

**An Appreciation of the Life and Career of
Professor Robert Frank Borkenstein
(1912-2002)**

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This booklet was prepared to commemorate the 20th anniversary of the death of Professor Robert Frank Borkenstein (10th August 2002) as an appreciation of his many contributions to the field of traffic safety, especially his invention of the Breathalyzer® instrument for use in law enforcement and a driving force in creation of the International Council on Alcohol, Drugs and Traffic Safety (ICADTS).

An Appreciation of the Life and Career of Professor Robert Frank Borkenstein (1912–2002)

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Professor Robert Frank Borckenstein
The Man

Professor Robert F. Borkenstein

An Appreciation of His Life and Work*

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2.1 Introduction

In a 1985 paper, Professor Robert F. Borkenstein wrote about a former colleague:

It is interesting just how much influence one person can have on a field. Just as Widmark was a 'one man army' in Sweden, a young American physician, Dr. Herman Heise, became a similar one man army in North America. (Borkenstein 1985)

No words could better have summarized Bob Borkenstein's influence on his chosen field of endeavor than his own words, as used to describe Dr. Heise.

* This chapter is an updated version of a review article previously published in *Forensic Science Review*: Lucas DM: Professor Robert F. Borkenstein—An appreciation of his life and work; *Forensic Sci Rev* 12(1/2):1; 2000.

In 1999, Dr. Herbert M. Simpson, former president and CEO of the Traffic Injury Research Foundation in Ottawa and a longtime colleague of Professor Borkenstein, described his friend thus (Simpson, Personal Communication, 1999):

When most people in traffic safety hear the name Bob Borkenstein, they immediately think of the Breathalyzer. Some also recall his landmark study from Grand Rapids, Michigan in the 1960s, which provided real-world evidence of the risk of collision associated with different BACs (blood alcohol concentrations). This remarkably influential study continues to be widely cited today. A few others may think of Bob in the context of the International Council on Alcohol, Drugs and Traffic Safety, the organization he co-founded almost 70 years ago, which has fostered research cooperation and information sharing around the world. Those of us who know him personally think well beyond those impressive achievements. As someone who has known Bob for many years, I immediately think of two prominent attributes. The first of these is his genuine dedication and intellectual commitment to the field of alcohol, drugs and traffic safety. He has never been content to rest on his accomplishments, always looking for new issues and insights. The second attribute that impressed me is the scope of his thinking. He has never been content to think about the problem in traditional ways; he is always open to new perspectives.

“Genuine dedication,” “intellectual commitment,” and “innovative thinker” were perceptive summaries of Robert F. Borkenstein’s professional persona, but there was much more to him than that. His friend and collaborator for over 50 years, the late Professor Kurt Dubowski, an international scientific celebrity in his own right, had this to say about his colleague:

... a superb career-long teacher and mentor to thousands of students at all levels, a talented and highly successful (rare!) inventor, an inveterate world traveller (to all five continents, I believe), a world class researcher (whose major opus, the Grand Rapids Study, is still being cited, debated, and repeated after more than 35 years), an innovator and a highly effective, devoted, and generous leader and official of many professional organizations (two of which he reorganized repeatedly—the Committee on Alcohol and Other Drugs of the National Safety Council, and the International Council on Alcohol, Drugs and Traffic Safety—very probably keeping them alive and productive through his stewardship and contributions). (Dubowski, Personal Communication, 1999)

These summaries by two such distinguished researchers form an appropriate preface to this appreciation of the life and work of another. While essential biographical details will be included below, most of this review will consist of an appreciation of the significant accomplishments of a remarkable individual who actually became a legend in his own time. If Bob Borkenstein was not truly a genius, he was certainly the closest to it that most of us will ever have the privilege to meet.

2.2 Biographical Information

Robert Borkenstein was a prime example of the sort of person who achieved greatness from relatively humble beginnings. Born in Fort Wayne, Indiana, on August 31, 1912, Bob’s grandparents were German speaking and, although he spoke both German and English by the time he entered grade school in Fort Wayne, he was actually more comfortable

in German. (Some of his papers in later life were published in German.) Bob finished high school just at the onset of the Great Depression and, as a result, was unable to go on to college.

He had, however, developed a great interest and considerable skill in the rapidly advancing field of photography and therefore, in the early 1930s, he worked as a photographic technician in Fort Wayne. This involved leaving home early in the morning, picking up film to be developed from a variety of locations and businesses, returning to the studio/laboratory to develop the photos and then delivering the finished product to the clients later that day. The resultant long days nourished the incredible work ethic which persisted throughout his career. The income from this work was essential to the family since, during the Depression, funds were scarce. Darlena Lindsay, who Bob hired in 1991 as his office manager and later became his course coordinator, remembered him describing how as a child he would go to buy coal by the wheelbarrow load to heat the home since that was all the family could afford at any one time (Lindsay, Personal Communication, 1999).

Borkenstein's father, although lacking in much formal education, had the same inventive mind that Bob demonstrated. He became a successful building contractor who built several well-known buildings in Fort Wayne and served on the City Council (Faville, Personal Communication, 1999). As Bob was growing up, he and his father worked together on many projects. During his high school days, Bob and some of his friends built a robot which, although crude by today's standards, was remarkable for its time—and actually worked (Lindsay, Personal Communication, 1999).

During his career as a photographic technician, Robert experimented with color film (before Kodak marketed it extensively) and developed considerable expertise that served him well in his later work (Dubowski, Personal Communication, 1999). Indeed, according to an article in the Indianapolis Star in 1940 (Anonymous 1940), in collaboration with a colleague, he “developed a simplified color printing process which eliminates the black printing plate, which has a tendency to dull color brilliance.” This process eliminated several steps in the engraving of color printing plates resulting in quicker production and higher fidelity. During this time, Bob also built two color cameras using an optical system similar to the Technicolor camera, demonstrating the creative and technical skills that were to mark him as a special individual throughout his entire career.

From 1936 to 1958, he served the people of Indiana in the Indiana State Police (ISP) laboratory, about which more will be described below.

In 1942/1943, Bob also used his color photographic skills to develop the Rex Optical Comparator for the inspection of precision parts using color discrimination. This was produced for him by Rex Laboratories in Indianapolis, the same company that he later used to produce the early models of the Breathalyzer. In a 1997 letter to Lord Bramall at the American Air Museum in Britain (Havard, Personal Communication, 1999), Bob described a wartime application of this device (he had received an invitation from the Queen to attend a ceremony at the US Air Force Cemetery in Cambridge where she was unveiling a memorial):

I was approached by a firm which was producing bomb latches intended to hold bombs in the bays until they were released when the aircraft had reached their targets. There were numerous failures because of the lack of the necessary precision. They were spot-inspecting the stampings for quality. This was slow and difficult because of the 50× magnification required

and the effects of even the slightest vibration. I introduced color (both actual and afterimage) into a novel system that showed more at 10× magnification than the traditional comparator showed at 50×. Moreover, it was rapid enough that every piece could be inspected. So I feel I had a small role in the success of these missions. (Borkenstein 1997)

The comparator was patented in Bob's name and the patent "was donated to the cause" (Borkenstein 1997).

Although never hampered in his efforts by his lack of advanced academic qualifications, Bob's continuing thirst for knowledge drove him to gradually accumulate science and foreign language credits at the Indiana University Extension Center in Indianapolis. He finally received his AB degree in 1958, the year he retired from the ISP and joined the faculty at IU as chairman of the department of Police Administration. It is remarkable, and a tribute to his outstanding abilities and character, that Bob became chairman of a department in a large university while only recently having obtained a Bachelor's degree from that very university. Furthermore, he was a pioneering director of a major forensic science laboratory for 20 years and invented a very widely used breath testing instrument, without any formal academic background in science. These remarkable achievements were capped with the award of an Honorary Doctor of Science degree by Wittenberg University in 1963 and, the one of which he was most proud, an Honorary LL.D. from IU in 1987. The latter is something virtually unheard of for a member of the IU faculty itself (Dubowski, Personal Communication, 1999).

During his long career, Robert Borkenstein was an active contributor to many professional associations including: the Indiana University Society for Advanced Study, Indiana University Transportation Research Center, American Academy of Forensic Sciences, Harvard Associates in Police Science, International Association of Chiefs of Police, Academy of Criminal Justice Sciences, Alliance for Traffic Safety, American Public Health Association, National Safety Council, as well as the two in which his leadership was most pronounced, the International Council on Alcohol, Drugs and Traffic Safety and the Committee on Alcohol and Other Drugs of the National Safety Council which he joined in 1939.

Professor Borkenstein published approximately 50 papers, in both English and German, in various international journals. Most, but not all, dealt with some aspect of alcohol and traffic safety.

Shortly after moving from Fort Wayne to Indianapolis and the ISP laboratory in 1938, Bob married Marjorie, his best friend and strongest supporter for 60 years. In October 1997, Bob suffered a massive and debilitating stroke, which put an end to his brilliant active career. He never returned to his office and received home care for the rest of his life. Marjorie died in December 1998 followed by Bob at the age of 89 on August 10, 2002.

2.3 The Laboratory Director

Bob's photographic skills, combined with his fundamental analytical and creative ability, prompted some friends who were members of the ISP in 1935 to seek his advice and assistance with their investigations. He spent many evenings and weekends helping his friends in the investigation of traffic accidents and other incidents but, at that time, had no intention of entering police work on a full-time basis.

As a result of this experience, however, in 1936 when the ISP decided to establish the Indiana State Police criminological laboratory in the basement of the State Capitol building, Borkenstein was a natural to be looked to for advice during the developmental stages. This was one of the first forensic laboratories in the United States. Sharon Faville, who was Bob's lab and teaching assistant at IU for 16 years and lived with Bob and Marjorie for 8 of those years, recalled him saying that, after the laboratory was actually in operation in Indianapolis, he was literally drafted to become a member of the staff, initially as a civilian clerk because he did not meet the minimum height requirements for a trooper (Faville, Personal Communication, 1999). His importance to the ISP became such that eventually the height requirements were waived and he became successively a corporal, sergeant, lieutenant, and eventually captain (Conley, Personal Communication, 1999).

Bob did not have any intention of making law enforcement his career and planned to return to his first love, photography, as soon as the laboratory was running smoothly. As is so often the case with young people's ideas, the plan to move on to other endeavors never reached fruition. He quickly recognized the great potential of the forensic sciences which needed to be exploited, so he stayed on until retirement as captain in charge of Laboratory Services in 1958 (Kraemer 1996). During his career in the lab, in addition to his innovations in breath testing for alcohol (which will be described below), Bob was a leader in advancing the use of photography, particularly color photography, in law enforcement. He designed and built small labs for photo and fingerprint development in many of the ISP posts. More remarkably, he actually designed and had built 300 4×5 cameras (at a cost of \$35.00 each) to equip these facilities (Borkenstein 1943). Bob Conley, a retired commander of the ISP Laboratory Division, described these as the "Rex 4×5 s" (Conley, Personal Communication, 1999), a further indication of Bob's confidence in the Rex Company.

During his career in the ISP, he also worked with John Larson on the development of the polygraph and, in 1957, published a paper with Larson on "The Clinical Team Approach to Lie Detection" (Borkenstein and Larson 1957). Bob also made significant contributions to the evaluation and improvement of the first major electronic speed measurement device in traffic law enforcement (Anonymous 1983).

2.4 The Inventor

2.4.1 Early Work on Breath Tests for Alcohol

The observation that small amounts of alcohol are excreted in breath was reported by Anstie as early as 1874 (Anstie 1874). Cushny subsequently reported, based on his work with cats, that:

The exhalation of volatile substances (including alcohol) from the lungs is exactly analogous to their evaporation from solutions in water, and the pulmonary cells seem to be purely passive in the process. (Cushny 1910)

His observation that these substances obeyed Henry's Law established that the concentration of alcohol in blood could be predicted from the concentration in the alveolar air. Another important milestone in the history of breath alcohol analysis appeared in a 1927

paper by Bogen. He collected expired breath in a football bladder and made an analysis for alcohol by passing two liters of this breath through a solution of potassium dichromate in sulfuric acid. Bogen reported that:

...as soon as the disturbing factor of alcoholic liquor still in the mouth is removed, which occurs usually within fifteen minutes after imbibition, in the absence of hiccupping or belching, the alcoholic content of 2 liters of expired air is a little greater than that of 1 cc. of urine." Further, "... the alcoholic content of these excretions (urine and breath) may also be determined for the purpose of evaluating the degree of alcoholic intoxication." (Bogen 1927)

Shortly thereafter followed the most substantive work of the early years of breath testing, a major publication by Liljestrand and Linde in 1930 (Liljestrand and Linde 1930) showing that the time courses in the body of breath alcohol concentration (BrAC) and blood alcohol concentration (BAC) were similar and that 1 cc of blood contained as much alcohol as is contained in 2 liters of air at 31°C. Over many years of research, a consensus was reached that, for law enforcement purposes, a blood/breath ratio of 2100/1 was gradually accepted to be most practical. For a detailed review of the history of the development of breath and blood testing for alcohol, the reader is referred to a publication by Wayne Jones (Jones 1996).

Although much of the basic research on alcohol and its measurement had occurred in Europe, little further happened there with respect to the development of breath testing after Liljestrand and Linde's work. The construction of compact and practical breath alcohol instruments suitable for use by the police was not considered feasible at that time, therefore it was left to researchers in the United States to pursue further developments. The idea of developing a practical instrument for breath alcohol analysis came in 1931 from Professor Rolla N. Harger at the Medical School in Indiana University. Research on chemical tests for intoxication had begun to gather momentum during the late 1930s as a result of the work of Heise and others that demonstrated that excessive drinking was a major cause of road-traffic accidents. The end of prohibition in the United States in 1933 had undoubtedly contributed to this (Borkenstein 1985). Breath alcohol testing became a major focus of interest, in part because of the practical problems associated with sampling blood for law enforcement purposes not the least of which was its inherent intrusive nature. Other problems included the difficulty in locating physicians or other medical personnel willing to draw the blood, often in the middle of the night; the need to transport the subject to that location; the requirements for the preservation of the sample and maintaining the chain of continuity until the analysis could be performed; the necessity of having a qualified laboratory perform the analysis and, of major importance, the delay in the results of the analysis being available to the investigator. A device that would permit a properly trained police officer to obtain reliable results using a sample of breath overcame many of these difficulties and thus was very attractive.

The first practical instrument intended for use by the police for breath alcohol analysis was the Drunkometer developed by Prof. Harger (Harger et al. 1938). It was quickly followed, in 1941, by the Intoximeter (Jetter et al. 1941) and the Alcometer (Greenberg and Keaton 1941).

The Drunkometer used a sample of mixed expired breath collected in a balloon. This breath was passed through a dilute solution of potassium permanganate in sulfuric

acid until the color was removed, which required a fixed quantity of ethyl alcohol, 0.169 mg. The approximate volume of breath required to reach this end point was determined by direct water displacement which provided a preliminary rapid semi-quantitative screening test. For quantitative results, the volume of breath required to decolorize the permanganate was passed through a tube of Ascarite to remove the CO₂. This tube was then weighed in a laboratory and the amount of CO₂ determined. The weight of the alcohol accompanying 190 mg of CO₂ in the breath was considered to be “very nearly equal to the weight of the alcohol in 1 cc. of the subject’s blood” (Harger et al. 1938).

In 1937, while searching for practical input into the development and application of his new invention, it was natural for Prof. Harger to request the assistance of the ISP lab to field-test his prototype Drunkometer. This was Bob Borkenstein’s introduction to breath testing and the beginning of a long professional association of two great minds. Together, in 1937/1938, they established a 44-hour lecture and laboratory course for the training of Drunkometer operators. Because the operation of the Drunkometer was quite subjective, carelessness could not be tolerated so they also set up a statewide system of field supervision and retraining (Borkenstein 1976). While perhaps not directly related, it is also not surprising that the first law in the United States defining driving under the influence of alcohol in terms of blood alcohol concentration was passed in 1939 in Indiana (Borkenstein 1976).

2.4.2 Development of the Breathalyzer

As described above, the Drunkometer, while deserving of great credit as a “first,” was somewhat complicated and, not surprisingly, the reliability of it and the other first generation breath test devices was frequently challenged. Borkenstein recognized the validity of some of these challenges and, based on this background, developed the Breathalyzer, the first of the “second generation” of breath testing instruments. This device represented a significant improvement over the earlier ones and incorporated several unique features. It was compact, robust, simple to operate and, of greatest importance, produced reliable results. It was destined to change the approach of law enforcement to drinking-and-driving problems nationwide. This technological innovation enabled traffic enforcement authorities to determine and quantify BACs with sufficient accuracy to meet the demands of courtroom evidence and with an immediacy that dramatically increased the ability of the police to respond quickly to potentially dangerous traffic situations.

In an interview with a writer for the IU Alumni magazine in 1988, Bob recalled that:

The Breathalyzer came out of all this because I became so very discouraged with the whole problem. An invention is not just an idea; it’s an idea to fill a need or an anticipated need. Here was a tool that was needed. It was my interest in photography that led to the Breathalyzer. In color photography work, I had developed a number of instruments for measuring light and had developed a densitometer to make the methods more exact. I drew on these same basic principles to create an instrument that would be extremely stable and objective in measuring body alcohol. The Breathalyzer is so amazingly simple—two photo cells, two filters, a device for collecting a breath sample, about six wires. That’s about all that’s in it. I left out every nut, bolt, screw and wire that was not important. The strength of the Breathalyzer is its innate stability. It requires less skill on the part of the operator, and its life expectancy is unlimited. There’s nothing to wear out. The Breathalyzer is so simple and direct that it will be hard to kill. (Schuckel 1988)



Figure 2.1 Professor Borkenstein holding the original prototype Breathalyzer instrument. (Photo taken in the early 1990s.)

Although it has long since been replaced by more modern instruments, the fact that the Breathalyzer was still in use in some jurisdictions 50 years or more after its invention confirmed Bob's prediction of its persistence (Figure 2.1).

