project was remarkable in many
respects. For one, while it was financially sponsored by the API, i.e. by the entire petroleum industry, its operations took place outside industry and its results were openly published.

The project's organization was of a novel cooperative nature. The cooperation among the oil companies embodied by the API, and the cooperation between the API, on the one hand, and the Federal government and several universities, on the other, affected the goals and the modes of operation of Project 6. Both kinds of cooperation involved contradictions. One basic contradiction could be noticed in the initial formulation of the research program. It had to generate knowledge relevant to the interests of the petroleum industry. At the same time that knowledge had to be fundamental, i.e. not 'too relevant', because the practical application and commercialization of the results had to be left to individual companies. The maintenance of a balance between relevance and fundamentality was a major concern for those involved in the research planning at the API.

The API would not sponsor a program the results of which might be disputed among its constituent members, i.e. among the oil companies. Not only could it disrupt peace in the family but it could also be seen as an infraction of the antitrust laws of which the API was only too aware. In fact, the very existence of the API is partly traceable to the dissolution of the Standard Oil Trust on the eve of the First World War. The API was a post-war formation designed to provide cooperation within the industry in areas not covered by the anti-trust laws, namely in "fundamental research", as it was defined by the API.

Beside the novelty of the organization of the project it is the results of the research that finally matter. In the framework of Project 6 46% of the hydrocarbon compounds of petroleum were isolated, this percentage decreasing from 100% for the lighter fractions to as low as 10% for the heavier ones. This was a substantial improvement over the state of knowledge in the mid-1920s when the project got under way and when only the simplest petroleum hydrocarbons had been separated. The isolation and identification of petroleum hydrocarbons was a stepping stone to the development of new refining techniques based on chemical transformation of oil components.

Starting in the 1930s, new information about the structure and properties of petroleum hydrocarbons opened the way to applications of catalytic organic chemistry to petroleum refining. Introduction of reactions such as alkylation, polymerization, dehydrogenation, increased gasoline yields by an order of magnitude. It also signalled the start of the transformation of the petroleum industry into a chemical one which it is today. The rapid pace of the development of these innovations was mainly due to the increased demand on gasoline during World War Two. The necessary condition for these innovations was the availability of knowledge about