CHEMICAL HERITAGE FOUNDATION

JACQUES-EMILE DUBOIS

Transcript of an Interview
Conducted by

Colin B. Burke

at

Paris, France

on

21 January 2001

(With Subsequent Corrections and Additions)

CHEMICAL HERITAGE FOUNDATION
Oral History Program
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Jacques-Emile Dubois, interview by Colin B. Burke, in Paris, France, on 21 January 2001 (Philadelphia: Chemical Heritage Foundation, Oral History Transcript #0216).

Chemical Heritage Foundation
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Philadelphia, Pennsylvania 19106

JACQUES-EMILE DUBOIS

1920	Born in Lille, France on 20 April
2005	Died in Paris, France on 2 April

Education

1942-1943	École Nationale Supérieure de Chimie de Lille
1944	Bureau of Liberation Committee of the Isère region of France
1947	Ph.D., physical sciences, University of Grenoble
1948-1949	Ramsay Fellow, University College London
1956	Fulbright Smith-Mund Scholar, Columbia University, New York

Professional Experience

1948-1949	Scientific Advisor to the French Cultural Counselor, London, England
	University of the Saarland, Saarbrücken, Germany
1949-1957	Professor of Physical Chemistry and Petrochemistry
1949-1957	Director of Chemistry Institute
1953-1957	Dean of Science Faculty
1957-1958	Guest Professor of Physical Chemistry
	University of Paris, later Paris 7-Denis Diderot
1957-1988	Professor, Chair of Physical Organic Chemistry, later of Chemical Informatics
1961-1975	Board of Directors, Palais de la Decouverte, Paris, France
1962-1963	Scientific Advisor to the French Minister of Education, Paris, France
1963-1965	Joint Director of Higher Education in France
1963-1975	Member Directorate CNRS [Centre National de la Recherche Scientifique]
1965-1968	Board, French Chemical Society, Paris
1965-1977	Director of Research for the Ministry of Defense, Paris, France

1966-1980	Member, International CODATA Committee on Electrochemistry, Thermodynamics and Kinetics
1967-1997	Board of Directors, Institut de Biologie physico-chimique, Paris, France
1969-1977	Chair, IUPAC Interdivisional Committee on Machine Documentation
1972-1989	Vice President, National Centre for Chemical Information [CNIC], Paris, France
1972-1998	Founding President, Association for Research and Development in Chemical Informatics [ARDIC], Paris, France
	French Physical Chemistry Society, Paris, France
1972-1974	Vice-President
1974-1976	President
1977-1980	Co-Director, Curie Foundation, Paris, France
1977-1988	Founding Director, ITODYS [Institut de Topologie et Dynamique des Systèmes]
1978-1981	Director, French National University Agency for Scientific and Technical Documentation and Information [AUDIST], Paris, France
1979-1983	Scientific Director, Cie. Generale d'Electricité, Paris, France
1979-1983	Chief Executive Officer, Novelerg Co.
	CODATA, International Committee on Data for Science and Technology, Paris, France
1980-1988	French National Delegate, Vice-Chair, and Chair, Artificial Intelligence and Graphics Task Group
1980-1988	Vice-President, CODATA/ICSU
1994-1998	President
2000-2005	President, CODATA FRANCE
1993-2005	Vice-President, Center for Scientific Defense Studies, University of la-Vallée, Marne-la-Vallée, France

Honors

1946	Medaille de la Resistance, France
1948	Ancel Prize, French Chemical Society
1950	Stas Medal, Belgian Chemical Society
1953	Le Bel Prize, French Chemical Society
1954	Gold Medal, Society for the Encouragement of National Industry
1962	Commander of the Order of Merit of the Senegal
1962	Commander of the Order of Merit of the Ivory Coast
1965	Jecker Prize and Berthelot Medal, Academy of Sciences
1967	Commander des Palmes Academiques, France
1975	Commander of the German Order of Merit
1975	Grand Prix Technique for DARC System, City of Paris
1977	Commander Ordre National du Merite, France
1982	Bruylants Chair, Louvain University, Belgium
1986	Grand Prix of Graphic Animation du Festival d'Angers, Angers, France
1989	Commander Legion d'Honneur, France
1989	Dr. Honoris Causa, University of Regensburg, Germany
1991	C.A.O.C. [Correlation Analysis in Organic Chemistry] Medal, Paris
1992	Herman Skolnik Award for Chemical Information, American Chemical Society

ABSTRACT

Jacques-Emile Dubois begins the interview with a discussion of his family and early education. He discusses his paternal grandfather's and father's roles in World War I and his family's influence, his father's in particular, on his education. Dubois then details his experiences during World War II. He describes how he studied chemistry and medicine during the German invasion of France and elucidates his active roles in the French Resistance and in post-War French politics. Next, Dubois discusses how he came to be an essential figure in the creation of the University of Saarland. He details the reasons he accepted a professorship at the university and eventually the directorship of the Chemistry Institute. He also discusses his work at the University of Paris, which he did in parallel. Dubois then describes his work in the French Ministry of Education. He describes, in particular, the need for change in the French education system and his efforts to bring it about. He also talks about his role in the Centre National de la Recherche Scientifique [CNRS] and France's underdevelopment of instrument technologies at that time. Next, Dubois discusses his involvement in the creation of the chemical information system, DARC, and his important role in the Ministry of Defense. He describes how his fast kinetics research and his work at the defense ministry gave him an interest in computers and how that interest eventually led to his work in information systems. In addition, Dubois discusses his development of a topocoder instrument and his work on various information systems, including his cooperative efforts with the Chemical Abstracts Service [CAS]. He describes his work as head of IUPAC's [International Union of Pure and Applied Chemistry] Committee on Machine Documentation, the creation of CEDOCAR [Centre de Documentation de l'armement], and his creation of the Bureau of Scientific Information [BIS]. In conclusion, Dubois discusses the successes and failures of various information systems in France.

INTERVIEWER

Colin B. Burke had recently retired from the history department at the University of Maryland at Baltimore County and held a research fellowship at Yale University when he came to CHF. He spent his residency working on his book on the history of computer-based scientific information systems and related government policies, from the 1950s through the early 1990s. He received his Ph.D. from Washington University in St. Louis and currently serves as Associate Professor Emeritus at the University of Maryland. He also served as a Fulbright Scholar in Poland and as a Scholar-in-Residence at the National Security Agency.

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INTRODUCTION

By Bernice Dubois

What can I say? Let me start with the cornerstone. My husband had a deep and enduring love, indeed a passion, for chemistry. It was, to him, the foundation of all things living. "I have only one mistress" he used to joke "chemistry."

Very early on, he was convinced that chemistry not only called for informatics but was uniquely ready for it, thanks to the structure of the Mendeleev Table. As he poetically expressed it in the title of a film: "Since the dawn of history, molecules were awaiting informatics."

Although he will probably best be remembered for his DARC topological system, in the field of chemical information, his research also led to significant breakthroughs in such diverse areas as organic chemistry (beginning with his thesis on regio and stereoselectivity in ketolisation), reaction mechanisms, analytical chemistry, fast kinetics (including patented inventions like the Titravit in 1954, a polarovoltmeter for fast kinetic measurements with platinum electrodes, which Prolabo commercialized for decades), and surface phenomena.

This variety was emblematic of a mind that greatly valued cross-pollination. For instance, due to his keen interest in mathematics and physics, as well as in chemistry, the laboratories he directed, first in the Saarland and later in France, were multidisciplinary, with researchers from very diverse scientific backgrounds coming together. When responsible for defining policies for higher scientific education in France, he chose to create degrees in joint areas, structurally meshing organic and physical chemistry in ways that were new at the time.

He was a systemic and visionary thinker, combining to a rare degree creativity, analytical capability, and a gift for synthesis: he would approach concepts broadly, in a set theory mode, aware of their potential, before delving deeply and with sometimes maddening perfectionism into their component parts, exploring every potential ramification and application, all the while never losing sight of the whole.