Borkenstein had been thinking about the device for a long time, but it took only about two weeks, his annual ISP vacation in February 1954, to build a working model in the small, partial dirt-floor basement of 618 E. Third Street, his Indianapolis home. The "homemade" prototype Breathalyzer was contained in a wooden case with a sample chamber made from a 100-mL glass syringe with a cut-off portion of the plunger as the piston. Bob's longtime friend Bill Picton, formerly with the RCMP laboratory in Edmonton, Alberta, recalled visiting this "workshop" and being amazed at the almost primitive nature of the facility in which such an important invention had been conceived and developed:

Bob Borkenstein showed that it was the forensic scientist and not the facilities that count. (Picton, Personal Communication, 1999)

The first public demonstration of the Breathalyzer was in October 1954 at the National Safety Congress in Chicago. This was described by George Larsen Jr. in *Traffic Digest and Review*:

A new and significantly improved and simplified method of using breath to determine the degree of alcoholic influence was demonstrated last month before the Committee on Tests for Intoxication of the National Safety Council at the National Safety Congress in Chicago. Both the method and a lightweight compact device for using the method were developed by Lt. Robert F. Borkenstein, chief technician of the Indiana State Police and director of the ISP crime laboratory. Tests run by Lieutenant Borkenstein under varying conditions, many of which were observed by this writer, have given highly uniform results. In addition, other experts in the field such as Dr. R.N. Harger of the Indiana University School of Medicine and Dr. Ward Smith of the University of Toronto have run large numbers of tests with excellent results, according to reports they made to the Committee. (Larsen 1954)

Six prototype units were built based on the original model (a stainless steel cylinder with two holes at the appropriate level in the side replaced the glass syringe). These were field tested by various workers in the United States and Canada including Dr. Kurt Dubowski (at that time the first State Criminalist of the State of Iowa), Lloyd Shupe (of the Columbus, Ohio PD Laboratory), and Dr. Ward Smith (at the University of Toronto). After incorporating and testing their suggestions, 100 commercial instruments were built. These quickly found their way into practical police and courtroom use in many parts of the United States and Canada. The first commercially built instrument went to Grand Rapids, Michigan, and the second and third to the Province of Ontario (Borkenstein 1976).

2.4.3 The Design

Despite this considerable activity in the mid-1950s, a formal publication about the Breathalyzer did not appear in the peer-reviewed literature until 1961 (Borkenstein and Smith 1961). In addition to being so busy with this and other projects, one of the reasons for this delay was Borkenstein's hesitancy to publish since, as already described, he had minimal academic qualifications in science, particularly chemical analysis, and very limited experience in the preparation of a scientific paper. Bob finally was persuaded by his friends of the need to document his invention in the literature so he turned to Ward Smith to assist him with the preparation of the manuscript. By 1961, the Breathalyzer had been in use by the police in Ontario (under Smith's leadership) since 1956 so there was practical operational experience available to support the technical data in the paper.

The paper described the many unique and innovative features that were incorporated into Bob's design and which accounted for the Breathalyzer's wide acceptance, not only as a tool for law enforcement but also in scientific research.

2.4.3.1 The Sampling Device

Most of the "first generation" devices had relied on a sample of mixed expired air which required that an estimate be made of the proportion of alveolar air in the sample based on its CO₂ content. The sample in the Breathalyzer was collected using a modification of Haldane's method (Haldane and Priestley 1905). The breath was led into a stainless steel cylinder where it caused a piston to rise until it was above the level of two vent holes.

As long as the subject blew, the air was vented until, at the end of an expiration, the piston dropped to close the two vents thus capturing a fixed volume of the last portion of an expiration (“end-expiratory air”).

The volume collected was equivalent to 52.5 mL at 34°C. (In their 1961 paper, Borkenstein and Smith used a temperature of 31°C as “the temperature at which the breath leaves the mouth.” This was the temperature reported by Liljestrand and Linde in 1930 but later work by others confirmed 34°C as the more acceptable figure for this temperature.) This volume (52.5 mL) was 1/40th of 2100 mL and thus equivalent to 1/40th of one mL (25 μ L) of blood. This was determined to be a sufficient volume to contain enough alcohol for an accurate determination and yet small enough to ensure uniform sampling of something approaching alveolar air.

In Borkenstein’s original design, 100 mL had been collected using the glass syringe but he eventually became convinced that a smaller sample was practical and the final prototype had a vent slot cut in the syringe at the appropriate level. Because the 100 mL syringes broke quite regularly during this experimentation phase, their cost almost aborted the project prematurely (Dubowski, Personal Communication, 1999). That was not the only mishap during the development. Sharon Faville recalled almost burning down the home when “a hose slipped off the acetylene torch I was using to seal ampoules. Dr. B. rushed over to the tank and turned it off” (Faville, Personal Communication, 1999).

2.4.3.2 The Reagent

Using a very simple valve arrangement, the breath sample was passed through a glass ampoule containing acid dichromate, a common reagent for alcohol analysis. The ampoule served not only as a container for the reagent but also as the fixed length light path for the subsequent photometric measurement. One of the modifications made after the prototype was examined by Bob’s colleagues was the composition of the reagent. The original dichromate concentration, which was based on Heise’s and others’ work with blood and urine samples, was too strong for the very small amounts of alcohol in a breath sample. (It must be remembered that Borkenstein’s expertise was in photography, not chemistry. He was comfortable with color filters and photocells but not chemical stoichiometry.) Dubowski calculated a more appropriate concentration of 0.025% potassium dichromate in 50% sulfuric acid (Dubowski, Personal Communication, 1999).

In the early Breathalyzers, the reagent was heated to 50°C using an automobile cigarette lighter unit, but eventually a silver nitrate catalyst was added to the reagent and the heater was no longer required (Schuckel 1988). Under these conditions, the alcohol was quantitatively oxidized to acetic acid within 90 seconds. While many compounds may react with acid dichromate if introduced directly into the solution, when the sample was breath from a living person, considerable “biological specificity” was imparted to it. The analytical conditions (reagent concentration, temperature, and time) also provide some specificity for alcohol. Acetone, one of the chemicals that may be found on the breath of some living persons, does not react under these conditions. The reaction with ethyl alcohol remained virtually constant after 90 seconds. If methyl alcohol was present, a second reading after 10 minutes would have changed significantly from the first. In the early days, when many small hospitals in rural areas had minimal laboratory facilities, it was not unknown for them to request a Breathalyzer-equipped police officer to assist with the diagnosis of patients suffering from possible methyl alcohol-induced intoxication.

2.4.3.3 The Photometer

The truly unique and innovative design feature of the Breathalyzer was its photometric arrangement. This consisted of an incandescent visible light source (an automobile light bulb) on a moveable carriage between two similar ampoules (one “Test” and one “Reference”), two blue filters and two photocells wired in opposition through a simple galvanometer. The reaction between the acid dichromate and alcohol caused a quantitative decrease in the yellow color of the reagent and therefore, in accordance with the Beer-Lambert Law, a logarithmic increase in the blue light transmittance. If only one reagent ampoule, filter and photocell had been used (the conventional arrangement), the increments on the BAC scale would then have had to be logarithmic rather than linear.

Of greater importance, it would also have been necessary to use a potassium dichromate solution of exact, known strength. This would have presented a production quality control challenge because of the very weak solutions of potassium dichromate necessary to make the instrument sufficiently sensitive for the small amounts of alcohol actually being measured in a breath sample. With the photometric system in the Breathalyzer, the change in transmittance of the “Test” solution was measured by the distance through which the light source had to be moved to re-establish a null condition in the photoelectric circuit (the so-called “Bunsen Principle”) (Dubowski, Personal Communication, 1999). This movement was automatically expressed in blood alcohol units (% w/v) on the instrument scale by a pointer driven across the scale by the movement of the lamp carriage. Because the galvanometer was always electrically and mechanically at “null” when readings were taken, indicating that the two photocells were receiving identical amounts of light through the ampoules and filters, the actual difference between the ampoules was determined by the position of the light required to attain this condition. Thus the intensity of the light source, its age, or changes in line voltage did not affect the results.

The photometric arrangement of the Breathalyzer also made the scale reading virtually independent of the concentration of dichromate. It thus allowed for a “Blank” test for possible contamination, a “Standard” test of the calibration and tests of two or more samples of breath from the subject, all with the same ampoule of reagent. Most users of the Breathalyzer incorporated these quality control checks into their operational protocols.

The linear BAC scale on the Breathalyzer was originally calibrated on a purely arithmetic basis. The factors in this calibration were the volume of the sample, the relationship between the concentrations of alcohol in breath and blood (1/2100), the quantitative relationship of the reaction between alcohol and acid dichromate, and the optical and spatial relationship between the movement of the light and the position of the pointer. These calculations were subsequently tested during practical evaluations and found to be valid.

2.4.4 Commercial Production

While it had never been Borkenstein’s intention to patent his invention, he was persuaded by his friends and his attorney to do so. To pay the costs of this process he had to sell his dearly loved British sports car. The patent application was filed in 1954 and US, British, Canadian, Australian, Mexican, French, and German patents were eventually obtained. The royalties were assigned to the Indiana University Foundation (Kraemer 1996).

Commercial production was first arranged with Rex Metalcraft, a small company in Indianapolis. Bob was familiar with this company because it had produced his Optical Comparator and also the metal cases for Harger’s Drunkometer (Dubowski, Personal

Communication, 1999). Being located in Indianapolis, Borkenstein was able to closely monitor the quality of the production. The actual manufacturing and distribution rights had been purchased by the Stephenson Corporation of Red Bank, New Jersey, a company which produced a variety of respiratory equipment and had also been the distributor of the Drunkometer. Although the early models of the Breathalyzer were manufactured by Rex, the Stephenson Corporation later turned to another company, Radio Frequency Laboratories in New Jersey, to redesign (with little or no input from Borkenstein) the electronic components of the Breathalyzer. The resultant RFL model was produced for only a few years and was quite unpopular with users because it was much more complicated to service than the original Rex model.

Stephenson reacted to the complaints about the RFL units and, with Borkenstein's substantial input, redesigned the Breathalyzer into the Model 800, which rapidly evolved into the Model 900. A 1969 replacement of the galvanometer in the Model 900 with an electronic unit converted the 900 into the Model 900A. This also was done without Borkenstein's advice and resulted in a brief furor in 1982 when an issue arose in the courts about the possibility of an effect on test results obtained with the 900A as a result of "radio frequency interference" (RFI). The amplification in the null meter of the 900A actually did result in fluctuations of the needle if a source of electromagnetic radiation (usually a police portable radio transmitter) was activated in very close proximity to a 900A. This effect was quite familiar to users of the instruments and was easily compensated for in their operations or with minor modifications to the electronics of the instrument. Nevertheless, it did, for a brief period, slightly tarnish the reputation of the Breathalyzer (Figure 2.2).

When the Stephenson Corporation was purchased by the Bangor Punta Corporation in the late 1960s, the Breathalyzer rights were assigned to one of that company's subsidiaries, Smith and Wesson (S & W). In addition to its engineering/manufacturing capability, S & W also had significant marketing contacts within the law enforcement community through their firearms and chemical crowd control agent sales. S & W designed (on their own) and briefly marketed the semi automated Model 1000 Breathalyzer. They also worked closely with Borkenstein on the development of the Model 2000, a microprocessor-controlled unit which used infrared (IR) absorption as the alcohol measurement technique. Bob had started thinking about an IR unit in the early 1970s and, although the Model 2000 was produced as a prototype in the early 1980s, it was never marketed. Despite this, his interest in IR devices for breath testing persisted and he assisted his friend Werner Adrian with the development of a prototype IR breath alcohol analyzer which became the progenitor of the BAC Verifier and eventually the BAC Datamaster (Dubowski, Personal Communication, 1999).

S & W continued to manufacture the Breathalyzer until 1984 when the rights for the Models 900 and 900A were sold to National Draeger Corporation (rights to the Model 2000 were not included in this transaction) (Blasi and Ryser, Personal Communication, 1999). Draeger also worked closely with Bob in the late 1980s/early 1990s to develop the Model 900B, a semi automated version of the 900A. It used the same sampling device, reagent and photometer arrangement as the Model 900A but incorporated a timer to turn on the light after 90 seconds, a microprocessor-controlled motor to drive the lamp carriage and an internal printer. It too was never marketed, primarily because the market had moved on to instruments that did not require the use of a chemical reagent.

Draeger continued to produce the Model 900A until late 1997. The final five instruments were sold in early 1999. In all, over 30,000 of the various models of the Breathalyzer

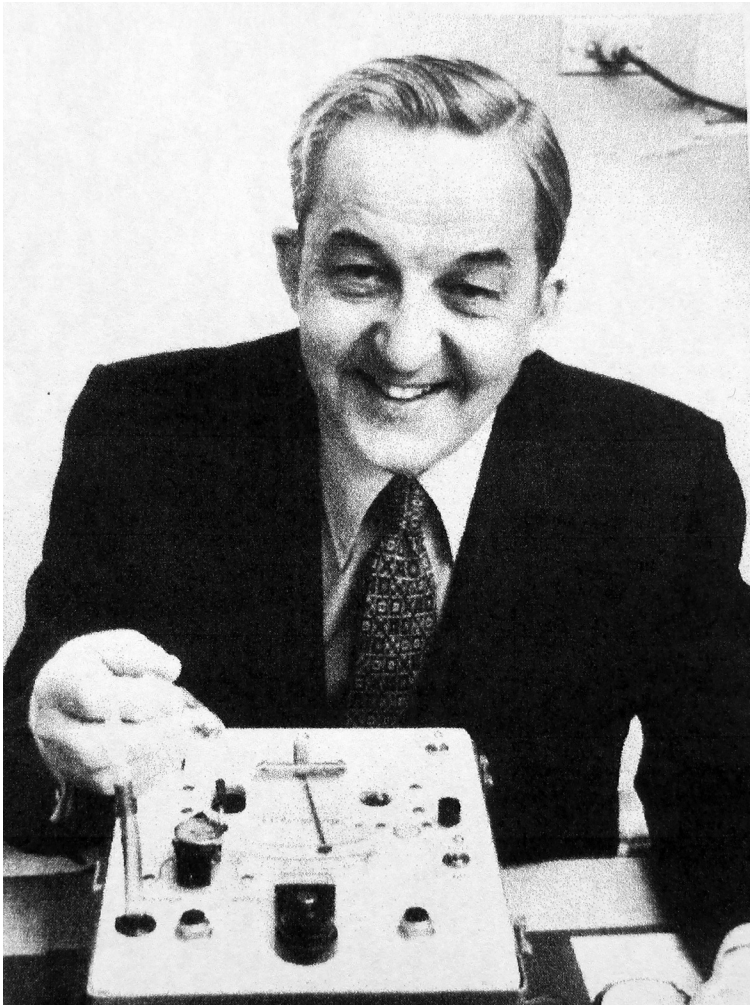


Figure 2.2 Professor Borkenstein checking one of the Series 900 Breathalyzer instruments.

were built and sold between 1955 and 1999, a remarkable record for any piece of equipment, particularly an analytical instrument. The Breathalyzer was, at one time, used in almost every state in the United States and Australia as well as every province in Canada (where it was often referred to as “the Borkenstein” in the courts to differentiate it from other devices; although the spelling “Breathalyzer” as opposed to “Breathalyser” was a registered name, the name had become generic among the general public for any breath testing device with little attention paid to the specifics of the spelling).

Despite the introduction of third generation instruments in the 1970s and early 1980s, by 1985, 30 years after its introduction, the Breathalyzer was still being used in 24 states in the United States and in Canada. By 1999, 150 were still in use in New York, 950 in New Jersey, and about 1,500 in Canada (Blasi and Ryser 1999). It is difficult, if not impossible, to think of any item of scientific equipment, other than the microscope, that has had such a prolonged and important application in forensic science. The Breathalyzer can surely be considered to be to law enforcement what the Douglas DC-3 was to air transport.

2.4.5 The Breathalyzer in Research

The significant role of the Breathalyzer as a reliable tool for measurement of BAC was not restricted to law enforcement. It also found its way into scientific research into the effects of alcohol on behavior. Research in this area had slowed considerably during World War II but the explosion in motor vehicle registrations and use which followed in the late 1940s/early 1950s brought with it a dramatic increase in highway fatalities which rekindled interest in drinking/driving research and legislation (Borkenstein 1985). The fortuitous arrival on the scene of the Breathalyzer facilitated much of this research.

One of the early reports of such usage was a paper by Drew et al. (1959), "Effect of Small Doses of Alcohol on a Skill Resembling Driving." Although primarily dealing with the effects of alcohol on driving simulator tests, in this project Drew compared the results of the then existing breath testing methods with blood and urine tests and stated:

The results from the Breathalyzer were good enough to warrant its consideration from a practical point of view.

This was a remarkable statement by investigators in a country that had theretofore viewed breath testing with skepticism, and it therefore attracted considerable attention in England and elsewhere.

The Breathalyzer was used in epidemiological studies by McCarrol and Haddon in New York City (McCarrol and Haddon 1962) and, of course, by Borkenstein himself in his massive Grand Rapids Study (Borkenstein et al. 1964). It was used in studies by the Royal Canadian Mounted Police of the effect of alcohol on driving ability as measured by road tests (Coldwell 1957) and by Smith and Lucas in 1966 in the classic Canadian Television Network (CTV) television documentary "Point Zero Eight." Although unpublished in the conventional sense, this 30-minute Christmas season television film had a major impact on legislation in Canada. Copies of it became very widely used internationally in driver education courses.

The Breathalyzer gave rise to a large body of literature concerned with its design, applications, limitations, and characteristics. Studies were performed in Switzerland, Germany, Australia, France, Italy, and Canada, particularly in the late 1950s and 1960s. Countless correlation studies between Breathalyzer results and blood tests were conducted. Some of these directly impacted on legislation in various countries. For example, in Australia, a study was done in the Australian Capital Territory in 1969, details of which were included in a "Report on Breath Analysing Equipment for Drivers of Motor Vehicles." This report stated:

Having taken evidence from medical officers, scientists, police officers, and others experienced in the use of this equipment, the Committee is satisfied that the Breathalyzer is an accurate instrument providing a reliable method of measuring blood alcohol concentration in the human body.

This led to the adoption of the Breathalyzer as the only official instrument in the Australian Capitol Territory. Other Australian states followed this lead and the Breathalyzer became the standard instrument for law enforcement and court evidence in Australia for many years (Borkenstein 1976).

Similarly, in 1967/1968 Canada's Parliament gave careful consideration to the Breathalyzer as a device which would make it practical to enact enforceable legislation establishing a 0.08% "legal limit" based primarily on mandatory breath testing. In a letter to Prof. Borkenstein at that time, Mr. P. J. Farmer of the Canada Safety Council stated:

The outcome of much soul-searching was that the Parliamentary Committee agreed that the provision of breath samples was neither an invasion of privacy nor self-incrimination. This and the fact that the Breathalyzer was considered reliable and the simplest way to measure blood alcohol content pretty much dictated that the .08 (%) legislation be tied to breath testing for legal determination of blood alcohol content. (Borkenstein 1976)

In fact, the Canadian legislation enacted in 1969 was widely referred to as "The Breathalyzer Law" and a large legal reference book is entitled *Breathalyzer Law in Canada* (McLeod et al. 1986).

A sidelight to the legislation in Canada was that it originally included a clause requiring the police to offer to collect a sample of breath for the use of the defendant before they could demand a breath test for evidential purposes. This clause was based on work that Borkenstein had done in the mid-1960s on a method for collecting the alcohol from a sample of breath for later analysis. He had been working with tubes packed with calcium chloride (later calcium sulfate) as an adsorbent and in fact, with Dubowski published a paper on this work in 1977 (Borkenstein and Dubowski 1977). Problems with production of tubes that would meet Bob's standards for quality persisted and the project never achieved commercial viability. The "sample for the accused" clause in the Canadian Criminal Code was therefore never proclaimed and was eventually removed from the Code.

Typical of similar activity in the various states in the United States, W. E. Smith in California published a paper in 1969, "Breathalyzer Experience under the Operational Conditions Recommended by the California Association of Criminalists" (Smith et al. 1969). In it he said:

It is concluded that the Breathalyzer meets the standards of good law enforcement when operated in accordance with the operational disciplines recommended by the California Association of Criminalists.

The Breathalyzer became one of the first instruments to be placed on the 1974 Approved Products List issued by the National Highway Traffic Safety Administration of the Department of Transportation (Borkenstein 1976).

2.4.6 The Breathalyzer and the Law

There were hundreds of appellate court decisions bearing directly on the Breathalyzer, none of which were successful in attacking the scientific/analytical principles on which it was based. Reversals did, of course, occur but were based on improper use or on circumstances such as untrained operators, lack of evidence of the quality of the solution in the ampoules, lack of evidence of allowing sufficient time for mouth alcohol to disappear, civil liberties issues, and biological variables. Suffice it to say, the Breathalyzer weathered over half a century of scrutiny by law, medicine and science and survived, paving the way for later generations of instruments.

One of the major legal challenges, *State v. Downie*, occurred in New Jersey in 1989. This case concerned the reliability of the Breathalyzer and particularly its reliance on the 1/2100 breath/blood ratio to convert the BrAC to the BAC. Borkenstein marshaled an impressive array of expert witnesses (including this author), of whom he was the most persuasive, to present data in support of the Breathalyzer. The court ruled in favor of the use of the Breathalyzer in law enforcement and there were few significant challenges afterward. Boris Moczula, one of the prosecutors in the Downie case, described his first contact with Professor Borkenstein as follows (Moczula, Personal Communication, 1999):

I had previously known him only by reputation. Influenced by his status as a giant in the forensic scientific community, I expected to greet a man of imposing physical size. How surprising to find such a diminutive individual, with the ever-present sparkle in his eye.

Prosecutor Moczula was also impressed (although it came as no surprise to Bob's friends) that the Professor insisted on receiving no compensation for his testimony in order that no one could suggest that his testimony was influenced by anything other than the science. He described an example of Bob's expertise as a witness:

At a point in the litigation when defense attacks on the Breathalyzer's components were particularly intense, Doctor Borkenstein offered this simple analogy as explanation and encouragement: "If we focus upon the individual parts of a bumblebee, no one would expect such a cumbersome insect to be airborne. Yet the bumblebee flies." Several months later, when I first notified him of the court's favorable decision, I ended my correspondence with these same words: "The bumblebee flies." (Moczula, Personal Communication, 1999)

It has been said of Professor Borkenstein that, "He was not only one of the founding fathers of breath alcohol testing but also the attending pediatrician" (Jones, Personal Communication, 1999) and, perhaps even its geriatrician!

2.5 The Researcher

At a Symposium on Alcohol and Road Traffic conducted at Indiana University in 1958 chaired by Prof. Borkenstein, a panel of seven distinguished international experts approved the following statement:

As a result of the material presented at this Symposium, it is the opinion of this Committee that a BAC of 0.05% will definitely impair the driving ability of some individuals and, as the BAC increases, a progressively higher proportion of such individuals are so affected, until at a BAC of 0.10%, all individuals are definitely impaired. (Borkenstein 1985)

This statement was soon endorsed by the National Safety Council, the American Medical Association, the International Association of Chiefs of Police and the Junior Bar Association, among others.

While immensely pleased with the fact that he was able to persuade such a panel of experts to agree on anything (including where to have lunch), the statement had required an all night session to draft (Shupe, Personal Communication, 1999), the discussions convinced Borkenstein of the need for a major research project to consolidate the bits and pieces of data on which the statement was based. The Grand Rapids Study, funded by the

US Public Health Service and the Licensed Beverage Industries of New York, was the result (Borkenstein et al. 1964). Without question, this research performed in 1962/1963 became the most influential epidemiological study of the role of alcohol in traffic accidents. On this topic, Dr. John Havard, longtime Secretary of the British and the Commonwealth Medical Associations and for over forty years one of Bob's closest friends, commented:

What has always been so remarkable about Bob is the breadth of his knowledge of so many disciplines, particularly law and public health. He recognized the importance of the epidemiological approach to mortality and morbidity from road accidents, long before it had occurred to traditional epidemiologists, and it was his realization of the potential of the digital computer in advancing knowledge in this field that was such an influential factor in developing the Grand Rapids Study. This at a time when distinguished medically qualified epidemiologists were asking me what was meant by the epidemiology of road accidents. (Havard, Personal Communication, 1999)

The Grand Rapids Study was a large-scale roadside survey designed to assess the risk of a driver being involved in a crash as a function of the BAC. The concentration of alcohol in blood was estimated indirectly by taking samples of breath at the roadside in special plastic bags for later analysis with the Breathalyzer. The BAC of the drivers involved in accidents was compared with the BACs of a large control group of drivers passing the site of the accident on the same week day and the same time of day as the accident group. In this way, the risk of being involved in a crash was plotted as a function of BAC. As later described by Borkenstein himself:

This study was designed to explode the monolith of the 'drunken driver' into as many components as practicable so that target groups could be identified. It was also designed to compare the alcohol factor to other factors involved in traffic accidents, or parametric to them. It was not originally designed to generate countermeasures or to estimate the relative risk of driving while intoxicated; however, the data by their nature suggest an exponentially increasing relative risk curve which was calculated from the data as an afterthought. This relative risk curve has been the basis of much controversy because of the under-representation of drinking drivers in accidents at 0.03% BAC. In spite of this, it has found its way into countless papers, books and educational material. (Borkenstein et al. 1974)

As principal investigator of the study, Bob demonstrated the wide scope of his detailed thought processes, his analytical mind and his innovative problem-solving ability. Not content to pick the most convenient site (Bloomington or perhaps Indianapolis), he researched and selected one that would meet his broad criteria and which would ensure the validity of the findings. Some of the factors involved in the selection of Grand Rapids were its size (large enough to have a sufficient sample of accidents for statistical validity), freedom from extreme seasonal population fluctuations, a good balance of heavy and light industry, commerce and educational institutions, a good accident records system, and a progressive police department. In addition, and not inconsequentially, the population demographics closely reflected those of the entire United States at that time.

Another matter which contributed to the significance of this research was the fact that it studied the role of alcohol not only in drivers who were involved in crashes, but also the involvement of drinking drivers at the same locations and in similar circumstances, who did not experience crashes. The one, by itself, was not significant without the other.

Borkenstein also recognized the importance to the study of obtaining the cooperation of the drivers being interviewed. There were a number of potentially sensitive matters in the questionnaire used for the interviews which required subjects to provide information of a personal nature. Bob identified another organization within his own University that had considerable experience with asking intimate questions of large numbers of people, the Kinsey Institute for Sex Research. Since, for some, “drunken” driving can have a stigma attached to it similar to that placed on socially unacceptable sexual practices, the Kinsey results suggested a risk that Borkenstein’s investigation might find drinking and driving to be, for some, acceptable behavior unless it was discussed seriously by the interviewees. Staff members of the Institute for Sex Research were therefore asked to train the members of the research team who would conduct the interviews in Grand Rapids. This training proved to be of immense value to them and thus to the study (Borkenstein et al. 1974).

The BAC “legal limit” of 0.08%, which became so widely accepted internationally, was derived principally from the Grand Rapids Study and included other factors such as age, socioeconomic status, and education that interact with alcohol as accident causation factors at concentrations below 0.08%. The study concluded, however, that this competition diminishes and appears to disappear as BACs exceed 0.08% (Borkenstein 1985). The impact on public policy both in North America and in Europe was exemplified by events in England. In 1967, Barbara Castle, the Minister of Transport, while launching the Drink/Drive publicity campaign associated with the new Road Safety Act of 1967, stated:

In recent years research has further increased our knowledge of the effects of alcohol on drivers. The most important contribution was Professor Borkenstein’s study at Grand Rapids, Michigan, involving over 12,000 drivers. The results confirmed a good deal of earlier research, which by itself had remained inconclusive, and also gave more precise information than ever before about the increased accident risk at various blood-alcohol levels. Faced with the need to strengthen the law, and armed with this new scientific evidence, we decided that it would be right to lay down a blood-alcohol level above which it should be illegal to drive. The level has been set at 80 mg/100 ml (0.08% BAC) and to exceed it is to commit an offence. (Borkenstein 1985)

Also in 1967, at the seventeenth meeting of the Council of Ministers of the European Conference of Ministers of Transport, it was resolved that the member countries adopt a BAC not higher than 0.08% in legislation (Borkenstein 1985). Reference has been made above to Canada and Australia where legislation was very much influenced by the study. This policy also found its way into most states in the United States, which adopted a 0.08% BAC as the dividing point above which driving is prohibited by law.

The Grand Rapids Study became a cornerstone of traffic alcohol control legislation in the United States and abroad, and in the highway safety standards of the US Department of Transportation.

2.6 The Professor

Although the Breathalyzer and the Grand Rapids Study exemplify Bob’s outstanding abilities as an inventor and as a researcher, some would say his most impressive achievements were associated with his career as a teacher. Sharon Faville, who worked closely with Bob for 16 years, described him thus:

... a compassionate, caring human being whose commitment to service assisted many young students and colleagues to develop their talents and careers. Teaching for Dr. B was both a passion and a mission. He challenged students to think independently and shared the analytical tools he used himself. He inspired creativity and critical thought. At a commencement address, he spoke to graduates about the 'indissoluble residue' they would take from their university experience: the process of learning to learn, of critical thought and investigation. (Faville, Personal Communication, 1999)

Robert Borkenstein's initial association with IU occurred when he joined the ISP Laboratory. The ISP Academy was located in Bloomington and became affiliated with the University in 1936/1937. It was the first police academy to be directly associated with a university, although the cadets were housed in tents during their stay. Lectures were held in the Chemistry Building auditorium. Because of his position in the Laboratory, Bob had a close association with the Police Academy as a lecturer and, through this, with members of the faculty of the Law School who also lectured at the Academy. In addition, the Laboratory occasionally required assistance from the IU Medical School in Indianapolis and so he developed associations with this faculty as well (Anonymous 1983).

Eventually, some of the Academy courses evolved into university credit courses and a Department of Police Administration was established in the Faculty of Arts and Sciences. Several attempts were made to recruit Bob into this department on a full-time basis but he resisted these efforts until 1958, when he retired from the ISP. The associate dean of Arts and Sciences was then finally able to persuade Bob to become an associate professor and chairman of the Department of Police Administration. At that time there were only two other similar programs in the United States, one at the University of California at Berkeley and the other at Michigan State University (Kraemer 1996).

As the new chairman of the Department, Professor Borkenstein's initial goals were to strengthen the faculty, to attract better students and, perhaps most challenging, to actually persuade some in the University that this department deserved to be based within the university. Eventually he succeeded but it took time. He distinguished his department's program from the Police Academy program by convincing the university senior faculty that, while the Academy effectively taught the "how", his department taught the "why." He insisted that the program become multidisciplinary, drawing on resources in psychology, political science, sociology, law, philosophy, and other disciplines. The curriculum was thus knit into the entire fabric of arts and sciences. In 1970, the department changed its name to Department of Forensic Studies and in 1985 it became the Department of Criminal Justice (Kraemer 1996).

Eventually Prof. Borkenstein was also able to develop a Master's and finally a Ph.D. program. The department had developed from one of only three in the United States, in a very humble and simple beginning without much acceptance in the academic environment, to one that contributed significantly to the university and the community it served.

Not content with having established a viable university department, Bob was very interested in ensuring that the resources of the department were made available to the community. He therefore formed the Center for Studies of Law in Action ("law" and "action" are words not often used in the same phrase) as a means of collecting relevant information from the field and disseminating it to practitioners. The philosophy of the center was to expose practitioners to academic developments while at the same time exposing faculty members to the real world from time to time to learn what problems they needed to

work on. For example, in one of its most successful programs, the center brought qualified people from all over the country to Bloomington to learn the latest concepts in the supervision of programs for alcohol testing of drivers and the techniques that are used to carry out these tests. Resource people from around the world interacted with these practitioners to try to develop solutions to a major societal problem. This course, established in 1958 as Supervision of Chemical Tests for Alcohol with 11 students, is now known as the Robert F. Borkenstein Course on Alcohol and Highway Safety. It is offered twice a year and typically has 40 to 50 students. Boris Moczula, following his association with Prof. Borkenstein in the Downie case, became one of the instructors in the course. He said about it:

I would marvel at how class members scurried for the opportunity to speak to him (Borkenstein) or be photographed with him. He greatly enjoyed the interaction and unpretentiously honored all requests. (Moczula, Personal Communication, 1999)

A second course, *Effects of Drugs on Human Performance and Behavior*, was established in 2002.

In summary, Prof. Borkenstein converted the Department of Police Administration from a traditional police training program to a multi-disciplinary teaching, research, and service center that rapidly achieved national prominence for its pioneering insistence on the integration of a liberal arts core into professional training in criminal justice. His vision established the department as one of the few in the field that is truly of university caliber, with emphasis on research and scholarship as well as teaching and service. Bob served as chairman until 1971 and continued as a professor in the department until his retirement from the university in March, 1987. He continued to hold the position of professor emeritus and director emeritus of the Center for Studies of Law in Action until his death in 2002.

2.7 The Laureate

For over 60 years, Robert F. Borkenstein was an international leader in the forensic sciences, criminal justice education, and traffic safety. His extensive research on highway safety established this field as an area for scientific research as well as social concern, and he served as a consultant in many countries around the world. He was most famous for his contributions to the understanding and control of alcohol impairment in traffic accidents, and his research and numerous publications on this subject are well known to the international forensic science and traffic law community. As might be expected, he was also the recipient of many awards and other honors. Among these were:

- The Liberty Bell Award from the Indiana Bar Association “for outstanding contribution to public understanding of the law,” 1966;
- A Special Citation from the Ministry of the Interior of the Republic of China (Taiwan), 1970;
- The Distinguished Service to Traffic Safety Award of the National Safety Council, 1982;
- The Award of Merit of the Association for the Advancement of Automotive Medicine, 1982;
- A Distinguished Service Award in Recognition of Service to the State of Alaska, 1983;

- Induction into the Safety and Health Hall of Fame International, 1988;
- A Special Minister of Justice's Award, Government of Canada, 1992;
- The Gerin Medal of the International Association for Accident and Traffic Medicine, 1992;
- A Special Presidential Award of the International Council on Alcohol, Drugs and Traffic Safety, 1995; and
- The National Association of Governors' Highway Safety Representatives Award, 1996.

While each of these was special, Bob would probably have acknowledged two others as being particularly close to his heart. These were the prestigious Widmark Award of the International Committee (now Council) on Alcohol, Drugs, and Traffic Safety (ICADTS) awarded in Toronto in 1974, and the Robert F. Borkenstein Award established by the National Safety Council in recognition of his lifetime of work in the area of alcohol and drugs in relation to traffic and transportation.