At a time when they were not yet popular or recognized as promising, he had the pioneer's uncanny and sometimes stubborn sense for as yet largely untapped fields that would become critical to all in the future, such as informatics or surface phenomena.

In the early sixties, some of the young researchers he had oriented towards surface phenomena worried that they were struggling in the desert, but he remained confident, urging them to stay with it. In the same way, during the early years of his running the research and space programs department for the French Ministry of Defense, he hastened to launch and fund major programs in informatics and in the still burgeoning laser technology field.

A born teacher, he had the gift of rendering complex concepts clear and understandable and of communicating his enthusiasm to all, his synthetic mind excelling at painting the big picture from the start, like a frame. "Simple, no?" "See how simple?" he would rejoice, with a twinkle in his eye. Over the years, many students and researchers testified to this gift.

On a completely different front, colleagues from different walks of life have commented on his remarkable ability as a manager in a variety of situations, for instance:

- directing a large university laboratory, the ITODYS, successfully engaged in pursuing quite different areas of research, with the usual scientific, human, organizational, and financial challenges implied
- balancing that task with modernizing the university system and research areas in France
- then, for some thirteen years, with running and modernizing the research and space programs for Defense in France

While eagerly embracing these responsibilities, and later others in the private sector or in the French health system, he steadfastly refused to give up his lab or his research. These always remained his life's work and true "*raison d'etre*."

How did he manage, you might ask, along with being a highly present husband and father?

One answer is certainly that he loved his work, and as he states in his oral biography, had a voracious appetite for it!

Another clearly lay in his organizational skills and leadership, his systems thinking or architect's mind, if you will, enabling him to successfully pursue many interrelated strands.

He was also helped by an uncanny skill as a negotiator, due to a mix of determination, empathy, and creativity. He had to a rare degree what is called in French "*l'intelligence des hommes et des situations*." That's hard to translate, but basically means understanding and making the most of both the human element and the situation at hand. An ever ready, wonderful sense of humor at critical junctures didn't hurt, lowering the tension for all involved.

*

* *

But beyond the scientific pioneering, the teaching, or the leadership, what he may be most remembered for by those who knew him best was his profound humanity and humanism.

If he was infinitely curious, ever eager to challenge any set ideas or habits of his own, he was equally passionate to transfer whatever knowledge and abilities he might have. And in so doing, he showed endless patience. Whether on a ski slope, swimming, discussing science, art, recipes, or a protégé's education or career, he lived to pass on, to enrich and counsel those he met. Their problems or challenges swiftly became his own. He was the ultimate coach.

While deeply ethical and willing to make critical commitments in trying times, he knew no narrow boundaries or biases: just as, with a completely open mind, he believed one could learn from anyone, so was he ready to work with all and help anyone who wanted to build something worthwhile. For instance, while active in the French Resistance in World War II, he was already truly European in spirit and understood the value of spending the next seven years of his career creating and directing a Franco-German university, drawing on the best aspects of both systems to make it work.

Throughout his life, he was highly interested in other cultures and people, eager to work on projects with colleagues from all over the world (the U.S., the U.K., Russia, the Ivory Coast, Senegal, Israel, China, Japan….to mention only a few). His friendships and interest extended well beyond science. I remember his returning from Japan in the late sixties fascinated by ideograms (with their curious kinship to the DARC concept), by the workmanship and the overall culture. One immediate consequence was a dramatic increase of fish in our family diet, as well as the habit of lunching at a Japanese restaurant every Sunday for many years thereafter! He took a similar interest in other countries, causes, and situations.

A recent essay about him was titled *A Man Without Boundaries*. In a way, that sums up what I am trying to express. There were no boundaries to his imagination, intellectual curiosity, love of science, joyful appetite for life, or to his deep involvement and caring for others. Only death set its boundary, a boundary that, to his very last days, he kept urging us to transcend, willing us not to be sad or regret the past, but to always look to the future.

I wish it were that easy.

Let me close by saying how happy he was to receive, shortly before passing away, *The History and Heritage of Scientific and Technological Information Systems*: *Proceedings of the 2002 Conference*[1], which featured his retrospective article on the DARC system. Even in those last moments, chemistry retained a beloved mistress's hold on his heart and mind.

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1 W. Boyd Rayward and Mary Ellen Bowden, eds, *The History and Heritage of Scientific and Technological Information Systems*: *Proceedings of the 2002 Conference* ASIS&T Monograph Series (Medford, New Jersey: Information Today, Inc., 2004).

INTERVIEWEE: Jacques-Emile Dubois

INTERVIEWER: Colin B. Burke

DATE: 21 January 2001

LOCATION: Paris, France

BURKE: Professor Dubois, would you tell us a little about your early life and the influences that your family and education had on your career and life choices?

DUBOIS: My father came from the north of France, where his family had lived for generations. I myself was born in Lille, where my parents briefly settled after WWI [World War I], my father's hometown having been virtually destroyed during the war. My mother [Emilienne Chevrier], on the other hand, was from the southwest of France. My parents met and married there upon my father's regiment being sent there to get back in shape after having been prisoners of war [POWs] in a German camp for some fifty-four months.

My paternal grandfather was a military man. In those days, officers' wives needed dowries and my grandmother came from a well-to-do family in the cider producing and grocery wholesale business. They also owned real estate in the city and a few farms in a neighboring village. Both he and his wife led busy lives and my father, a bright, highly independent minded only child, grew up somewhat on his own.

When the time came to choose a course of studies, he left his family and went to England, where he spent the next five years trying his hand at various trades, before joining the French Army for World War I. His regiment was captured early on and sent to a POW camp in Germany for the next four-and-a-half years. He returned to France in 1918, fluent in both English and German, a great believer in the importance of foreign languages (at an advanced age, he taught English to a whole village!), and in making one's way independently.

Faced with an all but destroyed city, (in addition to which, all the fruit trees in the countryside had been cut to the ground, thus killing the cider trade), he temporarily moved to Lille and, while rescuing and rebuilding what he could of his parents' property and assets, launched into what would be the first of several business ventures throughout his life: he became a negotiator of German war reparations in the area and as such launched a timber business, selling timber to saw mills. Later ventures drew on his early experiences in England. In the 1930s, the Depression hit the north of France hard, and many of our tenants could no longer afford rent, which led my father to mortgage the properties. He then struggled to meet the various mortgage payments and finally defaulted on them in 1943 and 1944, losing most of the family's inherited assets. Ironically, property prices soared after the war: that one year hiatus was fatal to him!

You asked about influences on life choices. I can speak of three or four distinct influences on me and on my future life and career choices.

Art for one. Saint-Quentin was the birthplace of a famous eighteenth century pastel portrait painter, Maurice Quentin de la Tour, whose tricentennial anniversary was just celebrated throughout France in 2004. He gave his name to a museum in the city and founded a highly regarded art school there. My father, a gifted amateur painter, had attended that school as a child, and encouraged me to attend it as well, despite the demanding schedule: 6 to 8 am every morning, before regular classes began in the Lycee just across the street.

The director of the Lycee would often be standing by the entrance, on the lookout for stragglers from the art school and did not hesitate to discipline us. Art was a fine thing, but no excuse for distraction from school work in his eyes!

The art school's influence on me was profound. Even though I ceased painting as an adult, I retained a keen interest in, and awareness of, design, perspective, architecture, modern art, and all spatial, three-dimensional configurations. I was to find these again with the DARC [Documentation and Automated Retrieval of Correlations] and 3D molecular and drug design. Those years probably deepened in me a passion for abstract design and for the experiential, almost mathematical treatment of space by artists like [Georges] Seurat, who brought art and science together in a unique way.

Another influential pastime, in a completely different way, was water polo. Saint-Quentin had a canal and several nearby lakes in which one could swim and fish. Early on, I became a strong swimmer and competed in swim meets. Since my father kept only a loose rein on my activities, I also joined the local water polo team.