The Widmark Award was established in honor of Professor Erik M. P. Widmark of the University of Lund, Sweden, whose comprehensive research during the first half of the twentieth century touched on all aspects of the pharmacology of alcohol and its quantitative estimation in body materials. He was the first person to apply the then contemporary knowledge to the problem of transportation safety. This award is the highest honor that the ICADTS can confer on individuals who have made outstanding contributions to the basic knowledge of alcohol and other mood-altering drugs and have applied to traffic safety problems. Each laureate must have contributed significantly and must have achieved international recognition over a sustained period of many years. These are demanding criteria. The first recipient was Bob's colleague, Prof. Rolla Harger, in 1965. This award was so special to Bob because he was a founding member of the ICADTS, serving as president from 1969 to 1986, and its driving force for over 40 years. He chaired the Widmark Awards Committee from 1986 to 1992. Of Bob's importance to ICADTS, Dr. John Havard wrote:

He is one of the few people I know who has won international fame and yet has found time, as he so often has, to encourage and to help young workers in his many fields of interest. There are a number of well-known figures working in the field of alcohol and road accidents today who owe their success to his insistence, as a long serving member and as president of ICADTS, that priority should be given to helping young workers and, in particular, to making it possible for them to participate in its international conferences. (Havard, Personal Communication, 1999)

The Borkenstein award honors Bob's active participation in many of the activities of the National Safety Council for almost 60 years, including chairmanship of the Committee on Alcohol and Other Drugs. The first of these awards was presented to Professor Borkenstein himself on October 26, 1989. It was a source of great pride to him that his name was being used to honor the recipients, most of whom, until recent years, were close colleagues and good friends and all of whom still consider it to be one of their greatest honors because it is named after a person for whom they have enormous respect.

In addition to these formal awards, Bob was honored by invitations to present papers to national and international conferences on law enforcement, traffic safety and forensic sciences in Austria, Australia, Canada, the Republic of China (Taiwan), England, Finland, France, Germany, The Netherlands, Puerto Rico, Sweden, Switzerland, and New Zealand.

He served on the editorial boards of *Alcohol, Drugs and Traffic Safety*, *Forensic Science Review*, and *Journal of Traffic Medicine* as well as serving as a consulting editor for *Blutalkohol*.

2.8 The Person

All of the above describes many of the truly outstanding contributions that Robert F. Borkenstein has made to his chosen profession and particularly to traffic safety. What it does not adequately present, however, is the enormous impact of his persona on friends, students, colleagues and associates. His mind was always working; many of his colleagues described one of his outstanding characteristics as always working on a new project. His enthusiasm for these projects could be overwhelming. While discussing some of the activities of the Department of Criminal Justice in 1996, he enthused:

I'm excited about it, I'm really excited about the years to come. (Kraemer 1996)

A journalist who interviewed Bob in 1988 described him thus:

He is a reporter's dream. He automatically answers Who? What? When? Where? and How? It's as if he's methodically going through in his mind how the material should be presented and in what order—much like he must do when conducting an experiment or devising an invention. (Schuckel 1988)

Although deeply committed to his work, Bob was not a “one trick pony.” He was equally at home in a snowball fight at his Divide, Colorado cabin as he was in the meeting rooms of international professional organizations. He and Marjorie were deeply caring, thoughtful, gracious and consummate hosts at magnificent dinner parties at 821 South High Street in Bloomington and at the Colorado cabin. These locations became the “crossroads of the world of alcohol and traffic safety and professional policing on a truly international scale” (Dubowski, Personal Communication, 1999). Lloyd Shupe described one of these occasions when:

Bob asked a group of us to stop at his home for what he called a “Meeting of the Young Bucks with the Old Farts.” The young bucks were Ward Smith, Kurt Dubowski, Jim Osterburg, and me. The old farts were Rolla Harger, Charlie Wilson, Clarence Muehlberger, and Raphael Ruenes (from Havana). (Shupe, Personal Communication, 1999)

Despite himself qualifying by 1999 as an “old fart,” Bob's friends always looked upon him as a “young buck.”

Bob was very much a hands-on host at these affairs. Kurt Dubowski remembered:

He personally prepared his special punch in ample quantities and arranged the cheese platter just so, after hours of personally shopping for the right ingredients in Chicago, Indianapolis, or Bloomington. (Dubowski, Personal Communication, 1999)

The Professor also had a recreational as well as a professional interest in good wine. Bill Picton remembered a discussion about wine with Bob during which Bill mentioned that

there was a winery in Edmonton, a city known more for its snow and cold winter weather (its football team is named “the Eskimos”) rather than for its viniculture:

Upon my departure, Bob presented me with a bunch of plastic grapes for use by the Edmonton winery. (Picton, Personal Communication, 1999)

Darlena Lindsay described how she and Bob had lunch together in Bob’s office every day he was there. They took turns preparing it. The conversations, usually one-sided, covered an amazing range of topics with Bob’s encyclopedic knowledge and range of interests never failing to amaze her. She recalled:

If anything came up that he didn’t know at that time, he would by the next day. He loved the theatre and dancing and, as an adult, took up fencing, the only sport he had any use for. (Lindsay, Personal Communication, 1999)

In these lunchtime conversations, Bob described his travels and the many wonderful places he had been, Vienna and Paris being his favorites.

His telephone bills must have been enormous; if he did not invent the term “networking,” he certainly was one of its foremost practitioners. Many of his colleagues all over the world would describe his calls, arriving straight out of the blue, sometimes to discuss whatever was Bob’s issue of the moment, or sometimes just to talk. This author’s calls almost invariably arrived early (for him) on Saturday mornings, including one Saturday that happened to be Christmas day. John Havard described this characteristic:

One of the most remarkable facts about Bob was the wide range of eminent people in different countries who count him among their friends. Around 1962, I was trying to interest a very large and important government department in Britain about a certain problem, and was having no luck whatsoever in getting anyone in authority to listen to me. I was astonished when the distinguished chief of the department (later ennobled as Lord ---) phoned me personally explaining that he had heard that Bob was visiting London and had given my number as a contact. He asked me to make it clear that he insisted that Bob stayed with him in London. (Havard, Personal Communication, 1999)

Marjorie was a highly talented artist who fostered Bob’s interest in art. One of her pieces, of which he was particularly proud, was an interesting collage made from component parts of old Breathalyzers. It hung prominently on his office wall at IU. They had no children but shared a love for their beautiful cabin on the side of a mountain near Divide, Colorado, which they visited whenever possible until they found it necessary to give it up in 1996. Some of Bob’s most creative thoughts were developed in the peace and solitude of the Rockies.

2.9 Conclusion

As a forensic scientist, one might assume that Bob Borckenstein would have considered that the solution to the problem of alcohol and traffic safety rested with technology and better ways of measuring BAC. As a police officer, he might have seen the answer in greater enforcement of stricter laws. As an educator, perhaps public information was the route

to follow. While each of these has a role to play, such single solution approaches were not how he thought. A much broader approach is required. In a plea for more creative thinking, Bob proclaimed to an international audience in 1985:

Perhaps we have been too optimistic in believing that the media, public information meetings, driver education schools and other means of disseminating information would solve the problem of understanding and would gain support of the public. This has been a dismal failure. I read over most of the papers I have written on this general subject during the past 30 years. In nearly every one of them I stated that the weakest link in attacking this problem has been public support. What we perceive as low-level action against the drunken driver is probably a direct result of lack of public support. We can inform and we can enforce and as a result change behavior through fear for a while. But when we fail to change attitudes, regression is bound to occur. (Borkenstein 1985)

In 1985, John Havard described one of Bob's legacies in the following way:

If I was asked to identify the person who has made the biggest contribution toward the reduction of death and disability from motor accidents associated with alcohol, I would have no hesitation in identifying Bob. (Havard 1988)

The first words in this appreciation of Robert F. Borkenstein's life and work were those of Dr. Herb Simpson; it is therefore fitting that the final words also be his:

His spirit, enthusiasm and dedication inspired me very early in my career and I think fondly of his influence, not only in the field of traffic safety, but on me personally. (Simpson, Personal Communication, 1999)

There are hundreds of others, including this author, who could only add "Amen."

Acknowledgments

The nature of this type of article is such that it depends on the willingness of many people to share their recollections and memories. The contributions of Robert Conley, Kurt Dubowski, Sharon Faville, John Havard, Wayne Jones, Boris Moczula, William Picton, Lloyd Shupe, and Herb Simpson are gratefully acknowledged. Much of the material for this article was derived through personal access to Prof. Borkenstein's papers in his office at Indiana University. The cooperation of Darlena Lindsay in guiding me through that material and her diligence in seeking out items that might answer my many questions could not have been more complete or more efficiently provided. Without all of these, this article would not have been possible. Dr. Ray Liu and *Forensic Science Review* made this trip to IU possible.

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Professor Robert Frank Borkenstein
Obituaries Appearing in Scientific Journals



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**ACCIDENT
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Obituary

Professor R.F. Borkenstein (1912–2002)

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We are saddened to report that Prof. Robert Borkenstein, a past president of ICADTS and inventor of the Breathalyzer, died on 10 August 2002, at his home in Bloomington, Indiana, after a long illness.

Few men have made such a significant and sustained contribution to their chosen field of endeavor as Robert (Bob) Frank Borkenstein. All who had the privilege to know Dr. Borkenstein held him in high esteem and greatly admired him for his personal qualities, sharp wit, and not least his scientific achievements. Bob's many outstanding accomplishments and lifelong dedication to the field of alcohol and traffic safety research made him an international celebrity among his peers. Two of Bob's many contributions stand out in particular, namely invention of the Breathalyzer instrument in 1954 and being the driving force behind the "Grand Rapids Study" a seminal investigation into the epidemiology of traffic crashes and the role played by alcohol. This study established a quantitative relationship between the risk of being involved in a road-traffic accident and the driver's breath-alcohol concentration.

Robert F. Borkenstein was born in 1912 in Fort Wayne, Indiana, and attended school there. He began his career in traffic safety in 1936 as an Indiana State Trooper and subsequently worked as a laboratory technician with the Indiana State Police. Bob quickly moved through the ranks to become director of the scientific unit of the State Police Laboratory in Indianapolis. Among his major interests and duties in criminalistics was the use of color photography to document crime scenes and in the investigation of the cause of road-traffic accidents. The devastating role played by drunk drivers in causing deaths on the highway was strikingly obvious to all concerned with this work. This probably marked a turning point in Bob Borkenstein's career and he began to devote his interests and energies to the fight against drunk driving, in particular, the development



Professor Borkenstein (photo taken 1996) holding the first hand-made version of the Breathalyzer.

of better ways to prove that a person was unfit to drive through over-consumption of alcohol.

Bob's formal studies on alcohol began in 1939 when he enrolled in a training class for police officers to learn about the effects of alcohol on the body and how this drug impairs a person's performance and affects behavior. In this connection, he learned the principles and practice of the Drunkometer, which was the first practical breath-alcohol analyzer designed for use by police officers. The Drunkometer training classes were held at the medical school in Indianapolis and headed by the legendary Prof. Rolla N. Harger, the dean

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¹ Retired Director.

of forensic alcohol studies in America at the time. A life-long friendship developed between Bob and Rolla Harger and the State of Indiana is justly proud of these two men of achievement and pioneers in the development of chemical tests for alcohol influence.

Bob's early experience with color photography, colorimetry, and the use of optical filters was a crucial element in the development of a new instrument for breath–alcohol analysis. This instrument was christened the Breathalyzer and it incorporated many novel features. The first scientific report of this work appeared in 1954 and shortly afterwards a prototype Breathalyzer instrument became available for field testing. This instrument gave on-the-spot results and furnished the police with objective evidence that a person had consumed too much alcohol and was thereby unfit to operate safely a motor vehicle (Borkenstein and Smith, 1961). The Breathalyzer became widely accepted and used in traffic law enforcement in the US, Canada, Australia, and several European countries. Tens of thousands of lives have been saved by keeping drunk drivers off the roads, thanks to the effectiveness of the Breathalyzer and the evidence it provided for the successful prosecution of offenders.

In the early 1960s, an urgent need arose to demonstrate in an unequivocal way to policy makers and others the great danger of drunk driving and the added risk it represents for traffic crashes. With this in mind, Dr. Borkenstein, then and since 1958, the Chairman of the Department of Police Administration at Indiana University, and his associates embarked on what became known worldwide as the “Grand Rapids Study.” They planned and executed the largest ever road-side survey to establish the role of alcohol in traffic crashes. The city of Grand Rapids, Michigan was selected because its demographics matched those of the US as a whole. The results of the study were published in 1964 (Borkenstein et al., 1964) and furnished scientific proof of the heightened risk of causing a crash as the breath–alcohol concentration increased. The Borkenstein risk analysis curve has become a classic diagram in the annals of traffic safety research (Borkenstein et al., 1974). The immense media coverage of the results of the Grand Rapids Study proved significant in bringing drunk driving to the attention of legislators all over the world. Many US states, Canada, as well as countries in Europe were prompted to redraft their road safety laws to include for the first time punishable limits of blood–alcohol concentration.

Throughout his long career, which spanned some 60 years, Dr. Borkenstein, in addition to his research work, devoted much time and effort to teaching, committee work, and helping to educate and spread information about the negative impact of alcohol on driving skills. The short courses on

breath tests for alcohol influence, first organized and offered in 1937, became and continue to be, a tradition at Indiana University. Dr. Borkenstein was one of the founder members of the US National Safety Council, Committee on Alcohol and Other Drugs, and also served as the Committee's chairman. The name of Bob Borkenstein will always be closely linked with new ideas and international developments in the field of alcohol and traffic safety.

Among other things, he served the longest running presidency of the International Council on Alcohol, Drugs, and Traffic Safety (ICADTS) from 1969 to 1983 and was chairman of the Widmark Awards Committee from 1986 to 1992. Indeed, in 1974, Bob Borkenstein was himself a recipient of the prestigious Widmark award for his longstanding contributions to the field of alcohol and traffic safety.

Bob Borkenstein received honorary doctorate degrees from Wittenberg University (D.Sc.) in 1963, and from his own alma mater, Indiana University, (LL.D.) in 1987, in recognition of his accomplishments in science and law, respectively. Scores of other awards, medals, and prizes, too numerous to mention came his way over the years. These included the Gerin Medal of the International Association for Accident and Traffic Medicine for outstanding achievements in the field of traffic medicine (1992), a Minister of Justice's award from the Government of Canada (1992) in recognition of work leading to the development of the Breathalyzer and in 1988, Dr. Borkenstein was inducted into the Safety and Health Hall of Fame International.

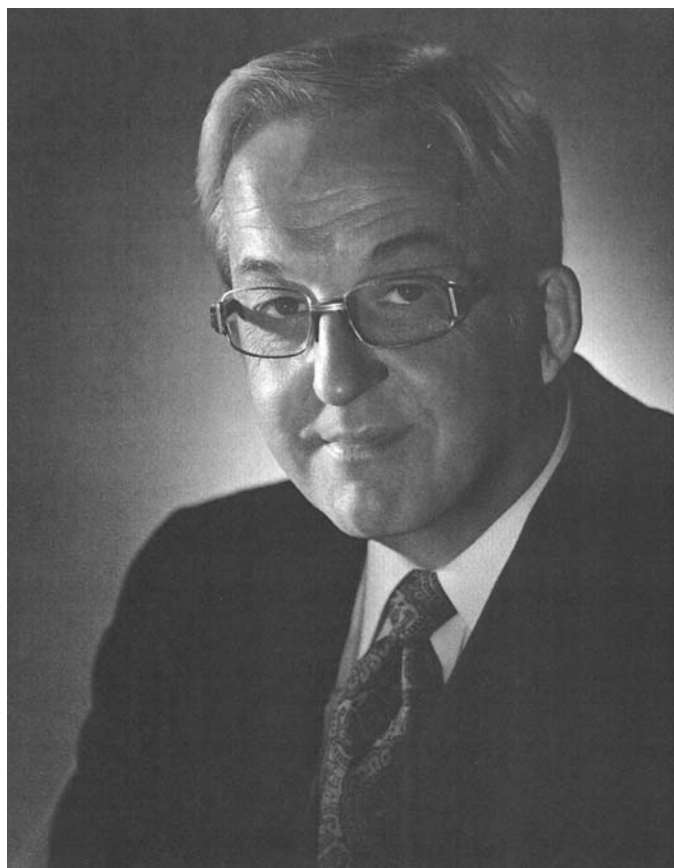
One of Prof. Borkenstein's international colleagues and friends said of him; “*If Bob Borkenstein is not a true genius, he is the closest to it that any of us will ever have the privilege to know.*” A symposium in honor of Prof. Robert F. Borkenstein was held 1–2 December 1999 in Taipei, Taiwan. In the published proceedings of this meeting a more detailed account of Dr. Borkenstein's life and work can be found (Lucas, 2000).

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*Robert F. Borkenstein 1912–2002*¹

Obituary



Professor Robert F. Borkenstein, inventor of the Breathalyzer and a leading light in the development of alcohol impaired driving research and legislation, passed away at his home in Bloomington, Indiana, on August 10, 2002. He was 89. His life is an example of the impact that the application of science at its best can make in people's everyday lives, changing attitudes and behavior, and ultimately saving lives.

Bob Borkenstein was born in Fort Wayne, Indiana on August 31st, 1912. Finishing high school at the onset of the Great Depression, he missed the opportunity to attend college, but helped support his family by working in a variety of jobs, eventually securing a position as a photographic technician. He developed considerable

skill in this field, and soon demonstrated the innovative, problem-solving temperament which would characterize every challenge he subsequently took on, developing and improving on equipment, procedures and processes in the emerging field of color photography. The skills he developed in optics and photography led to the invention of several other devices, including a color comparator, which made a significant contribution to the war effort.

It was Borkenstein's proficiency and expertise in photography that led to his involvement with the Indiana State Police (ISP), whose troopers he assisted with documenting and photographing traffic accidents and other investigations. He so impressed the officers he worked with that when the State's first criminological laboratory was established in Indianapolis in 1935, he was consulted on its design and operation, and a year later formally went to work there first as a civilian technician, rising through the ranks to director of the laboratory and Captain, retiring in 1958. He then went on to join the faculty at Indiana University's Police Administration Department which evolved into today's Criminal Justice Department, rising to the rank of professor. He joined the General Section of AAFS in 1967, and was elected fellow in 1969. He taught and researched at IU until becoming too ill to work in 1997.