Now, even though it is played at Eton [College] by Prince William [Arthur Phillip Louis Mountbatten-Windsor], the fact is that water polo did not typically attract intellectual student types in Saint-Quentin! It was a tricky sport, which catered to tough youths. Being viewed with suspicion by them at the start, as the intellectual of the team, I had to establish myself as a respected teammate and leader. That gift for survival in tough circumstances stood me in good stead during my Resistance years.

A third influence on my future was languages. My father sent me to England and Germany to perfect my knowledge of those languages and this opened me up to two very different cultures from my own at a young age, at a time when few Frenchmen were fluent in foreign languages. My knowledge of German and familiarity with Germany incidentally played a part in saving my life a few years later in the Resistance, when I was arrested by the Gestapo! It also enabled me to acclimate easily to the Saar [University of the Saarland] from 1949 to 1958. But more importantly, it reinforced a family openness to other cultures. In the same way, I would later be fascinated by the U.S., by Japan, by Russia, et cetera, and cultivate many friendships in countries other than France.

A fourth passion of mine in those early years was history. I was fascinated by the broad fresco of clashing and merging civilizations, by the lessons one could pick up from the different waves, by how each act contained in it the seed for the following eras. Later I would look to history for metaphors, but also try to stay ahead and shape it, if I could, to be a little visionary because the present is by definition always already dying and being supplanted by something new, and it is better to ride that wave than to be its casualty.

What about my studies, you will ask? On the one hand, my father was a tough disciplinarian who expected me to do well, and gave my teachers full latitude to be exacting with me. On the other hand, he did not believe in long drawn out studies, but rather in achieving early independence through entrepreneurship and a mastery of languages.

My professors insisted that I pursue graduate studies, and the rest of the family supported that and brought my father round. But in what field? There were two possible baccalaureates (exams sanctioning the end of secondary schooling) at the time: philosophy and mathematics. I had been influenced by a wonderful math professor, Mr. Bouderlique, who wanted me to continue in science, while my father, in light of my good grades, felt I should study law. The compromise was that I went for both a mathematics and a philosophy degree, thus opening all possible undergraduate doors. That takes us to 1939. War [World War II] was imminent and my being drafted loomed as a real possibility.

In the few months before I assumed I would be drafted, still undecided between my father's wishes that I study the law and my own interest in the sciences, I applied to the national school of chemistry [École Nationale Supérieure de Chimie de Lille] in Lille, thinking it would be temporary anyway. But given the early armistice in June 1940, my 1940 class of soldiers was never drafted. I therefore attended the national school of chemistry for a year, as an engineering student.

By the fall of 1940 however, the Germans occupied the north of France and, not quite knowing what to do with myself, I left Lille for the "free" zone in the south. In those early months as a refugee, I found myself sharing lodgings with two older men, who had a great library of chemistry and medical books, and I put those months to use by studying them on my own. I also took chemistry classes in Lyon. Realizing that there was no swift end to the War or to the occupation in sight and that I would be remaining in "free" France for quite a while, I left Lyon and enrolled in law and chemistry at the University of Grenoble.

I chose Grenoble because two friends of my family were refugees there. Both of them were militantly against the [Henri-Philippe] Pétain regime that had given France to the Germans. Through them, I joined the Resistance from the very day I arrived in Grenoble and was active in it from 1941 to 1945. One of the challenges of the Resistance was the variety of underground movements and the potential friction between them. Beyond typical resistance activities, one of my roles became to act as liaison between the different movements.

November 1943 in Grenoble would come to be called by some the "Saint-Barthelemy of Grenoble," because of the way the Gestapo cracked down on the Resistance there at that time.

They targeted and either gunned down or tortured all the intellectuals and thought leaders heading up various underground "*reseaux*" (networks, as they were called) in an attempt to decapitate the movement and kill all support for it. That came to life in a particularly stark way for me. Professor [Jean] Bistesi, my electrochemistry professor, headed the regional section of Combat, a famous national underground movement, in which I was active. I was working in the lab directly under his on 29 November, when I heard a slight thud above my head. You had to be constantly on the alert for anything unusual in those times, and react swiftly. On instinct, I took off my lab coat and left the building at once, stopping only to warn someone I thought would be in danger on the floor below mine. Five minutes later, the entire building was cordoned off by the Gestapo. The thud I had heard was that of Professor Bistesi's body falling to the ground when they shot him with a silencer. A few days later, they shot down the science faculty dean, Rene Gosse, together with his son.

My Resistance activities forced me to interrupt my studies for a couple of prolonged bouts, but each time I returned to my work. At one point, I was turned in by an informer, arrested, and interrogated by the Gestapo. My apartment was one of our unofficial Resistance hideouts and had luckily just been emptied of a store of weapons the previous day. The Gestapo took me back to it and kept it and me under surveillance for a while, hoping to catch other Resistance members. Luckily, I had identified the spy responsible for my arrest and been able to send out a warning just in time, so that no one suspicious ever came. My cover story was a good one, my knowledge of German probably helped and, tired of finding nothing, the Gestapo and the Italian police finally gave up on me.

Throughout those four years from 1941 to 1945, I had very little money to live on although, midway, in 1943, I got a lucky break. René Freymann, a physics professor who was one of the few infrared spectroscopy experts in Europe, had brought most of his lab equipment with him from the University of Paris to Grenoble. Much of it was intended to bolster defense at the time—for instance, we used the infrared spectroscopy equipment to measure the quality of fuel—and all of it was hidden in Grenoble. In fact, being Jewish, Professor Freymann was often in hiding himself. One day, the newly created national research center [Centre National de la Recherche Scientifique, CNRS] awarded a grant to me.

BURKE: This was Vichy France?

DUBOIS: Yes.

Although I hadn't applied for anything, here is how it came about. Professor Pierre Dupont came from Paris to visit our lab when he was both a professor in Paris and the deputy director of the recently created CNRS. At that time, there were no facilities, heat, or electricity because of the War, and Professor Freymann was in hiding. He asked me to entertain Professor Dupont the whole day of his visit. Towards the end of the day, Professor Dupont asked me what my plans were, and I said, "To present my thesis." He replied, "From everything you told me today, you have a lifetime of activities in mind!" Two months later, to my surprise and delight, I received a retroactive grant from the Centre National de la Recherche Scientifique. I was rich! To celebrate, I purchased all the food I could on the black market that day and ate and ate! [laughter].

BURKE: You were twenty-two or twenty-three years old at that time, correct?

DUBOIS: Yes.

BURKE: And you already held a position of responsibility?

DUBOIS: Yes. In fact, I had just passed my license (B.S.) and was made *preparateur* (preparer) in the lab. Given Professor Freymann's having to be in hiding much of the time, I often had to be more or less in charge of things in the lab. The War made many of us grow into positions of responsibility early.

The following year, I traded the CNRS grant for a full position as assistant professor in general chemistry. That was the only field with an opening available just then, although my Ph.D. research was in both chemistry and physics.

Few people managed to keep up their research work during that period, and I was among the very few to earn a Ph.D. in those War and post-War years. In Grenoble in particular, which was one of the hotbeds of the Resistance, you needed to be well organized and have a lot of patience and perseverance to keep working on your Ph.D. The simplest aspects of everyday life were hard to manage in those times, what with rationed food, et cetera, on top of which some of us were juggling our underground activities and our work. Life was only easy for people making money on the black market!

I ended the War as a member of the underground Liberation Committee for the northern Alps, namely the Dauphiné region, and part of the southern Savoie region, including Annecy. By 1945, when the War was nearly over and the Americans came through the city, I was in charge of some of the area's administration; by then everything was under control and working smoothly. For eight months or so, I was one of the nine members of the Liberation Committee running the Isère region.