Seminal work on the measurement of alcohol in breath had been conducted in Sweden in the early 1930s, but the challenge of developing a portable breath alcohol testing device had been taken up by Professor Rolla Harger at the Indiana University Medical School in Indianapolis, leading to the invention in 1938 of the Drunkometer. Harger turned to ISP and its crime lab director, Lt. Robert Borkenstein for assistance in evaluating this device in the field. Borkenstein immediately saw the value of this device, but recognized its limitations in terms of portability and robustness, making it difficult to use in the field. Employing his knowledge of optics and photometry from his early photographic training, he designed a unit consisting of "two photocells, two filters, a device for collecting a breath sample, and about six wires," which was reliably accurate, simple to use and robust enough to use in the field. Thus, the Breathalyzer was born. Borkenstein patented the device in 1954, and described its use in the scientific literature in 1961. Royalties from the patent were donated to the Indiana University Memorial Foundation.

Borkenstein remained involved with development and innovation in breath testing technology and alcohol related traffic safety issues for the remainder of his career. Not satisfied with the invention of a device with which to measure breath alcohol, he aggressively pursued the implementation of stricter standards under which it would be statutorily illegal to drive—the so-called illegal per se standards. Critical to the success of this effort was a demonstration of a quantitative relationship between breath alcohol concentration and driving impairment. Borkenstein initiated what be-

¹ Much of the detail in this brief memorial of Professor Borkenstein comes from a lengthy article on his life and work, written by his close friend and colleague Doug Lucas (Lucas DM, *Forensic Science Review* 2000;12(1/2):2–21).

came known as the “Grand Rapids Study” for the city where it was conducted. This was an ambitious, case-controlled epidemiological study involving approximately 8000 accidents. The study resulted in the “Grand Rapids Curve,” a plot demonstrating the increasing risk of accident involvement with increasing breath alcohol concentration. A breath alcohol concentration of 0.08g/210L (“0.08%”) was identified as the limit above which all other contributing factors became subordinate to the effects of alcohol, and was correlated with a three-fold increase of alcohol related crash risk compared to the sober driver.

Remarkably, Bob Borkenstein’s achievements were accomplished without the benefit of any formal science education beyond high school. However, his innate curiosity and thirst for knowledge led him to accumulate credits at Indiana University, graduating with an AB degree the same year he retired from ISP. His contri-

bution to the field of traffic safety toxicology led to acknowledgment in the form of an honorary doctor of science degree from Wittenberg University in 1963, and an honorary doctor of laws degree from Indiana University in 1987. In 1974 he received the prestigious Widmark Award from the International Council on Alcohol, Drugs and Traffic Safety (ICADTS), an organization he helped found, and numerous other awards and honors over the years. He established at IU, the Center for Studies of Law in Action, through which hundreds of students have been trained in medico legal applications of breath alcohol testing and program administration, in a program that continues today.

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Robert F. Borkenstein: an appreciation



Professor Emeritus Robert F. Borkenstein,
inventor of the Breathalyzer

The 20th century saw the development of the technology for alcohol testing that has become the basis of drink-driving enforcement throughout the industrialized world. Although many scientists made important contributions to that effort, two names stand out: Widmark and Borkenstein. Professor Erick Widmark of Lund University, Sweden, is generally considered the 'father of the field' for his research in the first half of the century on the relationship of alcohol consumption to blood alcohol concentration (BAC). Professor Widmark's estimation formulae, which bears his name, has become widely used for defining impairment in terms of BAC in modern *per se* laws. Andreasson (1986) has fully described his work.

Robert F. (Bob) Borkenstein, a professor at the University of Indiana and Chairman of its Department of Police Science from 1958 until his retirement in 1983, was associated with two major technical and scientific achievements that greatly influenced the adoption of modern drink-driving legislation world-wide. First, he invented the Breathalyzer™ in 1954. Although Rolla Harger (1938) is credited with developing the first functioning breath sensor for measuring BAC levels, it was Bob who developed a device so simple to operate that any police officer could conduct an evidential breath test for

use in court. The Breathalyzer eliminated the need for a physician or phlebotomist to collect blood and the long wait for laboratory results, thereby significantly increasing the efficiency of drink-driving enforcement. The Breathalyzer was rapidly adopted by police departments both in the United States and in several countries around the world. Although current breath-test devices use a more modern fuel cell or infrared technology, 'Breathalyzer' has become the generic name for such test devices, just as Kleenex has become a generic term for facial tissues.

To support the concept of a legal BAC limit for driving, researchers, police and others needed evidence of the relationship of BAC to crash risk. Borkenstein provided this evidence in his classic study, the 'Grand Rapids' (Michigan) report (Borkenstein *et al.* 1974), in which he compared the BAC levels of crash-involved drivers with non-crash-involved drivers who were using the roads at the same times and in the same places. Although others (McCarroll & Haddon, 1962; Perrine 1969) conducted similar research, it was Borkenstein's work that caught the world's attention and had the greatest influence on the adoption of *per se* illegal BAC laws outside Scandinavia in the United States, Europe and Australia. Four decades later, when Compton *et al.* (2002) repeated Borkenstein's classic study, he found it to still be valid at low and moderate BAC levels. However, Compton *et al.*'s study captured BACs from hit-and-run drivers that Borkenstein did not attempt to measure and concluded that the classic Grand Rapids study underestimated risks levels at BACs higher than 0.10.

Aside from those two landmark contributions, Borkenstein contributed substantially to the enforcement literature. He was the first to report on the low rate of enforcement of driving-under-the-influence (DUI) offenses. In the early 1970s he estimated that only one in 2000 trips by a driver with a 0.10 BAC resulted in an arrest in the United States (Borkenstein 1975). Since that time, impaired driving has decreased and enforcement intensified, yet the arrest rate is still around one in 300 (Hause, Voas & Chavez 1982). He reported that the average officer made only two drink-driving arrests per year. As a former Captain and Director of the State Laboratory for the Indiana State Police, in which he served for 22 years, he was intensely interested in police training.

At the University of Indiana he developed a nationally recognized course in impaired-driving enforcement that bears his name and continues to attract faculty from around the world and police officers from all over the United States.

During the 1950s, 1960s and 1970s, when the National Safety Council's Committee on Alcohol, Drugs and Traffic Safety played a particularly strong role in the development of model alcohol safety legislation for the United States Borkenstein, as a senior member of the committee, strongly influenced the committee's recommendations. An interesting example of that influence was the recommendation to stay with the traditional 2100:1 blood-breath ratio for breath-test laws, even though more recent research had shown that the true ration was 2300:1, to give offenders a 10% margin of safety on the breath test. The National Safety Council recognized his contribution to the field in 1997 by establishing the annual Robert F. Borkenstein Award, of which he became the first recipient.

His world-wide reputation resulted in invitations to many international meetings. He attended the first meeting in 1950 in Stockholm of what was to become the International Council on Alcohol, Drugs and Traffic Safety (ICADTS), which meets every 3 years; ICADTS meetings attract nearly all the most active scientists in the alcohol safety field. He kept the organization going almost single-handedly during its early years. In the organization's early years, he worked tirelessly to find venues for conferences and even financed some meetings of the executive ICADTS board from his Breathalyzer royalties. He leaves behind an organization that has sponsored 16 international meetings since 1950, creating with its proceedings a history of the development of the alcohol safety field in the last half of the 20th century: an organization that is a vitally important stimulus to scientific research for which his many fellow researchers are indebted.

Robert Borkenstein, born 31 August 1912, followed an unusual professional path into becoming a world-renowned researcher into traffic safety. Rather than obtaining the typical advanced degree in science or medicine, he began his career without a college degree as a police photographer and then became a police technician, from which he moved on to become the police laboratory director and then a university professor. Unusually creative, he invented or improved several devices. He invented the first coin-operated breath-test device for use in drinking establishments. In the process

he became an expert on the polygraph, or lie detector, conducting over 15 000 tests (Woo 2002). He also worked on a color-sensing system for inspecting precision parts on bomb-bay doors applicable to military operations, for which he received an award from the British government in 1997 (Indianapolis Star 2002).

Robert Borkenstein passed away on 10 August 2002. He is survived by nieces, Jill Borkenstein and Sue Swift, and nephews, David and William Borkenstein.

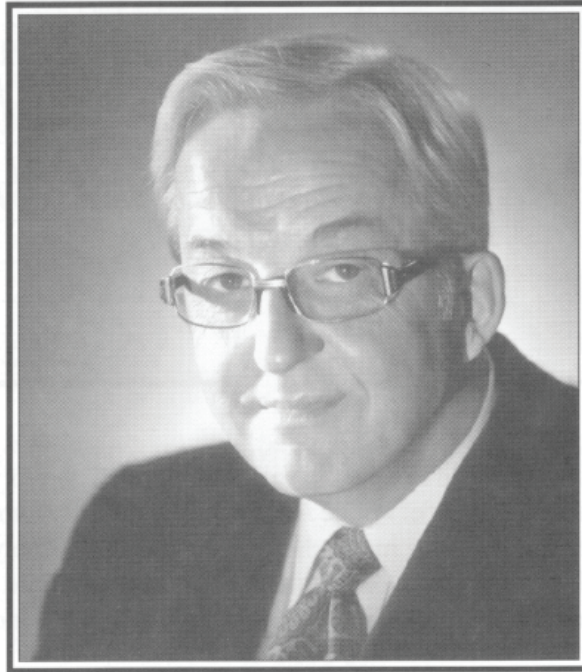
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IN MEMORIAM



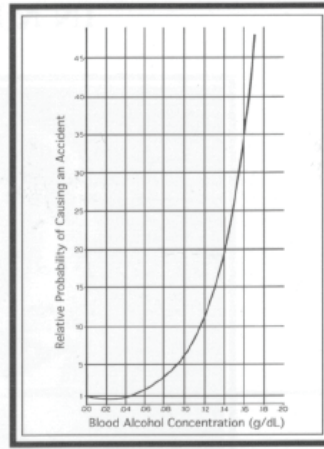
Robert F. Borkenstein
(1912–2002)

Professor Robert F. Borkenstein, LL.D. (Hon.), D.Sc. (Hon.), A.B., Professor Emeritus at Indiana University, died at his home in Bloomington, Indiana, on August 10, 2002, after a lengthy illness. He had been predeceased by his much-loved wife Marjorie in 1998.

Throughout an active career of over 60 years, Bob Borkenstein had been a professional photographer, police officer, forensic scientist, researcher, inventor, educator, and, of greatest importance, friend and respected mentor to hundreds of professionals concerned particularly with traffic safety. He was known best internationally for his invention of the Breathalyzer[®] in 1954, the first truly practical device that allowed police to quickly determine and quantify blood alcohol concentrations with sufficient accuracy to meet the demands of the courtroom, and for what is known worldwide as the Grand Rapids Study, his enormous research project in 1962–63 that documented the “real world” elevated accident risk of drinking drivers.

These contributions had far wider impact than even he might have anticipated. The Breathalyzer[®], while producing evidence that made prosecutions more reliable (and which, remarkably, is still in use in a few jurisdictions almost 50 years after its development), also became a significant research tool that was used to study many aspects of the role of alcohol in human behavior. The Borkenstein “Relative Risk Curve” from the Grand Rapids Study had a profound influence on public policy internationally. It became the cornerstone of drinking/driving legislation in the USA and abroad.

Although an intrepid international scientific “superstar” with many friends and colleagues around the world, Bob Borkenstein was a “Hoosier” (native of the State of Indiana in the USA) through and through. Born and educated in Fort Wayne, Indiana, he became an Indiana State Police trooper in 1936, rising to the rank of captain and director of the State Police Criminological Laboratory, one of the first police laboratories in the USA. In this capacity, Bob expanded the use of color photography in police investigations and introduced breath testing, which became much more reliable after his invention of the Breathalyzer[®], the prototype for which he built in his basement during his annual vacation in 1954. He also contributed to the development of the polygraph and to electronic speed-measurement devices.



Following his retirement from the State Police in 1958, Bob was invited to join the faculty of Indiana University as chairman of the Department of Police Administration, a truly remarkable achievement since he had, after years of effort, just received his bachelor's degree that same year from the university's Department of Extension. (His outstanding contributions to his chosen field were subsequently recognized by the award of an honorary D.Sc. by Wittenburg University in 1963 and an honorary LL.D. by his own university in 1987.)

As an educator and academic administrator, Professor Borkenstein proved to be a compassionate and caring human being for whom teaching was both a passion and a mission. His challenge to his students to think independently mirrored his own practice of "thinking outside the box." To ensure that the resources of the university were made available to the community at large (and vice versa), he established the Center for Studies of Law in Action. A prominent example of the Center's mission is the Robert F. Borkenstein Course on Alcohol, Drugs, and Highway Safety, a program which since 1958 has influenced and expanded the knowledge and skills of persons responsible for related highway safety programs across the USA and elsewhere.

As an international leader in the forensic sciences, criminal justice education, and traffic safety for more than six decades, Professor Borkenstein was the recipient of many well-earned international honors including the prestigious Widmark Award of the International Council on Alcohol, Drugs, and Traffic Safety, an organization of which he was a founding member, president from 1969 to 1986, and principal driving force for over 40 years. In addition, the U.S. National Safety Council established the Robert F. Borkenstein Award in 1986 in recognition of his lifetime of work in the area of alcohol and drugs in relation to traffic safety.

Although always deeply and enthusiastically committed to his work, Bob and his wife Marjorie were also well known to their legion of friends from around the world as intensely caring, thoughtful, gracious and consummate hosts at magnificent dinner parties at their home in Bloomington and their mountain retreat near Divide, Colorado.

Robert F. Borkenstein's dedication and enthusiasm for his chosen work, his creativity of thought, and his discipline in execution of his research and development projects made him a pleasure to work with. His spirit, encouragement of and challenge to his students, and his graciousness and loyalty to his friends made him a delight to be with. I was and will always be proud to be considered his friend.

Douglas M. Lucas
December 2002

Additional details about the life and accomplishments of Professor Borkenstein are available in Forensic Science Review, Volume 12, pages 1 to 21, 2000.



NEWSLETTER

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The Mark of a Man

By Shirley Ezelle

Dr. Robert Frank Borkenstein
Born August 31, 1912 in Fort
Wayne, Indiana

Died August 10, 2002 in
Bloomington, Indiana



Dr. Robert Borkenstein passed away August 10 at the age of 89 at his home in Bloomington, Indiana. In life he was far more than just a professor, inventor, educator and mentor. He left behind friends from all around the world who loved and respected him for his accomplishments and his endearing qualities. He was a genius, an accom-

plished chef, an encourager and a true servant leader. He was considerate, devoted, compassionate, dedicated, inquisitive, brilliant, humble, and courteous. He was one of the most inspiring people I have ever met.

In death he was editorialized by the New York Times; the major television networks broadcast his death announcement; and The Royal Canadian Mounted Police sent a color guard to his funeral. Although his name may not have been well known to many of those outside the world of forensic science, those who came in contact with him always remembered him, and almost everyone recognizes the name "Breathalyzer" one of his many inventions. Robert Borkenstein gave far more to the world than what he became famous for.

His inquisitive nature was evident very early in his life; as a youth he loved to perform scientific experiments. After high school he went to work in a photography shop where he invented a new color printing process that he later sold. He went to work for the Indiana State Police in 1936, eventually

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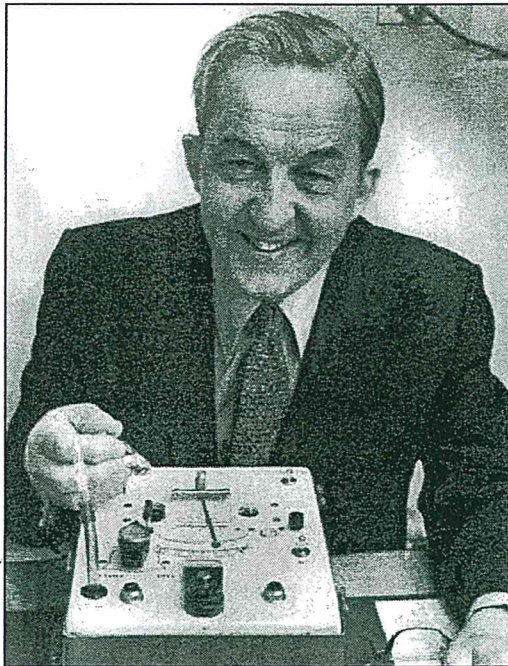
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rising to Captain of Laboratory Services. While there he was also involved in developmental work on the lie detector. His 1954 invention of the Breathalyzer, the most widely used alcohol breath instrument in the world, revolutionized the field of alcohol testing and traffic safety and for a long time was the standard bearer.

He received a bachelor's degree from Indiana University in 1958 and was later appointed Chairman of the University's new Department of Police Administration. In 1962 he was the principal investigator for the "Grand Rapids Study", one of the most elegant, elaborate, and complete studies ever performed on alcohol and traffic safety. It has become a classic in the field.

Doctor Borckenstein was recognized nationally and internationally for his career accomplishments. Over the years he served as Chair of the National Safety Council's Committee on Alcohol and Other Drugs (NSC CAOD), president of the International Committee on Alcohol, Drugs, and Traffic Safety (ICADTS), president of the Academy of Criminal Justice Sciences, a life member of the International Association of Chiefs of Police, a fellow of the American Academy of Forensic Sciences, and a Charter and Emeritus member of the International Association for Chemical Testing.

The ICADTS honored him with the Widmark Award in 1974; The National Safety Council inducted him into the Safety Hall of Fame for Distinguished Service in 1988; and the NSC



Professor Borckenstein and the Breathalyzer Model 900

CAOD presented him with the first Robert F. Borckenstein Award named in his honor in 1989. He served as a consultant to Presidential Task Forces on Traffic Safety; he was awarded two honorary doctor's degrees and published more than 45 articles. Queen Elizabeth invited Dr. Borckenstein to England in 1997 to honor him for his development of color photography techniques that were utilized in wartime. He was very excited about receiving this honor and bought a top hat for the event.

This gentle man was well known and respected for his commitment to saving lives. In a 1995 interview published in the *Indiana Wire*, he said, "If we can make life better simply by controlling alcohol, that's a very small price to pay. My whole life's work has been spent trying to make life better for people." An

October 18 Indianapolis Star editorial said he "doubtlessly saved lives and millions of dollars." I do not doubt it.

There is much that can be said about Bob Borckenstein, but much of it is said best by some of his closest friends. J.D. Chastain remembers meeting him for the first time in 1948 when they were both enrolled in an arson investigator's seminar at Purdue University. J.D. recalls that Bob had seemingly endless energy and enthusiasm. Although he was involved in literally hundreds of projects, he took time to discuss any problems that J.D. had. Doctor Borckenstein came to the Department of Public Safety in Austin three times to teach in the first Breathalyzer schools (75

students each) and helped in starting the statewide breath testing program. Then he organized a special school at Indiana for Texas Technical Supervisors.

Doug Lucas remembers the marvelous hospitality that Bob and his loving wife Marjorie showed him on many occasions. Once while Doug was chairing a CAOD subcommittee, he and several other committee members were invited to dinner at the Borckensteins' cabin in nearby Florissant, Colorado. The Borckensteins introduced him to fondue that evening and he was so impressed that when he returned home he immediately invested in a fondue set.

Natalie Essary's mother used to travel with her a lot and her mother always looked forward to seeing Dr. Borckenstein because he was always impeccably dressed and perfectly groomed. "He looked like a little doll with polished shoes, perfectly tailored suits and

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bright white shirts with never a wrinkle or smudge in sight. He was always a perfect gentleman and a very gentle man."

Darlena Lindsay, program director at the Indiana University Center for Studies of Law in Action, worked closely with Dr. Borkenstein. She remembers the lunches they shared at work, with Dr. Borkenstein often bringing one of his own culinary creations or special items such as his mother's recipe for lentil soup. She will miss his warm, gentle, unassuming nature.

One of his closest friends, Kurt Dubowski, remembers how incredibly generous Bob and Marjorie were, while remaining very private about it. They maintained many long-term, and always unpublicized, philanthropies. Kurt's mother was such a favorite of Bob's that when she passed away he endowed a new church with an organ in her name as a memorial. Typically, he hardly mentioned the endowment to Kurt.

The last time I saw Dr. Borkenstein was a few years ago in a busy airport when he stopped to chat. He encouraged me a great deal that day as he shared about a number of projects that he still wanted to complete. They all

focused on saving lives. And as we parted he told me he always looked forward to seeing me.

Dr. Borkenstein's beloved wife Marjorie preceded him in death in 1998. Although they had no

were held August 31, 2002, in Krauss Chapel of Trinity English Lutheran Church, Fort Wayne, where he was a member. He was laid to rest in Lindenwood Cemetery in Fort Wayne. A

tribute service will be held in December at Indiana University during the Robert F. Borkenstein Course on Alcohol and Traffic Safety.

Dr. Borkenstein had several poems that spoke of dedication, devotion and the indomitable spirit of man. One of his favorites was Edgar A. Guest's "It Couldn't Be Done."

Doctor Borkenstein left a remarkable legacy. He cared deeply and he showed us the way to care too. We will miss him most assuredly because his life was one of example, dedication and excitement. I can still see that grin and those bright twinkling eyes so full of caring. We can all know that this earth is a better place because Bob Borkenstein was here for awhile and we are all a little wiser because of what he gave us and what he left us. He may have been small in stature but he was a giant to many, and he left a giant void.

Thank you Dr. Borkenstein for setting the standard! ☀

Dr. Borkenstein had several poems that spoke of dedication, devotion and the indomitable spirit of man. This poem was one of his favorites.

It Couldn't Be Done

By Edgar A. Guest

Somebody said that it couldn't be done
But he with a chuckle replied
That "maybe it couldn't," but he would be one
Who wouldn't say so till he tried.
So he buckled right in with a trace of a grin
On his face. If he worried he hid it.
He started to sing as he tackled the thing
That couldn't be done, and he did it.

Somebody scoffed: "Oh, you'll never do that;
At least no one ever has done it."
But he took off his coat and he took off his hat,
And the first thing we knew he'd begun it.
With a lift of his chin and bit of a grin,
Without any doubting or quiddit,
He started to sing as he tackled the thing
That couldn't be done, and he did it.

There are thousands who tell you it cannot be done,
There are thousands to prophesy failure;
There are thousands to point out to you, one by one,
The dangers that wait to assail you.
But just buckle in with a bit of a grin,
Just take off your coat and go to it.
Just start to sing as you tackle the thing
That "cannot be done", and you'll do it.

children of their own, they are survived by nieces Jill Borkenstein and Sue Swift, and nephews David and William Borkenstein. Memorial services

Professor Robert Frank Borkenstein
Other Selected Tributes



Robert F. Borkenstein
6th ACJS President
1968-1969

Robert F. Borkenstein was born in Fort Wayne, Indiana, on August 31, 1912, to German immigrant parents, and grew up bilingual, later writing scientific papers in both English and German. When Bob finished high school it was the beginning of the Great Depression. Unable to afford college, he began work as a photographic technician, and soon invented a new means for developing color photographs and two new cameras. It was these skills that allowed him to secure a position with the Indiana State Police (ISP) in 1936 in their newly formed forensic science program. Two years later, he was offered a position in the ISP laboratory in Indianapolis. Shortly after moving there, he met his future wife, Marjorie J. Buchanan.

While working for the ISP in the lab, Borkenstein became involved in a number of inventions, including working with John Larson and his polygraph. His most noted invention, however, was the development of the Breathalyzer. A Professor Harger had developed the Drunkometer, but it was large, cumbersome, and difficult to interpret. Borkenstein assisted in the fielding of the device for the ISP, but he began working to make a smaller, more efficient device. His result was a small box, with minimal parts, that was highly efficient. In 1954, he had invented and commercially produced the Breathalyzer. As Borkenstein explained, "The strength of the Breathalyzer is its innate stability. It requires less skill on the part of the operator, and its life expectancy is unlimited. There's nothing to wear out. The Breathalyzer is so simple and direct that it will be hard to kill."

During this same time period, Borkenstein began gravitating to many of the science and foreign language classes offered by Indiana University, and eventually earned enough credits to receive his Bachelor's degree in Forensic Science in 1958. That was the same year he retired as Captain of the ISP Laboratory, for he was offered a position with the faculty at Indiana University as Chairman of the Department of Police Administration. It was also during this time frame that he met V.A. Leonard, a friend of John Larson's, and Leonard encouraged Borkenstein to join the American Society of Criminology. In 1963, when Leonard retired, Borkenstein flew to Washington for Leonard's retirement party, thus becoming part of the new International Association of Police Professors (IAPP).

Borkenstein was elected the sixth president of the IAPP and served from 1968 to 1969. The emphasis of his presidency was to make criminal justice (as it was now being referred) an academic discipline. Also during his tenure as president, Borkenstein began conducting research with the Breathalyzer to determine the risk of a driver being involved in an accident as a function of his or her blood alcohol content (BAC). The famous Grand Rapids Study revealed that mild BAC rates, up to .03, made driver's safer (on account they are more relaxed), but that anything beyond .08 posed increased risks. This study proved to have a profound impact on public policy in both the United States and Canada.

Retiring in 1987, he was elevated to Professor Emeritus and was awarded an honorary LL.D. from Indiana University. The National Safety Council inducted him into their Hall of Fame and established the Robert F. Borkenstein Award, still issued today.

His wife of 60 years died in December of 1998, and Robert Borkenstein followed on August 10, 2002, at the age of 89. His papers are today located in the Indiana University Archives.

By Robert B. Voas, Ph.D.

On October 10, 2002, Dr. Robert (Bob) Borkenstein passed away at the age of 90. He can appropriately be called the "Father" of the International Council on Alcohol, Drugs and Traffic Safety (ICADTS). He attended the first meeting of what was to become ICADTS in 1950 and provided the leadership and inspiration for organizing its international meetings through the next four decades.

Founding a worldwide scientific organization is a remarkable achievement for an individual who began his career without completing a 4-year college program. However, Bob combined an innovative technical talent with a broad interest in science and an enthusiasm for international issues in criminal justice and traffic safety. He began his professional life as a police photographer and rapidly advanced as a criminal justice technician with the Indiana State Police. He wound up his 22-year police career as a Captain, heading the Indiana State Police Forensics Laboratory. Then, from 1958 to his retirement in 1983, he was a professor and Chairman of the Department of Police Science at the University of Indiana. Although he is best known for the development of the Breathalyzer(tm), he invented several novel devices throughout his career, including a color-sensing system for inspecting precision parts on bomb bay doors for which he received a special award from the British government in 1997.

Robert Borkenstein made two seminal contributions to the field of alcohol safety: (1) the invention of the Breathalyzer(tm) and (2) the conduct of the "Grand Rapids" study of the relative risk of a crash produced by a driver's blood alcohol concentration (BAC). Bob was not the first to invent a breath-alcohol-measuring device, but he was the first to invent an instrument so simple that any police officer could use it with high accuracy and minimal training. This greatly increased the efficiency of the arrest process by avoiding the need to call special technician to take a blood sample and eliminating the delay waiting for the laboratory result. Although only one of several research efforts to compare the BACs of crash-involved drivers with drivers using the roads at the same times and places to determine the relative risk of crash involvement, the Grand Rapids study was one of the earliest and largest studies of its kind and had a strong influence on impaired driving laws in the United States and abroad.

These achievements brought invitations to international conferences. Bob used his many contacts with foreign researchers to organize follow-up meetings to the original ICADTS conference in Stockholm, Sweden, in 1950. He played an important role in organizing the 1953 meeting in Toronto and the 1962 meeting in London. In 1965 he hosted the ICADTS meeting in Bloomington, Indiana. From 1969 to 1983, he served as president of ICADTS and was instrumental in arranging invitations for ICADTS meetings in Freiberg, Germany (1969); Toronto, Canada (1974); Melbourne, Australia (1977); Stockholm, Sweden (1980); and San Juan, Puerto Rico (1983). Beginning in 1963, the presidency passed on to others, but Bob remained active in planning and participating in ICADTS meetings through the 1986 meeting in Amsterdam, the 1989 meeting in Chicago, and the 1992 meeting in Cologne.

In the early years of the organization, Bob recruited the leading workers in the field to serve on the ICADTS executive committee and financed the cost of the communications and, in some cases, the executive committee meetings themselves from his Breathalyzer(tm) royalties. Bob had a great appreciation for the work being done in countries outside the United States and worked hard to establish an organization that would include strong participation from scientists throughout the world. He attempted to ensure that the meeting venues moved back and fourth across the four main areas of impaired driving research (Australia, Canada, Europe, and the United States), and made an attempt to reach out to Latin America by organizing a meeting in Puerto Rico in 1983. He also initiated the sponsorship of satellite meetings on specific topics such as the meeting on roadside surveys in Umea, Sweden, in 1980.

Another contribution of Bob Borkenstein to ICADTS was the establishment of the Widmark Award, which is presented to individuals and organizations that have made outstanding contributions to the field of impaired driving. It was Bob's belief that ICADTS should include

professionals from all relevant fields-medicine, law, public health, psychology, economics, public information, and law enforcement-as well as public officials active in the development and implementation of impaired driving policy. This has been reflected in some of the Widmark Organizational awardees, which have included The U.S. National Safety Council (NSC), The British Medical Association (BMA), and Mothers Against Drunk Driving (MADD).

Aside from playing a central role in the development of the organization, Borkenstein presented many provocative papers at ICADTS meetings that influenced policy making in the United States and abroad. His report at the Toronto meeting in 1974 on enforcement of driving under the influence (DUI) of alcohol indicated that the average officer made only two impaired driving arrests a year and suggested that there might be as many as 2,000 alcohol-impaired trips for each arrest. Although the level of enforcement in the United States has increased since that time, the low probability of being apprehended for impaired driving remains a significant problem in the United States. To more actively involve all officers in impaired driving enforcement, Borkenstein proposed the adoption of a law that would establish an additional sanction for a moving traffic violation aggravated by alcohol that could be added to speeding or red-light-running citations when a police officer determined that the driver had been drinking but was not over the legal limit. That idea was never implemented; however, with impaired driving deaths increasing in the United States, it merits consideration.

Bob Borkenstein left an important legacy to the field of impaired driving through his demonstration that rapid and valid breath-test measurements could be made by ordinary police officers. This led to the adoption of a breath sample as the method of choice for the enforcement of BAC limits in most countries and to the rapid development of small handheld preliminary breath sensors that provided the basis for random-testing programs around the world. He also left to his scientific colleagues an important instrument for the promotion and dissemination of research: the International Congress on Alcohol, Drugs and Traffic Safety.

| ICADTS Home Page |

NHTSA Newsletter, US Department of Transportation,
Vol 8, No. 9, Sept. 2002

Loss of a Giant in the Field of Alcohol and Highway Safety

By Jim Frank,
Office of Impaired Driving



NHTSA is saddened by the loss of Robert F. Borkenstein, Professor Emeritus of Indiana University and retired Indiana State Police Captain. Robert Borkenstein died Aug. 10 at his home in Bloomington, Indiana,

following a long illness. He was 89.

Dr. Borkenstein was a true pioneer in the field of alcohol and highway safety. He is best known for inventing the "Breathalyzer," the first commercially successful breath tester used by police in impaired driving enforcement. The introduction of the Breathalyzer revolutionized DWI enforcement, not only in the United States, but worldwide.

He is also known as the lead researcher in the famous Grand Rapids study, closely associated with his name. This study, completed in the 1960s, was the first large scale epidemiological study to assess the risk of being involved in an alcohol-related crash as a function of the blood alcohol concentration level of a driver. Today, it is viewed as classic research that laid the foundation for so much that has followed in the field of alcohol and highway safety.

Dr. Borkenstein was very active on the Committee on Alcohol and Other Drugs of the National Safety Council, was one of the founding members of the International Council on Alcohol, Drugs and Traffic Safety, and was known to all who worked in the field.

Dr. Borkenstein was based at Indiana University. His name will be perpetuated by the week-long alcohol- and most recently, drug-related courses, called the "Borkenstein courses", being offered twice a year at Indiana University's Center for Studies of Law in Action. Dr. Borkenstein's inventions and contribution to alcohol and highway safety research brought him worldwide acclaim. The field is not often blessed with giants of his caliber. ■

Professor Robert F. Borkenstein

Professor Robert F. Borkenstein, 89, who revolutionized enforcement of drunken driving laws by inventing the Breathalyzer to measure alcohol in the blood, died August 10 at his home in Bloomington, Indiana.

The Breathalyzer is a portable device that can determine whether the person being tested is legally drunk. It measures the proportion of alcohol vapors in exhaled air, a proportion that reflects the content of alcohol in the blood. Before widespread use of the device, police officers investigating an alcohol-related accident or noticing a weaving car had to look for physiological symptoms such as a flushed face, slurred speech, bloodshot eyes, poor balance, and/or poor eye - hand coordination. Determination of intoxication was therefore highly subjective, and convictions were difficult



File Photo Courtesy of Indiana University

to obtain. But the Breathalyzer provided solid scientific evidence of intoxication. "This technological innovation enabled traffic enforcement authorities to determine and quantify blood alcohol concentrations with sufficient accuracy to meet the demands of legal evidence," the National Safety Council said in naming Professor Borkenstein to its Safety and Health Hall of Fame International in 1988.

The ratio of breath alcohol to blood alcohol is 2,100 to 1, meaning that 2,100 milliliters of exhaled air will contain the same amount of alcohol as one milliliter of blood. For many years the typical legal standard for drunkenness across the United States was 0.10, meaning 0.10 gram of alcohol per 100 milliliters of blood. Many states have now adopted 0.08 as a standard, and the federal government has pushed all states still allowing higher levels to adopt the 0.08 standard.

Professor Borkenstein started working for the Indiana State Police in 1936 and did early research on the development of the lie detector, the use of photography in criminal and accident investigations, and the first major electronic speed measurement device for traffic law enforcement. He eventually rose to the position of Captain in charge of laboratory services. He collaborated with Dr. R. N. Harger of the Indiana School of Medicine to develop the Drunkometer, one of the first instruments that accurately measured blood alcohol. This led to his independent invention of the smaller, easier-to-use Breathalyzer in 1953. Subsequent, even more accurate devices to detect drunkenness use infrared radiation, among other means.

Professor Borkenstein received a Bachelor's degree in forensic sciences from Indiana University in 1958, a Doctor of Science degree from Wittenberg University in 1963, and a Doctor of Laws degree from Indiana University in 1987. He was a member of the faculty at Indiana University's Department of Forensic studies from 1958 through 1983, serving as Chairman from 1958 to 1971. Over the years he was Chairman of the National Safety Council, Consultant to the President's Task Force on Highway Safety, President of the International Committee on Alcohol, Drugs and Traffic Safety, and President of the Academy of Criminal Justice Sciences.

* * * * *

Breathalyser inventor dies

Robert Borkenstein, the inventor of the breathalyser, died in August, just short of his 90th birthday. A career policeman and initially self-taught scientist who later became a distinguished academic, Borkenstein was involved in a number of technical developments but will go down in history for his work on breath alcohol analysis.

As a photographer in the Indiana State Police, Borkenstein had to attend the scenes of many fatal accidents caused by drunken drivers. In the 1930s he collaborated with Rolla Harger, a toxicologist at Indiana University who had discovered the fixed ratio between blood and breath alcohol (2100 ml of breath contains the same amount of alcohol as 1 ml of blood).

Harger and Borkenstein developed the Drunkometer, which involved collecting a breath sample for laboratory analysis. Later, in the early 1950s, Borkenstein developed the portable tester that allowed police to conduct roadside tests. Marketed as the Breathalyzer, the device quickly caught on (see photo).



Breathalysers detect the colour change when reddish-orange potassium dichromate is converted to blue-green chromium sulphate by ethyl alcohol in the presence of sulphuric acid and silver nitrate. The colour change is directly related to the concentration of alcohol in the breath sample. Borkenstein's early training in photography probably helped him to choose and develop this method.