That's when I learned to assess people and see them in their true, if not always bright, colors. During the War, one's life was at risk, but we were all working for a common cause and Resistance members seldom betrayed one another. Managing the daily politics of a city was a completely different ball game! After eight months of it, on a part time basis, I decided to leave politics and go back to finishing my Ph.D. full time. I had come into the War pretty mature, but the whole experience was one that accelerated our political awareness at a relatively early age.

BURKE: Yes. The Resistance must have increased your self-confidence. Now, after that, you were awarded your Ph.D. formally in 1947.

DUBOIS: Yes.

BURKE: Did you then go on to London to do research?

DUBOIS: As I mentioned earlier, my professor in Grenoble was René Freymann, a physicist, one of the first in France to work on quantum physics. But his mentor, Professor Edmond Bauer, held the chair of physical chemistry in Paris and had previously been a professor at the Collège de France. As soon as the War ended, Freymann went back to Paris and I remained in Grenoble, traveling to Paris from time to time to do some experimental work.

That's how I got to know Professor Bauer, who became my mentor as well. He was what you'd call a scientific "elder" or "wise man." Professor Bauer believed that French chemistry was not what it should be and he encouraged me to go abroad. He said to me, "You were isolated during the War, but you should now go abroad because—you're worth it!" One did not want to disappoint such people. At that time, 1948, I held an assistant professorship in Grenoble. "You should give that up," he told me. "I've arranged for you to pursue your post-doctoral research at the State University of Liège, in Belgium." After which he secured me the Ramsay Fellowship in England, which is a significant grant awarded every few years.

BURKE: It is quite an honor as well.

DUBOIS: Yes. Professor Bauer thought the professors of chemistry at the Sorbonne [University of Paris] were too conservative, and he advised me to use the Ramsay Fellowship to go work in Christopher K. Ingold's lab at University College in London. I thought it would be very advantageous to learn kinetics there. It was also my first chance to live in one of the world's capitals, with all its' cultural opportunities, museums, intellectual activities, et cetera.

BURKE: You spoke briefly about your appointment as a scientific advisor while you were in London. Did that appointment help you as a science administrator later in your career?

DUBOIS: That's a very good point. I went to see the French cultural attaché in London and apparently made a good impression on him, because he invited me to act unofficially as his scientific advisor during my post-doctorate work at University College in London. That helped me tremendously. Three days a week, I would spend a couple of hours at the French Embassy, in that capacity; I was invited to attend important scientific meetings. Whenever the attaché asked some well-known scientist to the embassy, I would be invited along as the embassy's "in-house" scientist. It helped me greatly in two ways: not only did I get to meet people I would otherwise not have known, but it also provided me with a unique outside perspective on how science worked in France.

BURKE: That was very important for your later career.

DUBOIS: Yes. It's also funny to see how serendipitously careers can get started. While in London, I received five offers for professorships in France. The chemical industry also tried to attract me. I had proposals from two large companies; one French, one foreign. None of that is as surprising as it may sound today, because very few people had completed their Ph.D.'s during the War. Furthermore, not many of us had gone into spectroscopy and I had studied the most advanced spectroscopy.

I had been lucky enough, when in Liege, Belgium, to see and use the first Beckman [Instruments, Inc.] instruments from the United States. I thus went from using an infrared apparatus that was on the blink most of the time to advanced technical apparatus.

On top of that, I was suddenly offered a visiting professorship in the United States. I needed official permission to accept the latter, because I was technically an assistant professor on leave from Grenoble. So I called Pierre Donzelot, the director of higher education in the French Ministry of Education.

He asked me to come see him the very next morning. I did and we got along very well. He had a lot to rebuild and achieve in very difficult times. For instance, he was helping create a new university in Saarbrücken, a border region between France and Germany, to which it could be difficult to attract professors. He asked me to go there. I had the ideal profile due to both my scientific record and my command of German. The situation there was a bit shaky, but he didn't tell me that. Instead, he hinted that my professional life could be difficult if I refused to go, but that he would support me strongly if I agreed! That conversation was the start of a fifteen-year friendship and it afforded me reliable long-term support from someone high up in the system.

BURKE: It was an important job as well, because that new university in the Saarland was intended to be part of a grand plan to create a European community there.

DUBOIS: Yes. That was another reason I accepted the job. I had had friends in Germany before the War and although I had fought in the Resistance and been arrested by the Gestapo during the War, I thought we should work to end the difficulties between France and Germany. That was a big factor in my decision to go.

BURKE: But the situation there was politically delicate, no?

DUBOIS: Yes. But once there, I learned to make compromises and not impose the French system of education on the Germans, to which there would have been a negative reaction. I also created strong bonds with other neighboring German universities. As director of the Chemistry Institute, I created a hybrid system whereby our chemistry students obtained both a German title recognized in Germany and the title of chemical engineer in France. I also brought over Dr. Michael Ashworth, from England, for analytical chemistry, so as to have a trilingual Chemistry Institute: French, English, and German. Another important aspect I promoted, at least in my own lab, was a multidisciplinary approach to research: we had chemists, but also mathematicians and physicians.

We had bright students there, if from modest backgrounds. Wealthy local families tended to send their children to older, well established German universities, whereas many of our students were coalminers' children, which made them all the more motivated and determined to succeed. For instance, I had few research students, but they all got their Ph.D. degrees. So those were very good, constructive years for me.

BURKE: How many years did you spend at the Chemistry Institute?

DUBOIS: Eight years in all. I had originally been asked to stay two years, and after three years I went back to Pierre Donzelot at the ministry and asked to return to France. He asked why, and I replied, "Because those were the terms of our agreement." To which he responded, "We are making you a full professor in the French system. Go back." I was then about thirty-one years old.

At thirty-two, I got married. Everyone must have considered that that transformed me overnight from a young bachelor to a mature professor and therefore made me eligible to become dean of the science faculty, because at age thirty-three, the French and the German professors unanimously elected me dean!

Pierre Donzelot then asked me to stay on at the Chemistry Institute, promising that it would not hurt my career. He said he would make sure I could go wherever I liked in France when I returned.

Those eight years made for a rich and varied experience. We built the Chemistry Institute (literally!) and seeded and shaped the science faculty. As director of the Chemistry Institute and dean of the science faculty, one of my first challenges was to ensure that the sciences as such were properly supported. The then president of the university (*recteur* is the French title) had promoted liberal arts and international law, but I gradually shifted his focus to the development of a strong science faculty. I learned the political ropes of the university senate, powerfully helped in that by the university's secretary general, who taught me how to present, negotiate, and ensure the success of our projects. Another area of responsibility was working with architects to design and oversee the construction of some of the new buildings.

In 1958, when the dream of the Saar as a European entity with a European university faded, most of the French appointees went back to France. I was asked by the Germans to remain as a guest professor for another year, even though I had just been appointed as professor in the University of Paris. I worked both positions, traveling back and forth every week for a year. One of the reasons I accepted was to ensure that each French appointee found a position back home.

Five of the research students who were working with me at the time did very well with my successor and later became full physical chemistry professors in Germany. So that was a real success. I still have a very good relationship with the University of the Saar as with the Universität Regensburg, where one of my finest researchers, Josef Barthel, later became dean.

BURKE: Your wife [Bernice Claire Shaaker Dubois] is an American. How did you meet her?

DUBOIS: She came to visit France with a cousin and her college roommate even though she had studied Spanish rather than French in college. All three of them eventually married foreigners: two Frenchmen and a Dane! We met in Paris, at the Sorbonne. I had gone there to settle a few things and we met. We then corresponded for a long time and were only married two years later. Throughout my career, she has been highly supportive of all my activities.

BURKE: All right. Let me pause for just a moment. When we continue, I would like to discuss your move into administration and how you balanced your administrative duties with your advanced research.