In 1958, aged 46, Borkenstein retired as the captain in charge of Indiana State Police's laboratory services, took a bachelor's degree, and began a second distinguished career as professor of forensic studies at Indiana State University. □

Chemistry A-level numbers fall

This year's A-level chemistry results show a continuing downward trend, with numbers of pupils taking the full A-level chemistry falling from about 38 000 in 2001 to about 36 000. At the same time, however, numbers sitting the recently introduced AS-level chemistry rose from 39 000 in 2001 to 46 000.

The increased number of AS candidates is an encouraging sign of an improved general interest in chemistry. Academics may worry, however, that if the new recruits are not tempted enough to go on and tackle the full A-level, then the increase will not help to stop the fall in numbers of chemistry undergraduates.

John Holman, professor of chemical education at the University of York, believes that one way of addressing the decline in numbers is 'to show students something of the exciting frontiers of chemistry'. Salters Advanced Chemistry, of which Holman is a pioneer, embodies this philosophy, and has been available to schools for a number of years. The syllabus may be growing in popularity, yet overall numbers continue to fall. □

CHEMISTRY IN BRITAIN OCTOBER 2002

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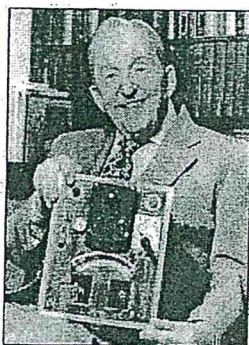
The week, 31 August 2002

The scientist who invented the Breathalyser

Robert Borkenstein
1912-2002

Robert Borkenstein, who has died aged 89, was the inventor of the Breathalyser, the portable device designed to test whether drivers have consumed too much alcohol to be safe behind the wheel. His invention was not widely welcomed by motorists, but has saved countless lives on both sides of the Atlantic. "If we can make life better simply by controlling alcohol, that's a very small price to pay," he once said. "My whole life's been spent trying to make life better for people."

Born in Fort Wayne, Indiana, in 1912, Borkenstein began working as a photographer for the state police after leaving high school. He had a natural flair for science, and soon found himself working on early incarnations of the lie detector. But it was his work on drunken driving that made his name, said David Osborne in *The Independent*. Until the advent of his inventions, there had been no scientific method of testing how much alcohol a driver had consumed, and police were forced to rely on their own



Borkenstein with his invention

observations: asking drivers to walk in a straight line, for instance, and smelling their breath. In the late Thirties, Borkenstein began collaborating with a distinguished toxicologist, Rolla Harger, on a machine called the Drunkometer. This was a rather cumbersome device requiring a suspect to blow into a balloon. The contents were then analysed in a laboratory. In the Fifties, Borkenstein came up with a more practical machine which he called the Breathalyser – a combination of the words "breath", "alcohol" and "analyse". It could be carried in police patrol cars, and gave instant readings. It was first marketed in the US in 1958, and introduced in Britain in 1967.

Borkenstein himself believed in total abstinence for drivers, said *The Guardian*. However, he also invented a coin-operated Breathalyser for use in pubs. When a customer dropped in a coin and blew through a straw, a reading of 0.04 or less would produce the message: "Be a safe driver." Between 0.05 and 0.09 would advise: "Be a good walker." At 0.10, it sounded an alarm and warned: "You're a passenger."



Robert Borkenstein

Robert Borkenstein, inventor of the breathalyser, died on August 10th, aged 89

WHEN Robert Borkenstein became a policeman in the 1930s, a motorist would need to have been clearly drunk before being thought a menace. Unless his speech was unmistakably slurred and he was a bit wobbly on his feet he could probably avoid prosecution. Even if he were taken to court, a lawyer might argue successfully that his client was tired through overwork. Worse, many Americans, happy to have got rid of prohibition, saw a drunk as simply a sociable fellow, a bit of a comic, even at the wheel of a car.

This was not the view of Mr Borkenstein. As a photographer for the Indiana police he had recorded a number of fatal accidents involving drivers that he was sure had drunk too much. When he became head of Indiana's police laboratory he puzzled over the problem of how to measure, simply and reliably, how much alcohol a driver had consumed.

A friend of his at Indiana University, Rolla Harger, was studying the effects of alcohol on humans. He worked out that the amount of alcohol in a person's blood could be measured by taking a sample of his breath. One millilitre of alcohol in the blood equalled 2,100 millilitres of breath. Helped by Mr Borkenstein, he devised an instrument they called the drunkometer. This was the forerunner of the breath-

alyser that Mr Borkenstein patented and marketed in 1954 and which for many years has been routinely used by police in the United States and other countries.

There is often an air of suspicion over claims to the authorship of scientific discoveries, especially those that have resulted in fame and fortune. Was Harger the real inventor of the breath test? He was a pioneer in the study of inebriation, and the drunkometer was an attempt to put his work to practical use. But it involved blowing into a balloon, which was then sent to a laboratory where the air was passed through a solution that changed colour if alcohol was present. The amount of alcohol could then be calculated. The breathalyser was fairly easy to use and could give a quick reading. Our picture shows Mr Borkenstein demonstrating it in the 1970s. Rolla Harger (who died in 1983, aged 93) admired the breathalyser and was happy to credit Mr Borkenstein with its invention. They remained good friends with the common aim of stopping drunken driving.

No lies

Robert Borkenstein was largely self-taught. As a youngster he dabbled in science and devised a system of colour photography. Science, he believed, could defeat the law-breaker. Not only would

science deter drivers from drinking, it would make evidence presented to the courts more reliable. He worked on improving the efficiency of the polygraph—the lie detector—and conducted some 15,000 tests with the instrument. But despite a successful career in the police, Mr Borkenstein felt he had missed out by not having had a university education. He gained the comfort of a degree in his late 30s, in subjects that came easy to him, police administration and French: his wife was French, and the couple often took their holidays in France. Eventually, he said goodbye to the police and took his experience to Indiana University where he became head of its department of forensic studies for 30 years.

As the inventor of the breathalyser, a name that went into the dictionary, Mr Borkenstein was in much demand as a speaker in a country in love with the car but appalled by the carnage on the road. Thousands of breathalysers were made by various manufacturers under licence, increasingly compact and increasingly efficient. One, a coin-machine designed by Mr Borkenstein for use in bars, would speak a variety of messages depending on the state of the user: "Be a safe driver", "Be a good walker", or "You're a passenger".

Competitors to the breathalyser, and claimed to be more efficient at measuring alcohol, are now on the market. Still, the effect of alcohol on the body remains not wholly understood. A study carried out by Mr Borkenstein in 1981 suggested that in certain cases a driver who had drunk less than two ounces of alcohol might be safer than a driver who was an abstainer, because he was more relaxed. The study was paid for by a liquor company and treated with suspicion. Mr Borkenstein was upset that his honest finding was applauded by motorists who said they drove better after a few drinks. He liked a drink, wine especially, but whatever might be its relaxing qualities in some situations, he advocated abstinence at the wheel.

It was a disappointment to him that although the threat of being breathalysed must have deterred many drivers from drinking, the number of road deaths attributed to alcohol remains high: 15,700 in the United States in 1999, more than a third of all road deaths. In Europe the fatalities are proportionately lower. Even so, about 5,000 people die on the roads in Spain each year as a result of drink. Even Sweden, where the legal limit is tiny and drunken drivers routinely go to jail, there are 500 road deaths a year attributed to drink. The Swedes are experimenting with a device fitted to a car dashboard that monitors the driver's breath. If he has been drinking, the car won't start. It may be the next step forward from Mr Borkenstein's breathalyser of 50 years ago. ■

Professor Robert Frank Borckenstein
Obituaries Appearing in US and International
Newspapers

THE TIMES, Wednesday August 21, 2002

Robert Borkenstein

Life-saving inventor of the Breathalyzer, who played both friend and foe to the drink driver

Robert Borkenstein invented the Breathalyzer, the handheld device that measures whether a driver has consumed too much alcohol to be safe behind the wheel. His invention, while the scourge of many motorists, has saved countless lives worldwide and also, thanks to its accuracy, led to the increasing social ostracism of those who still drink and drive.

Borkenstein worked on the first version, known as a Drunkometer, as long ago as 1938, but it was not until 1954 that he developed the Breathalyzer (a combination of the words "breath", "alcohol" and "analyse"). By 1958 it was being marketed, and was soon in use on both sides of the Atlantic.

While he personally advocated abstinence when driving and invariably practised what he preached, Borkenstein was happy to help the motorist to regulate his drinking. He produced a coin-operated version of the Breathalyzer to be installed in pubs and clubs. A low reading prompted the message "Be a safe driver"; a medium reading "Be a good walker"; and a high one "You're a passenger". He attracted controversy, though, in 1981, when he supervised a study, paid for by the drinks industry, which suggested that a small amount of alcohol might help a driver's performance behind the wheel by helping him to relax.

Before the invention of his alcohol-measuring devices, the determination of drunkenness was a subjective one, generally dependent on police observation — and subject to frequent and often successful challenge in the courts. The integrity of the Breathalyzer, however, has rarely been questioned, and the instrument has become an important weapon in the battle against drivers who might maim or kill for the sake of a few drinks.

Robert Frank Borkenstein was born in Fort Wayne, Indiana, and from a young age was passionate about scientific experiments. After high school he worked in a photographic shop, helping to develop a new colour printing process. He joined the Indiana state police in 1936, from where his scientific knowhow was put to good use in the development of the lie-detector.

He worked on the Drunkometer with Professor Rolla Harger. Although advanced for its time, the gadget required a suspect to blow into a balloon, which was later transported to a laboratory for ana-



lysis. The advantage of the Breathalyzer was that it automated the process and was relatively simple to operate. Soon it was being carried by police patrol cars as a matter of course.

It was introduced into Britain in October 1967 by Barbara Castle while she was Minister of State at the Department of Transport. Although she was denounced by some sections of the liquor trade, her obituaries when she died in May this year all paid tribute to the directly attributable reduction in the number of road deaths and the consequent change in driving habits.

After many years as head of the state police laboratory, Borkenstein enrolled at Indiana University in the 1950s, graduating with a degree in forensic sciences. In 1958 he was appointed professor of forensic sciences there.

He later served on numerous road safety bodies, as chairman of the National Safety Council and as consultant to the President's Task Force on Highway Safety. He eventually sold the rights to the Breathalyzer to a company based in Colorado.

Robert Borkenstein was married to Marjorie Buchanan, a children's author. She died in 1999.

Robert Borkenstein, Professor of Forensic Studies at Indiana University, 1958-83, was born in Fort Wayne, Indiana, on August 31, 1912. He died in Bloomington, Indiana, on August 10, 2002, aged 89.



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Professor Robert Borkenstein

Inventor of the breathalyser

19 August 2002

The unusual gadget invented by Robert Borkenstein may not have made him many friends around the world, but he always knew that it had surely saved countless lives. Its name, which he also coined, is familiar to us all. It is the breathalyser. Now with its own entry in most English dictionaries, it is a compound of breath, alcohol and analyser.

Robert Frank Borkenstein, forensic scientist: born Fort Wayne, Indiana 31 August 1912; Professor, Department of Forensic Sciences, Indiana University 1958-83 (Emeritus); married Marjorie Buchanan (died 1998); died Bloomington, Indiana 10 August 2002.

While police officers today have more sophisticated machines to measure the degree of intoxication of drivers, the breathalyser was standard equipment in patrol cars for decades after it was first marketed by Borkenstein in 1958. It replaced a far more cumbersome device, the Drunkometer, which he had also had a hand in inventing.

Born in Fort Wayne, Indiana, in 1912, Borkenstein showed a flair for science from his youth, working in a local photography shop as a teen even before leaving school. He developed a new colour printing process. His ingenuity later earned him a job with the Indiana State Police in 1936, where he rose to take charge of its laboratory services.

His motto might have been that all fibs told to the cops will not go undiscovered. His earliest work with the state police was on early incarnations of the lie detector. For years afterwards, he served as an expert on the use of lie detectors, lecturing to students and assisting police departments worldwide.

But it was his work on drunken driving that most distinguished him. Until his inventions came along, law enforcement had no scientific way to measure just how much a driver had consumed. Police officers had to rely on their own observations, watching how drivers stood, asking them to walk a straight line without wobbling, listening to their speech and checking if their eyes were bloodshot. Often attempts at convicting violators in court fell apart, because there was no evidence to support the drunken driving charge.

After associating himself with the University of Indiana, where he would later earn a Bachelor's degree in forensic science and work for decades as a lecturer to prospective police officers from all

across the United States, Borkenstein collaborated with the university's toxicology professor, Rolla Harger, on developing what became known as the Drunkometer. Introduced in 1938, it gave police officers the first tool scientifically to prove drunkenness at the wheel.

It was, however, a cumbersome machine. Drivers were required to breath into a balloon. Assuming it did not slip from the police officer's hands, it was taken to a laboratory where the breath inside was filtered through a concoction of chemicals, which turned different colours, depending on how much alcohol vapour it contained.

By 1954, however, Borkenstein had come up with the far more convenient breathalyser. The same basic science was involved. Alcohol in the blood passed into air in the deep lungs, which were then breathed into the machine. Easy to use, the breathalyser was able to determine the alcohol level instantaneously. Several years later, Borkenstein published a milestone paper, the Grand Rapids study, which argued that 0.08 blood-alcohol content should be the standard, above which any driver should be considered impaired. Over the years, 0.08 was adopted by most US states as the point beyond which convictions were pursued.

For decades since, drivers who had had one too many tried myriad ways to fool the breathalyser. Most famously, a Canadian driver ate his underwear after being stopped, erroneously believing that the cotton would somehow absorb the traces of booze. In court, he was acquitted after members of the jury had to leave, unable to stop laughing.

One of Borkenstein's last inventions was a coin-operated breathalyser. A reading of .04 or less would prompt the message "Be a safe driver." A reading between .05 and .09 flashed "Be a good walker." A score of .10 or higher: "You're a passenger." Most bar owners reckoned their patrons would rather not know, however.

Borkenstein once summed up the purpose of his career. "If we can make life better simply by controlling alcohol, that's a very small price to pay. My whole life's work has been spent trying to make life better for people."

David Usborne

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Robert Borkenstein

The man who invented the Breathalyser

Christopher Reed

Tuesday 20 August 2002 11.12 BST

The American Robert Borkenstein, who has died aged 89, was never a people's hero, but his most important invention, the Breathalyser, continues to save lives on both sides of the Atlantic.

He also worked on a study that led to the lowering of the permitted level of alcohol in the blood for drivers in most American states - from .1 to .08 grammes per 100 millilitres.

Both innovations were widely resented at the time, and the United States, with its greater dependence on the car, is still relatively lenient in its treatment of drunk drivers compared to many countries in Europe and Scandinavia.

Borkenstein was a genial fellow, who liked listening to Gilbert and Sullivan, enjoyed serving drinks to his friends and exhibited a catholic taste in wines and spirits. But on one thing he remained firm: abstinence before driving, even though he supervised a study, paid for by the liquor industry, that suggested that the relaxing effect of having drunk less than two ounces of alcohol might produce a slightly better driver than one who had none.

The Breathalyser - from "breath, alcohol and analyse" - depended on the relation between the amount of alcohol in exhaled air and the proportion in the blood. This was not Borkenstein's discovery, but he was the man who provided a small, reliable and portable device to take the measurements, which any police officer could handle.

An earlier instrument had been the drunkometer, on which Borkenstein collaborated with its inventor, Rolla Harger, a toxicology professor at Indiana University. In 1938, this had replaced laboratory analysis of drawn blood, but it required the driver to blow into a balloon, which was then taken to the laboratory. This was a time-consuming and awkward process that depended on the visual talents of the technician doing the analysis - a procedure in which defence lawyers were often successful in finding faults.

Borkenstein came up with the Breathalyser on his own in 1954 - before he even had a university degree. It was smaller than the drunkometer, substituted a rubber hose for the balloon, and added an automatic device to judge the colour comparisons previously made by the naked eye. It was marketed in 1958, and Borkenstein held the patent for most of his life, finally selling it to the Colorado firm that markets it today, although it is no longer the dominant instrument used by police forces. Its name, however, entered the vernacular.

Borkenstein displayed early technical skills when, in 1936, he began working as a photographer for the state police in his native Fort Wayne, Indiana, after leaving high

school. He invented a colour printing process that was sold to businesses, and rose rapidly to become director of the Indiana police laboratory.

After the Breathalyser went on sale, Borkestein took a degree in forensic science at Indiana University, and joined the faculty after graduation as chairman of the newly-formed department of police administration. He later became chairman of the forensic studies department and director of the university's centre for studies of law in action. The class he established on alcohol and highway safety became a national standard in the United States, and is now called simply the Borkestein course.

Well-liked and known for his generosity to younger colleagues, Borkestein was also a Francophile, and incorporated French into his degree. He travelled extensively to Paris and other parts of France with his wife, Marjorie Buchanan, a children's book author who died in 1999. They had no children.

As well as the Breathalyser, he worked extensively on developing the polygraph, or lie detector, and administered more than 15,000 tests before his retirement in the late 1980s. Polygraphs are not admitted as evidence in the US federal justice system, and, although widely used in police inquiries, they remain controversial assessors of honesty.

Another gadget Borkestein invented was a coin-operated Breathalyser that could be installed in bars. When a customer dropped in a coin and blew through a straw that popped up, a reading of .04 or less would produce a message: "Be a safe driver." Between .05 and .09, the machine blinked and advised: "Be a good walker." At .10 or higher, it sounded a small alarm and warned: "You're a passenger."

· Robert Frank Borkestein, academic and inventor, born August 31 1912; died August 10 2002.