[END OF TAPE, SIDE 1]

BURKE: We've discussed your marriage and the last years of your tenure at the University of the Saar. You began an amazing career in science, research, informatics, and the administration of science and education in France. A few years after moving back to the University of Paris, on top of your academic responsibilities, you were appointed scientific advisor to the Minister of Education Christian Fouchet. How did that happen?

DUBOIS: One of the reasons I was so quickly given that position was that, when I arrived in Paris at the age of thirty-seven, most people saw me as having extensive administrative experience due to my four year deanship in the Saar. Which was true in a sense, because, as we saw, the University of the Saar was not an established university where, as dean, one could step into a routinely run position.

I had also learnt from my Resistance experience. At the end of the War, there was so much enthusiasm in Grenoble to act creatively for the good of the region that we setup a continuing education university for those who had not a chance to pursue their studies during the War. The government, instead of dividing its then limited resources between France's many regions, allocated the lot to our Alpine region and asked us to create and run a pilot for the nation. This involvement in a broad, national scale, innovative project gave me an early taste of that kind of responsibility and may have helped prepare me to handle research problems on a global and national level.

Upon my return from the Saar to Paris, given my experience as dean, I had been asked to visit the French Ministry of Economy, Finance and Industry to discuss the needs of scientific research and an eventual joint financing of scientific entities by both industry and government. I decided to write the report myself rather than try to explain my views to the finance folks and have them represent those. Partly as a result of that report, the minister of education asked me to focus on the area of higher education and scientific research, which covered, in essence, universities and the research council.

BURKE: The CNRS.

DUBOIS: Yes. The first year was difficult because nothing new was being done in the ministry. Old habits were being repeated over and over again and no one in the ministry could see that. However, thanks to my years outside France, I knew that we needed to change. And I succeeded in modifying several things.

BURKE: You were a scientific advisor to the French minister of education in 1962. The following year, you became the deputy director of higher education in France for two years. What were your major policy goals and accomplishments in reshaping higher education, particularly from a scientific perspective, since that was your bailiwick?

DUBOIS: Let me just mention a few areas. One was to reshape the science curricula and strengthen areas in which France was weak at the time. I will come back to that in a minute. Another was to decentralize the university system and create more science and technical university centers in cities currently without those avenues for students. We accomplished that in a number of cities. In the same way, I felt we were headed for a catastrophe in Paris with the trend for a larger and larger university and corresponding campus. Of the gigantic *Halle aux vins* science campus, I remember saying to Fouchet, a few years before the May 1968 student riots: "This could be your Alcazar."

While I was adviser to the minister in 1962, I had realized that Paris was flooded with students and felt that we needed a number of separate universities to manage such numbers, rather than one gigantic University of Paris. At that time, for instance, we had several thousand science professors, where years earlier, we had had only one hundred and ten full science professors in Paris. The scale had exploded and needed to be managed differently. I therefore proposed that we move to a system with different universities within Paris. We had several meetings with different people and although some of them clearly saw the need, it took until May 1968 to make it happen. Today we have about fourteen different universities in Paris.

Regarding the curriculum, I published a couple of articles in the newspapers and in magazines on the reshaping of French education, the difference between the German, French, and English education systems, what should be changed, and how we should alter our curriculum in the universities. It wasn't very difficult because we were in such a rut.

BURKE: Yes, and you put in more science and research. As I understand it, CNRS was created to stimulate more research within the universities.

DUBOIS: CNRS was created right before the War with the generous intention of helping scientists who had escaped from Germany or Central Europe; people who didn't know French very well but were very valuable scientists. That was CNRS's original purpose when created by the Socialist government.

At the end of the War, it was still in the hands of people with the same intentions and policies, but overnight, it was given a far broader mandate to cover different tasks and generally shape research in the country. In the early 1960s, one of our challenges was to define a synergistic relationship between the CNRS and the universities. I was lucky enough to be in the right place at the right time for that constructive change.

BURKE: Wonderful. You were still doing chemistry research at that time, correct?

DUBOIS: Absolutely. Whenever I was asked to take on an administrative or even an industrial position of responsibility, I stood by a strong philosophy of mine, namely that I couldn't be a good administrator and help develop science without being involved directly in scientific research myself.

BURKE: Bravo.

DUBOIS: I believe one must be recognized by one's colleagues if one wants to bring about change. Besides my first passion was always research. Therefore, I always insisted that I be allowed to keep an active professorship and my lab. I would work in the lab every evening and through the weekend with my researchers, while working for the ministry during more conventional hours. I was able to do that because I'm a workaholic! Any paper that was given to me for review by Wednesday was discussed that Saturday.

BURKE: You were also starting to develop scientific instrumentation in France at this time, correct?

DUBOIS: Yes. French science had several weak areas. For instance, very little was known about chemical reaction mechanisms in my field. Having studied that in England, I introduced it into the curriculum upon my return. At the time, I was one of the few people in France to work in that chemistry field.

French instrumentation was also very weak. Physicists developed instruments at the exploratory level, but discontinued their work once their theses were over. There wasn't even exploratory development. Fortunately, there was a very good spectroscopy company called Les Laboratoires Servier that had begun working on spectroscopy before the War. We are still very good at instrument development in that field.

But, overall, France was not good at instrument development. So I founded my lab on two ideas—instrumentation and documentation. I can't remember the exact quote, but I believe that in many English books it says: "The best science is alive," or something like that. So one thing I did was to place our science library in the heart of the lab, fill it with all the English books we had, and it seemed to draw people in.

From the start, I also decided to have mathematicians, physicists, and chemists work on interdisciplinary teams in the lab. At first, I called it the Physical Organic Chemistry Laboratory and I suggested that the ministry create a degree in this discipline, which did not then officially exist in France. Later on, we became the Institute of Topology and Systems Dynamics [ITODYS, Institut de Topologie et Dynamique des Systèmes]. There was a lot of opposition to that name. People would ask, "What does systems dynamics mean?" And I would reply, "It means fast kinetics, for one thing, and relaxation methodology, for another."

I had begun working in fast kinetics in Saarbrücken, but no one in France seemed interested. In fact, when [Manfred] Eigen received the Nobel Prize[2] for fast kinetics, French scientific journals barely knew what it was, because no one in France worked in that field. So I had to write the article in *Le Monde* to explain fast kinetics.

[2] Manfred Eigen shares the 1967 Nobel Prize in Chemistry with Ronald G. W. Norrish and George Porter. The Prize was awarded for their studies of extremely fast chemical reactions, effected by disturbing the equilibrium by means of very short pulses of energy.

With the student uprising in 1968, our institute became part of a new, separate university called Université de Paris 7. We encouraged greater creativity, originality, independent thinking, and interdisciplinary work.

BURKE: You were a diplomat, a recognized scientist, and an experienced administrator, so you knew how to get things done.

DUBOIS: I hope so! In fact, just two years later, my life suddenly changed again when the minister asked me if I would consider becoming director of research and space programs for the French Ministry of Defense.

BURKE: We'll get to that in a second. First, in 1965 you invented perhaps one of the few famous systems for chemical information, named DARC. Why did you invent a new system and why weren't you satisfied with the old systems?

DUBOIS: That's a very good question. For one thing, my fast kinetics research led me to that conclusion. That kinetics research was entirely different from the kinetics research I had done in London with Professor Ingold, which took months. We would draw a new point every two or three weeks. Our subsequent fast kinetics reactions were so fast that we had to film the results and have them developed by the film industry to investigate our work.

Working on our fast kinetics research with the film industry made us ripe for computer technology. At about the same time, computers were becoming critical to our missile work in the defense ministry. I was in charge of all the missile ranges and, when you think of it, the shooting of missiles is essentially a kinetic process.

BURKE: Are you saying you were in charge of all of France's launching sites?

DUBOIS: Yes. When I took the job, for instance, the first thing we had to do was to launch a satellite from the Hammaguir region in the Sahara.

BURKE: Which region?

DUBOIS: The southern part of Algeria, near Morocco.

So, we needed cutting edge computers there. We didn't manufacture those in France, so we imported American ones. We had to deal with a lot of completely new and widely varying aspects, but we launched the first satellite successfully. Everything worked. In fact, it was a miraculous success. [laughter]

BURKE: Allow me to provide some background for the future readers of this interview. You were becoming a major figure in European informatics around that time. Not just with the chemical system, but with documentation as well.

DUBOIS: Thanks. The fact is that I first became interested in computing through my fast kinetics research and through the research work for the defense ministry. In addition, I had begun studying hindered compounds while in the Saar. Those compounds are interesting because they have a lot of steric hindrance, although they are not very useful otherwise. To have a coherent series, I needed ten or twenty of them. I always found it difficult to discuss that with my students, because science back then did not provide a way to map them. Organic chemists were happy to give a name and a structure to the compound, but they were not truly organized.

BURKE: And there were no graphics yet.

DUBOIS: Correct. I wanted to have a graphic type of organization, through which one could create a total or partial order in which the different ketones would have their proper places. I was very impressed by an American paper written by Robert [Burns] Woodward on alpha beta ketones, which I believe was topological (1). I decided to investigate the ketones and the influence of all the substituent sites of ketones in the first row of atoms—alpha atoms—and then the beta atoms.

Having done most of that work in Saarbrücken, I had that knowledge ready by 1958. I didn't have a systematic approach, but I had the facts. The facts showed me, though I hadn't yet realized it fully, that the first and second environments were enough. In the beginning of 1960, I started to work with punch cards to build a small file to see how we could organize that knowledge. I had the feeling that that could be useful as a unit of codification, but I hadn't put everything together yet.

It happened on a Sunday morning in 1964. I remember that I was teaching set theory, which was popular in mathematics at the time, to my children while my wife was doing a crossword puzzle. An hour later, I sat down with the concept of the limited portion of the molecule and all of a sudden realized that I could derive a way to classify a family and impose an order on a large series of compounds. I thought, "Now, I have a way to express the structure in order to build a correlation." I was not even thinking about documentation at that time.

However, very few of my colleagues supported me or even listened when I tried to explain my system to them. Then, looking at it, I thought, "If you can have that order, if you can read a code; if**,** instead of having a general code, you take a canonical pathway"—in essence, determine the starting point—"then you can make a canonical name, build a database, and finally, a retrieval system."

At that point, I thought it might not be successful for correlation because it might apply to most large populations. In general, chemists were content with six or seven compounds for correlation, but I needed at least thirty or forty compounds—or better yet, one or two hundred compounds—because my system was meant to be a tool for large populations. It would take time. Therefore, I wanted to begin in an area that had some chance of success and documentation seemed like a good place to start. Of course, chemists opposed the idea initially, saying, "That won't be useful. It's too intellectual. We are used to normal nomenclature, names, and keywords; we won't use that mathematical language."

BURKE: You felt that you would develop a system that was better in computer abstracts. Why? What would it provide?

DUBOIS: First of all, I thought we had to give up the concept of systematic nomenclature and work at the computer level only. I knew we could always restore the chemical names after we obtained the queries and answers in mathematical or topological terms.

BURKE: You felt that would be much more flexible, help researchers more, and you could use it on a computer better than, say, a CAS [Chemical Abstracts Service] kind of approach?

DUBOIS: Yes, it would be more flexible. The trouble was figuring out how to do it because I didn't have a large enough file; nobody did. At least ten or twenty thousand compounds were needed. The only organizations that had done the work were the CAS and the Basel group of pharmaceutical industries in Switzerland**.**

So, I had to find the right people and convince them to let me use those files so that I could work with them. At first, I was given only the search file and I developed the search file product, though I had to transcode their physical or classical language into topology. We basically created software to translate their classical language into our own. We also built an instrument from scratch for that purpose, a topocodeur.

BURKE: An automatic coding machine.

DUBOIS: Yes, an automatic machine with electronics and a display. We built the machine, patented it, and encoded about fifty or sixty thousand compounds. It worked very well. In fact, we did better with it than many people who were doing it manually or painstakingly on a screen.

BURKE: Could we have a copy of the article describing that machine (2)?

DUBOIS: No problem. I will give you the description. Of course, the topocodeur in time became obsolete, when the process was turned into software that was used on a PC [personal computer].

With that first success under our belt, we told chemists, “All you need to do is present your query in classical, chemical formula language and the topocoding will take place automatically. The answer will be displayed in your usual chemical language.” Unfortunately, there were no PCs in those days and they needed a screen. All we could find on the market was a Tectronix. We used that as an output machine for the chemists’ queries, but it was too expensive. Hence, when we wanted to make the DARC system broadly available to the public, we had to provide a code in which the chemists could write, because the machinery and graphics did not exist.

BURKE: Did you approach Chemical Abstracts Service and did they cooperate with you?

DUBOIS: Yes and no. I knew that France didn’t have an abstracting tradition. In fact, the abstracting power in the chemical world was divided between Germany and the United States, and the CAS had a slight edge in our area. So I thought it better to write a program to transcode from them, so that we could improve on what they were doing. They would still be recognized as the providers of the basic material, and we would provide an added value. That was the spirit.

I began negotiating with the CAS, and found an advocate in the president of the IUPAC [International Union of Pure and Applied Chemistry]. IUPAC decided to create what they called a Committee on Machine Documentation. Although we were very good at nomenclature, they realized that machine documentation would be important. The committee was interdisciplinary. For instance, they took one representative from Chemical Abstracts, one from *Angewandte Chemie*, the German equivalent of the CAS, a Dutch specialist and a Swiss one; later on, we added a Japanese representative. One problem they had was determining who would chair the committee that was thus to prepare the future for IUPAC.

The president of IUPAC was a Frenchman, Professor Jacques Bénard. Initially, I had had trouble getting my papers on coding accepted by the French Chemical Society because they said this really wasn’t chemistry. But when I spoke to Professor Bénard about it, he agreed to help get my papers accepted and I in turn agreed to chair his committee.

BURKE: You lasted eight years in that position, from 1969 to 1977. Was the committee also concerned with what we traditionally call documentation, namely indexing, abstracting, and retrieval information?

DUBOIS: Yes.

BURKE: So it was a very forward-looking organization.

DUBOIS: Yes.

BURKE: Would you say IUPAC is essentially the international union of national chemical organizations?

DUBOIS: Yes.

BURKE: While you were the head of research and space programs for the French defense ministry, you launched more traditional documentation projects in France. What were they, and how well did they succeed?

DUBOIS: I consulted my supervisor, who was a general and the right hand man of the defense minister. I said, "France is very weak in documentation and a small country cannot be weak everywhere. We must be strong on information. Look at the Swiss; look at the Dutch." He was not very excited about the idea, but he asked, "How much money would you like to invest in that project?" I gave a figure and he looked at me and said, "It's all yours, up to that figure." We never discussed it again. So I knew that I had freedom within my budget and decided to create a few entities**,** which became essential later on.

First of all, I created a unit for scientific watch called BIS [Bureau of Scientific Information] inside the DRME [Direction des Rescherches et Moyens d'Essais], or research for defense department. This was clearly of interest to the military as well as to scientists. I appointed Henri Viellard, who had started out with me on the DARC system, as that unit's (*division* in French) director. The unit maintained an active watch on the state of the art in different fields and how we positioned ourselves with respect to others' efforts. We were in NATO's [North Atlantic Treaty Organization] research unit, and I was an active director on the board of directors of the research unit. So we had good connections.

BURKE: Did you have an actual physical center? Did you collect documents and create your own abstracts and indexes?

DUBOIS: Yes. We had to be light and fast. And, matrix like, it worked in parallel with the rest of my organization. For instance, when someone wanted an updated statement on lasers, I would ask the man in charge of optics as well as other users and experts. The matrix relationships told us if anyone was lagging.