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August 17, 2002

Robert F. Borkenstein, 89, Inventor of the Breathalyzer

By DOUGLAS MARTIN

Robert F. Borkenstein, who revolutionized enforcement of drunken driving laws by inventing the Breathalyzer to measure alcohol in the blood, died last Saturday at his home in Bloomington, Ind. He was 89.

The Breathalyzer is a portable device that can determine whether the person being tested is legally drunk. It measures the proportion of alcohol vapors in exhaled air, a proportion that reflects the content of alcohol in the blood.

Before widespread use of the device, police officers investigating an accident or noticing a weaving car looked for symptoms like a flushed face, slurred speech and bloodshot eyes. If the suspect then went to sleep in the police station, they might have sufficient basis for charges.

Getting a conviction was harder still. Defense lawyers might say the suspect had been staggering because of the long hours he worked, and bring in friends to say he had had no more than two beers. The defendant might maintain that his eyes had been red as a result of allergies.

But the Breathalyzer provided scientific evidence of intoxication.

"This technological innovation enabled traffic enforcement authorities to determine and quantify blood alcohol concentrations with sufficient accuracy to meet the demands of legal evidence," the National Safety Council said in naming Mr. Borkenstein to its Safety and Health Hall of Fame International in 1988.

The ratio of breath alcohol to blood alcohol is 2,100 to 1, meaning that 2,100 milliliters of exhaled air will contain the same amount of alcohol as one milliliter of blood.

For many years the typical legal standard for drunkenness across the United States was 0.10, meaning 0.10 gram of alcohol per 100 milliliters of blood. Many states have now adopted 0.08 as a standard, and the federal government has pushed others to do so.

Robert Frank Borkenstein was born in Fort Wayne, Ind., on Aug. 31, 1912. His youthful passion was science experiments, and he went to work in a photography shop after graduating from high school. He developed a new color printing process, which was sold to other businesses.

He started working for the Indiana state police in 1936, did early research on the development of the lie detector and rose to captain in charge of laboratory services.

He collaborated with Dr. R. N. Harger of the Indiana School of Medicine to develop the Drunkometer, one of the first instruments that accurately measured blood alcohol. This led to Mr. Borkenstein's independent invention of the smaller, easier-to-use Breathalyzer in 1953. Subsequent, even more accurate devices to detect drunkenness use infrared radiation, among other means.

Mr. Borkenstein received a bachelor's degree in forensic sciences from Indiana University in 1958 and then joined the faculty there as chairman of a newly formed department of police administration.

Over the years he was chairman of the National Safety Council, consultant to the President's Task Force on Highway Safety, president of the International Committee on Alcohol, Drugs and Traffic Safety, and president of the Academy of Criminal Justice Sciences.

His wife, the former Marjorie K. Buchanan, died in 1999. He had no immediate survivors.

In 1981, Mr. Borkenstein supervised a study, financed by the liquor industry, whose findings suggested that a driver who had had less than two ounces of alcohol might be less dangerous than one who had had none. He theorized that some alcohol might help a driver's performance behind the wheel by relaxing him.

Nonetheless, Mr. Borkenstein continued to advocate abstinence before driving. He also lamented the effects of alcohol consumption on the job, which in 1995 he estimated cost American employers \$115 billion a year.

"One way to keep from sacrificing our standard of living is to keep our people sober at work," he told The Associated Press. "If we can make life better simply by controlling alcohol, that's a very small price to pay."

Photo: R. F. Borkenstein in the 1970's.

LOS ANGELES TIMES

Aug 18, 2002

**Robert Borckenstein, 89, Inventor of
Breathalyzer Intoxication Tester**

By Elaine Woo

Robert F. Borckenstein, whose Breathalyzer has helped snare millions of intoxicated drivers in the United States and around the world, died Aug. 10 at his home in Bloomington, Ind.

He was 89 and had been in declining health after a series of strokes.

Borckenstein was a professor of forensic studies at Indiana University for three decades, until his retirement in the late 1980s. He helped establish a class on alcohol and highway safety that became a requirement for law enforcement and forensic specialists in many jurisdictions. The university now calls it "The Borckenstein Course."

He also led several influential research projects, the best known of which was the Grand Rapids Study, in 1963-64. That study established that a blood alcohol level of .08 could impair driving. The legal standard for intoxication now applied in California and other states is .08, lower by half than the benchmark used by law enforcement before the study.

But Borckenstein was best known as the inventor of the Breathalyzer, the first practical instrument for determining blood alcohol in the field.

Although it no longer dominates the market, it was the standard for so many years that it earned its own dictionary entry, alongside such household names as Teflon and Kleenex.

“A trademark used for a device that detects and measures alcohol in expired air,” says the American Heritage Dictionary in the entry for Borkenstein’s invention.

“He was famous for good applied science,” said Hillard Trubitt, a retired Indiana University professor who worked under Borkenstein for 25 years.

Borkenstein was also a sought-after expert on the polygraph and administered more than 15,000 lie detection tests during his career.

A native of Fort Wayne, Ind., Borkenstein began working as a photographer for the Indiana State Police in 1936. He demonstrated a natural talent in science that quickly led him to become the director of the state police laboratory, even though he lacked a college degree.

While serving as lab director, he began an association with Indiana University, where he collaborated with toxicology professor Rolla N. Harger on the Drunkometer, the first accurate instrument for testing the breath to determine blood alcohol.

Before its invention in 1938, law enforcement relied on blood tests for scientific evidence of intoxication.

The Drunkometer took advantage of the fact that alcohol consumed by a person enters the bloodstream, goes through the lungs and is exhaled. The concentration of alcohol in deep lung air is related to the level of alcohol in the blood.

Harger’s device required a person suspected of excessive drinking to blow into a balloon, which was transported to a laboratory for analysis.

The suspect’s breath was passed through a fluid containing a chemical reagent, which changed color, according to the level of alcohol present.

The fluid’s hue then had to be compared with a chart color-coded to the chemical reactions triggered by various levels of blood alcohol.

It was a time-consuming and cumbersome process whose results relied heavily on the visual acuity of the person analyzing the test.

“The Drunkometer was magnificent technology for the time,” said Trubitt. “But you couldn’t take it out on the road. And an awful lot of variables could go wrong.”

Borkenstein wanted to “automate that process and compact it in such a way that you didn’t require an entire laboratory to do this thing,” Trubitt said.

What he came up with, in 1954, was the Breathalyzer, a compound of the words breath, alcohol and analyzer. Instead of balloons that could slip out of an officer’s hand, the Breathalyzer used a rubber hose connected to a vial that captured the person’s breath. It also incorporated a meter to perform the color comparisons that, with the Drunkometer, had to be done by eye.

The Breathalyzer was marketed in 1958 and quickly became a success because it was portable and reliable, removed significant human error, and didn’t require a PhD to operate.

It was routinely installed in police cars, and developed such a strong reputation for accuracy that some suspects took desperate measures to foil it: A Canadian man was reported to have eaten his underwear in the back of a patrol car while waiting for a Breathalyzer test to be administered, hoping the cotton fabric would absorb the alcohol in his system. According to a newspaper report, he was acquitted, but only after several rows of courtroom spectators had to be ushered out for laughing so hard that they were in tears.

Borkenstein joined the faculty of Indiana University in 1958 after 22 years as head of the state police lab. He later became chairman of the forensic studies department and director of the university’s Center for Studies of Law in Action.

He was known as a generous mentor with a wide-ranging intelligence for whom no question was unworthy of an answer.

Loren Reuter, an attorney who was Borkenstein’s course director in the 1980s, once wondered how gold plating was done. “For the next hour, he sat there and

explained it to me in great detail. You would never go see him unless you had an hour or so to spend,” Reuter recalled.

When Borkenstein finally pursued his bachelor’s degree in the late 1950s, he chose a double major in police administration and French. He never studied for an advanced degree, but ultimately was awarded two honorary doctorates, including an LL.D., or doctor of laws, from Indiana University.

A Francophile, he was passionate about Paris and traveled extensively with his wife, Marjorie, an author of children’s books, who died in 1998. They had no children.

He was keen on Gilbert and Sullivan, loved literature, and was an excellent bartender with eclectic tastes in wine and liquor.

But he practiced what he preached. “He certainly wasn’t a teetotaler,” said Reuter. “But I never saw him abuse it, either. He knew it helped people enjoy things.”

Borkenstein held the patent for the Breathalyzer for most of his life, finally selling the rights several years ago to a Colorado company that markets the machine.

“If we can make life better simply by controlling alcohol, that’s a very small price to pay,” Borkenstein once told an interviewer. “My whole life’s work has been spent trying to make life better for people.”

He invented many other gadgets. In 1970, he introduced a coin-operated Breathalyzer that could be installed in cocktail lounges. For 25 cents, a person could blow into a straw that popped out of the machine.

A reading of .04 or less would prompt the message “Be a safe driver.” A reading between .05 and .09 blinked out “Be a good walker.” A score of .10 or higher: “You’re a passenger.”

Professor Robert Frank Borckenstein
Curriculum Vitae and List of Publications

CURRICULUM VITAE

Professor Robert Frank Borkenstein

Professional History

- Professor, Indiana University, 1983–1998.
- Professor, Department of Forensic Studies, Indiana University. 1958–1983.
- Chairman, Department of Forensic Studies, Indiana University, 1958–1971.
- Director, Center for Studies of Law in Action, Indiana University, 1971–1998.
- Captain in Charge of Laboratory Services, Indiana State Police, 1936–1958.
- Consultant at the US Public Health Service, Division of Accident Prevention, 1962–1965.
- Board of Directors, Lutheran School of Theology at Chicago, 1964–1970.
- Principal Advisor, Office of Alcohol Countermeasures, US Department of Transportation, Washington D.C., 1972–1976.
- Lecturer (visiting), Northwestern University Traffic Institute 1938–1963.
- Lecturer (visiting), University of Louisville Southern Police Institute, 1953–1965.
- Lecturer (visiting), Louisiana State University Police Training Institute, 1970–1974.
- Consultant, Johns Hopkins Alcoholic Beverage Medical Research Foundation.
- Has given invited papers to National and International Conferences on Law Enforcement, Traffic Safety, and Forensic Sciences in Austria, Australia, Canada, Republic of China (Taiwan), England, Finland, France, Germany, The Netherlands, Puerto Rico, Sweden, Switzerland and, New Zealand.

Academic Degrees

A.B. Indiana University, 1958.

D.Sc. Wittenberg University, 1963 [Honorary].

LL.D. Indiana University, 1987 [Honorary].

Memberships

1. Indiana University Society for Advanced study (Board of Directors).
2. Indiana University Transportation Research Center (Associate).
3. International Association of Chiefs of Police (Life Member).
4. Harvard Associates in Police Science.
5. American Academy of Forensic Sciences (Fellow).
6. Association for the Advancement of Automotive Medicine.
7. International Committee on Alcohol, Drugs and Traffic Safety (President 1969–1986).
8. International Committee on Alcohol, Drugs and Traffic Safety Chairman of the Widmark Awards Committee, (1986–1992).
9. National Safety Council, Traffic Safety Division.

10. National Safety Council, Committee on Alcohol and other Drugs (Past Chairman), Executive Board.
11. Academy of Criminal Justice Sciences (Past President).
12. Alliance for Traffic Safety (Washington, DC).
13. Academy of Safety Educators (Fellow).
14. American Public Health Association.

Editorial Activities

1. Journal of Studies on Alcohol (Rutgers University)-(Editorial Referee).
2. Blutalkohol (Steintor-Verlag, Hamburg – Consulting Editor).
3. Alcohol, Drugs and Traffic Safety, Current Research Literature (Almqvist & Wiksell, Stockholm) (Editorial Board).
4. Forensic Science Review (Central Police College Press, Taipei, Taiwan (Editorial Board).
5. Journal of Traffic Medicine (Uppsala, Sweden (Editorial Board).

Research Inventions and Patents

Principal Investigator, Grand Rapids Study of the Role of the Drinking Driver in Traffic Accidents. Project funded by the US Public Health Service Grant and Licensed Beverage Industries of New York 1963–64 (now considered a classic in the field).

An Optical Means of Inspection of Precision Parts Using Color Discrimination, US patents sold to Jones and Lampson.

A New Method for Analysis of Alcohol in the Breath — The Breathalyzer (1954) US, British, Canadian, Australian, Mexican, French and German patents obtained.

Awards and Honors

1. Liberty Bell Award, Indiana Bar Association for Outstanding Contribution to Public Understanding of the Law, 1966.
2. Special citation from the Ministry of the Interior, Republic of China (Taiwan), 1970.
3. Widmark Award, International Committee on Alcohol, Drugs and Traffic Safety, Toronto, Canada, 1974.
4. Honorary Rank of Lieutenant Colonel, Indiana State Police, 1981.
5. Distinguished Service to Traffic Safety Award, National: Safety Council, 1982.
6. Distinguished Service Award in Recognition of Service to the State of Alaska, 1964–1983.
7. Award of Merit, Association for Advancement of Automotive Medicine, 1988.
8. Inducted in the Safety and Health Hall of Fame International, 1988.
9. Robert F Borkenstein Award, National Safety Council, 1989 (first awardee).

10. Minister's Award, Government of Canada, In Recognition of the Development of the Breathalyzer and Pioneering Research on the Blood Alcohol Concentration Limit in Canada's Impaired Driving Laws, 1992.
11. Gerin Medal, awarded by the International Association for Accident and Traffic Medicine for Outstanding Achievement in the Field of Traffic Medicine, 1992.
12. Sagamore of the Wabash Award from the Governor of State of Indiana, USA, 1994.
13. Special Presidential Award in Recognition of Leadership of the International Council on Alcohol, Drugs and Traffic Safety 1950–1983, Adelaide, Australia, 1995.
14. National Association of Governors Highway Safety Representatives (NAGHSR) Award, in recognition of long-term dedication to highway safety and professional achievements in the field, USA, 1996.

LIST OF MAJOR PUBLICATIONS

Professor Robert Frank Borkenstein

1. Borkenstein, R.F. The Role of Alcohol in the Traffic Safety Problem. *Police* (Nov–Dec 1958).
2. Borkenstein, R.F. Alcohol and Road Traffic, Proceedings. Ohio State Coroners Association (1958).
3. Borkenstein, R.F. Breath Tests to Determine Alcoholic Influence. Bloomington: Indiana University Center for Police Training (1958). Subsequently adopted by many states as a model for their own training manuals.
4. Borkenstein, R.F. Tests for Intoxication. *The Police Chief* (Dec 1958).
5. Borkenstein, R.F. Chapter in *Chemical Tests for Intoxication Manual*, Committee on Medicolegal Problems, American Medical Association, Chicago, Illinois (1959).
6. Borkenstein, R.F. and Larson, J.A. Clinical Team Approach to Lie Detection. In *Academy Lectures on Lie Detection*, edited by VA Leonard, Pullman, Washington: Charles C. Thomas (1957).
7. Borkenstein, R.F. The Evolution of Modern Instruments for Breath Alcohol Analysis. *Journal of Forensic Sciences*, Vol 5, no 4, October, 1960, pp 395–408.
8. Borkenstein, R.F. and Smith, H.W. The Breathalyzer and Its Applications. *Medicine Science and Law* Vol 1, no 4, June, 1961, pp 13-22.
9. Borkenstein, R.F. Chemical Tests for Intoxication Devices. *National Safety Congress Transactions* Vol 24 (1961).
10. Borkenstein, R.F. A Worldwide Survey of Methods of Handling the Drinking Driver. In *Proceedings of the Third International Conference on Alcohol and Road Traffic*. London. British Medical Association (1963).
11. Borkenstein, R.F., Trubitt, H.J. and Lease, R.J. Problems of Enforcement and Prosecution. In *Alcohol and Traffic Safety Chapter VI*, pp 137–188, Washington DC, National Institute of Health, US, Public Health Service Publication (1963).
12. Borkenstein, R.F. The Administration of a Forensic Science Laboratory. In *Methods of Forensic Science*, Vol. 3, edited by A.S. Curry, London: John Wiley and Sons (1964).
13. Borkenstein, R.F. Alcohol and Traffic Safety. In: *Law Medicine, Science and Justice*, Edited by Larry Alan Bear, Springfield, IL, Charles C Thomas (1964).
14. Borkenstein, R.F., Crowther, R.F., Shumate, R.P., Ziel, W.B. and Zylman, R. The Role of the Drinking Driver in Traffic Accidents. Research Report to the Injury Control Program, US Public Health Service, Department of Health, Education and Welfare, Washington, D.C (1964).
15. Borkenstein, R.F. Der trinkende Fahrer und die Verkehrsunfälle. In: *Aktuelle Fragen der gerichtlichen Medizin*. Wissenschaftliche Zeitschrift der Martin-Luther-Universität, Halle-Wittenberg (1965).
16. Borkenstein, R.F. and Britt, B.J. Reproducibility of Breathalyzer Tests Using an Alcoholic Breath Simulator. In *Proceedings of the Fourth International Conference on Alcohol and Traffic Safety*, edited by R.N. Harger, Bloomington, Indiana University Press (1966).

17. Borkenstein, R.F. and Sutherland, M.L. A Graphical Analysis of Blood Alcohol Levels in Two Groups of Drivers. In Proceedings of the Fourth International Conference on Alcohol and Traffic Safety, edited by R.N. Harger, Bloomington, Indiana University Press (1966).
18. Borkenstein, R.F. Das Gesetz die Wissenschaftliche und die Verkehrssicherheit, (Teil 1: die Alkoholkomponente) Aktuelle Fragen der Gerichtlichen Medizin II, pp 102–108. Martin-Luther-Universität, Halle-Wittenberg (1967).
19. Borkenstein, R.F. Prevention and Control Measures for Civil Disobedience. Proceedings of the Twenty-Second Annual Great Lakes Park Training Institute, pp 147–151. Bloomington: Indiana University (1967).
20. Borkenstein, R.F. Realistic Approach to Drinking and Driving. Traffic Safety Magazine National Safety Council, Vol 67, No 10, Chicago (October, 1967).
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