BURKE: Did you have specialists within the CEDOCAR [Centre de Documentation de l'Armement], creating bibliographies for people on request?

DUBOIS: Yes. They also worked within my department of research for defense and space programs, the DRME. Responsibility for the documentation center was one of our activities. With that in mind, I tried to influence them to work more with repertory files and to provide information to our watch system.

[END OF TAPE, SIDE 2]

BURKE: Please elaborate on your work within the CEDOCAR.

DUBOIS: The unit I mentioned, the BIS, did cutting edge work, but relied on information from the CEDOCAR. At that time, the CEDOCAR was a very traditional center, but we modified it over the years and introduced computer retrieval. We had some three hundred people and gradually introduced more mathematical data handling, keyword systems, and repertory file systems.

BURKE: Did you share methods with other people in NATO?

DUBOIS: Yes. We also had a large center in which people could work on their own research, and where we taught some of these topics to those who were interested. It was a very clever setup, which accommodated three different populations: civil engineers, defense engineers, and academic scientists. Each group could ask questions and there was no overlap of confidential/non-confidential things, you know? We designed it to be very practical for all concerned parties.

Now, at the same time, Boris Vodar, a French physicist working on UV [ultraviolet] spectroscopy, came to see me and told me that in the 1960s, the International Council of

Scientific Unions [ICSU] had created a group called CODATA [Committee on Data for Science and Technology]. He asked, "Why not have France become a member?" That meant paying national dues annually. I went to the CNRS but they were not interested, and neither was the Ministry of Education. Therefore, since I had a certain amount of budgetary freedom, I decided to back CODATA. I asked them to create, not simply a French committee for CODATA, but a non-profit French organization that was legally independent, and that was done.

BURKE: What were CODATA's major goals? What did they want to accomplish?

DUBOIS: Initially, CODATA focused on chemical thermodynamics before broadening its activity to many other scientific fields and publicizing its activities to motivate others. It extended to physics, chemistry, technical and bioscience fields, et cetera.

BURKE: Was one of the goals to provide standardized data?

DUBOIS: One of the goals was to validate and ensure the quality of data.

BURKE: Especially measurement standards information, much as the NIST [National Institute of Standards and Technology] does in the United States.

DUBOIS: Yes, except that the work in CODATA is performed by various academic or industrial teams in different countries rather than by official bodies. The fundamental physical constants are a major part of their activities. We don't have our own labs or equipment. It's complex, but it works.

BURKE: Did you work with many people who called themselves documentalists while you were working on documentation in that period? Or did you work with librarians much? What was the relationship?

DUBOIS: I naturally worked with the CAS first, and then decided to create our own applied databases on spectroscopy, NMR [nuclear magnetic resonance], or mass spectroscopy, for example, with my topocodeur. That was possible. But I needed to learn from the experiences of those who developed the keyword system. Therefore, I went to them and encouraged them to make progress as well. My interest was broad enough that I thought I would encourage the creation of more information and documentation through the successive four-year national plans in France. Unfortunately, there was a lot of indecision as to whether money should be allocated for that or invested in computers rather than in information.

It was very difficult to teach people the difference between information and informatics. I tried to explain that information is not merely computer science, but there was little interest in documentation or libraries in this country. People thought of those as very static fields and so there was no real increase in their financing. But as there was a need for more universities, more libraries were created almost automatically. That was a part of the educational system and also a part of cities' cultural development and was therefore not questioned.

Cities have local lending libraries. Therefore, the corpus of documentation people in a country is very large. It's a huge national society. I discovered that those who run libraries are very dedicated people, but not trained to create information systems. They had a different attitude.

BURKE: In America, there was a similar split between traditional librarians and those new people who called themselves documentalists; and later, information scientists. It's very hard to get them together.

DUBOIS: I found the same thing here. Since I was highly involved in national planning and well connected with the Ministry of Education, I therefore thought we could teach this and have, not top scientists, but scientifically minded people trained for documentation and information. I suggested creating two master's programs in the university curriculum: one on chemical and biological informatics and the other on scientific and technical information systems.

BURKE: Did that work?

DUBOIS: Fortunately, due to the position I was in, it was difficult for others to oppose my suggestion. [laughter] Still, my colleagues had no great enthusiasm for these topics, and they occasionally challenged the validity of having science departments award those degrees. They were also poorly accepted by the informatics departments because they were not considered sufficiently mathematical. Mathematicians ran those departments.

BURKE: They were hardware oriented.

DUBOIS: Yes, those courses were mainly hardware oriented. Also, the mathematicians didn't want the physicists encroaching on informatics, which they considered to be their territory. So there was a rift between pure mathematicians, who said they were about theoretical informatics, and all the others, who were considered "impure" informatics people and not yet information specialists. For many years, CODATA had to bridge the gaps between all those people and provide a framework in which they all could talk about information, the nature and definition of data, and its evolution.

BURKE: You were trying to build international science, correct?

DUBOIS: Yes, with an interdisciplinary focus. Take astronomers and the problems they encounter handling data, for instance. In astronomy, there are those who look through telescopes and those who handle data. Hence, there are many different jobs in any one field, and you can go through the different disciplines and have people with common interests who want and need to discuss their information-handling problems. That became one important activity of CODATA.

I also tried to convince the Ministry of Education to shape information science differently. As the DARC became more successful and economical, I was afraid people might think that my fight for information systems was in favor of my own system. Therefore, I tried to separate things, but it was not easy. I convinced the minister to create a national agency or several bodies in the government to study information. Unfortunately, most of the agencies created were run by people who weren't trained as information technicians. They came from different backgrounds and mishandled many things.

Over time, I convinced the minister to create the Agence Universitaire Nationale pour la Documentation et l'Information Scientifique et Technique. This way, we would draw an obvious distinction between the work of the national library [La Bibliothèque nationale de France], which is to preserve our written heritage, and the operation of a network that supplied information to the universities.

BURKE: So you wanted to create an information system in the more modern sense rather than just a computer network between all the universities.

DUBOIS: Yes. I thought it was better to have a university that was strong enough to have a good display center, rather than grumble that we didn't have enough money in the university. That is easy with the internet today.

BURKE: You helped create AUDIST [University Agency of Scientific and Technical Information], correct?

DUBOIS: Yes, and became its founding director for the next two plus years. Actually, I was in industry at that time. I was the scientific director of the CGE [Compagnie Générale d'Electricité], of which Alcatel [Compagnie Financière Alcatel] was a part, while still running my lab in the university of course. After a year and a half, there was a change of government and a different decision was made, that went both forwards and backwards in a way. They created a new department in the ministry, identifying documentation, but not as information, and combining museums and information. That turned out to be a bad solution.

BURKE: At one point, you mentioned that you created a center in Paris into which you brought scientific documentation people and librarians in equal numbers, hoping to make the library system more advanced and serve both scientific and cultural interests. Did that work out?

DUBOIS: Yes, for a while. I won't go into the details, but I brought about thirty librarians into the AUDIST. Most of the advisors were academics, still working with me now, who were very active in computing and information science. That worked, so we built a specialized library dedicated to the information field. Unfortunately, when the government changed a year later, they stopped the whole thing and even transferred the rights of the network to the national library, which couldn't care less about it. They were even quite destructive, in that they took this beautiful, small information library and stuck it in some ministry cellar somewhere. They didn't even try to transfer it somewhere else.

At that time, we had one team there working on graphics, as well as on a planned extension of the Minitel. I wanted an agency that worked, not on the electronics, but on the applications we had to decipher and transfer, which might eventually lead to the writing of information.

BURKE: Around 1980 you did something very unique. You transferred an interactive file from Paris, through Livermore, California, to Japan and worked interactively at that distance on bibliographic information.

DUBOIS: Yes. You're referring to the DARC, which was then being run collaboratively with the telephone company. We had the principles, and an agreement was reached between the CAS, the French government, and industry to convince people. A new organization, the CNIC [Centre National de l'Information Chimique], combined those three groups in France. As a by-product, we received the right to the CAS structure file, which was an internal instrument that helped CAS prepare their nomenclature and their product. It was not an online system, but when we combined their structure file with the DARC topology, we transformed it into what we called the EURECAS [European DARC version of CAS registry file]. We then linked the EURECAS to the CAS and made it an online product.

The EURECAS was primarily intended for documentation purposes, but in parallel, we built databases with the topocodeur, through which one could query with structures and receive an answer in the form of the physical spectra—either mass spectra, infrared spectra, or NMR spectra. It was interesting in that anyone could put his or her question in front of a display and get an answer on the display. One of our main challenges initially was to make our system work over long distances, and we used CODATA to ensure that it would. With help from our good friends in Livermore, we sent those images and data through CODATA to the [Seventh International] CODATA Conference in 1980, in Kyoto, Japan.

We then asked the conference participants in Kyoto to put a question in chemical formula terms and request the answer from Paris. That was the first time that text, structures, and images were transferred over such long distances.

BURKE: That was very advanced stuff for the time.

DUBOIS: Yes, it was very advanced stuff. One exciting aspect was that we transferred information across the world in both directions. We used the French telephone company and other telephone companies to transfer information in both directions from Paris to Kyoto and Kyoto to Paris. It worked beautifully.

BURKE: The DARC had received many international plaudits, though not many places have made it a commercial product. You received the prestigious Herman Skolnik Award for it in 1992 from the Division of Chemical Information of the ACS [American Chemical Society], among other things. On the other hand, your attempts within France to create advanced centers seemed not to get very far.

DUBOIS: Correct.

BURKE: Did you create an economic, general-intelligence documentation division when you were with the defense ministry?

DUBOIS: No. In fact, that field is even worse off now. The French have never been very good at creating databases from scratch. It only worked for the Minitel, for instance, which was a kind of forerunner of the internet and a major success. Among other applications, it replaced the need for telephone directories, enabled one to obtain information about hotels, industries, municipalities, to make airline and train reservations, and so forth. At one point, we built a very good database for construction materials that worked for a while, but it was not very clear whether it should be assisted by online advisors, or whether it should be a direct service user-computer service.

The linen industry also created a beautiful vocabulary. They used key words so that users could describe things very well, using only four sentences. It was a beautiful system, but unfortunately it was not a great success either. In general, those products weren't successful because they didn't make money. In fact, we had to spend money constantly to develop them.

It takes a long time to make those products successful and one must keep investing all the time. It is similar to Microsoft's [Corporation] products, in that it needs to be updated every year. In fact, we would perform nearly the same tasks for this information system as the people at Microsoft perform for their products, but since there was no charge for it, the government needs to fund it, the way they fund museums. That was the only valid reason for government officials to put museums in the same package: museums don't make money either.

BURKE: Was there any connection between scientific information and Minitel?

DUBOIS: No. An ongoing problem is that people in France tend to work in silos. For instance, we have high-level technological schools attended by most of the people studying telecommunications, but when they come out, they tend to be focused on information transfer, not on acting on the nature of the information. Today telecommunications is being privatized and this may change. Since the government had funded the Minitel's development, long before PCs, actually giving each household a free Minitel to ensure usage, it wanted a return on its investment; which is why Minitel's databases are geared primarily towards purchasing plane and train tickets, theater and opera tickets, ordering food for delivery, and so forth. There is even a "pink" Minitel for dating**.**

BURKE: Would I be correct in summarizing that you achieved some great things in information, but were frustrated in trying to create better scientific information systems?

DUBOIS: Yes and no. It's hard to tell. First of all, I am never depressed. [laughter] I'm very enthusiastic. When we built the beautiful EURECAS system, the researchers asked me, "What next? Will we be recognized? Will anyone make money?" They looked depressed. And I said, "We've known from the beginning that we don't own the abstracts work because it's done by the Chemical Abstracts people. So we have to compromise with them and see whether they will pay us for the added value or make us an offer to buy the EURECAS through an association." That made them more depressed!

I was never depressed for two reasons: I worked on our documentation problems enthusiastically and I knew that my work was important. The first time I named my system, I called it DARC. The private reason was because it's an acronym of our immediate family names, Dubois, Alain, Rhoda, and Claire; but the scientific meaning of the acronym is Documentation and Automated Retrieval of Correlations. My main goal was to develop a correlation tool.

I knew that it would take a long time to convince people to use the new correlation methods. This way, we could at least demonstrate the success of the documentation system and show that we could retrieve over five or ten million compounds in one minute. Unfortunately, proven success may not convince people sufficiently that correlation should be done with the DARC and that's where I feel frustrated, because the power of the DARC hasn't been used to its full extent, even in documentation. Topology is such a fantastic tool and this is only the beginning. Since our first demonstration and the first file that worked so very well, very little real progress followed.

Although people are satisfied with the current system, there is much more that could have been done in that field. Sometimes I wonder if I should have more strongly advocated integrating layers of DARC into what the CAS was doing, because they could have achieved so much more. It would have been a good compromise, and they could have gone into correlation more easily, which they didn't.

BURKE: You mentioned that one of the difficulties you faced was that France didn't create its own indexing and abstracting associations and companies. Has France made any progress in that area?

DUBOIS: No. The one thing France did was that the patent office**,** the INPI [Institut National de la Propriété Industrielle], put and still puts all pharmaceutical patents in DARC. And that's a good thing because users are not asking for retrieval in patents: they are protecting both their work to date and their foreseeable work. It means applying intelligence to foresee and cover a number of potentialities, even if you haven't reached those yet.

You get a patent, but those asking questions sometimes must be made aware that there are hundreds of solutions covered by the title. That is a special aspect of DARC, called Markush DARC, which handles that by providing a certain amount of fuzziness that allows one to cover much more than has been completed. The patent office in France uses it for a million compounds. That is not necessarily an impressive number, because with one million patents, you can, in fact, predict a hundred million compounds. Predicting matters to come can be huge nowadays.

BURKE: Is there anything I haven't covered yet that you would like to discuss in this history?

DUBOIS: I have only gone into select aspects, based mostly on the information sector of my work. When I got the idea on that Sunday morning, way back when, I said to someone the next day, "This is an idea that will keep growing. It will probably be the only big thing remembered of my work in fifty years." But there are many other very important aspects of my work. [laughter] In fact, over the years, I probably spent too much time on CODATA and other areas of my work and didn't develop the DARC to its fullest potential.

This interview has been great in that it made me go back and review all my research and I realize that we did a lot of work, mainly on correlation, and failed to publish it, which is prompting me to start thinking again. What I'm doing now, aside from this work, is a critique of correlation work prior to the DARC to show that standard correlation methodology is far too limited.

BURKE: Also, as you pointed out to me several times, the indexing and abstracting databases are not flexible enough, even today.

DUBOIS: You're right, they're not. I know it's very difficult for a large organization like the CAS to be very flexible, because they must retain momentum of millions of information items, and change seems dangerous. But I think, with today's computing, drastic overarching changes are possible and desirable.

Over the years, for instance, steroid chemistry was handled with the Cahn-Ingold-Prelog rules. But in my eyes, those rules were only valid up to a point. Should one retain imperfect rules? In the past, it seemed impossible to radically change accepted rules, but today, and even more so in the future, everything will change. In your daily life, you will realize that you're not acting in the same way and that you are making big changes.

BURKE: You're one of the very few people I've met in the information field who has retained an ongoing and cutting-edge interest in science itself.

DUBOIS: Yes, to me science is alive. Chemistry is alive, not dead, not frozen. It should be seen holistically and in relation to life and to society. It can be productive of much good, but we must view it creatively and with a global vision. That's how I want to keep viewing it and working on it.

[END OF TAPE, SIDE 3]

[END OF INTERVIEW]

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