
SCIENCE AND INDUSTRY

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Q. Our discussion today, Dr. Midgley, is about the role of science in industry. What have been among the outstanding contributions of science to industry, and where do the contributions of science to industry start?

A. Since mankind first developed co-operation, there have been activities such as the making of arrowheads that have been called industry. However, it was not until nearly two hundred years ago that what we now call industry started in England. This was founded on the application of power to production. I mean power other than man or animal power. This was done by James Watt developing the steam engine. This was not the result of young Watt watching the lid of his mother's teakettle blow off but actually was the result of applying science. Watt was an instrument maker at the University of Glasgow and was assigned a job of studying the operation of a steam engine used for pumping water out of mines. Watt decided that this device was inefficient and cumbersome and needed improvement. He spent two years in researching on the properties of steam and with the aid of this scientific knowledge was able to produce an engine that would not compare unfavorably with some of the present day. This made it possible to gather

people together in factories where steam power could be used and thus produce quantities of finished goods, the like of which had never before been seen. Thus what we call industry was actually founded upon a scientific development.

Q. Most of us, Doctor, think of science in industry as being solely in the laboratory and not something that is brought into the factory itself. Is this true?

A. No. For example, many years ago Mr. C. F. Kettering, who invented and developed the self starter, was calling on Mr. Nash in the expectation of obtaining a contract for that year's business. It so happened, that a competitive starter was being offered to Mr. Nash at $1.00 less than Mr. Kettering's. The arguments waxed thick and strong. Mr. Kettering continually telling Mr. Nash how much research Delco did in its laboratories to improve its products and Mr. Nash repeatedly saying, "I'm not paying that dollar just to run your laboratory." Finally with things deadlocked, Mr. Nash started talking about some troubles they were having with their rear axles and asked Mr. Kettering if he could make any suggestions. They walked through the shop to the heat-treating room and Mr. Kettering saw that they were judging the temperatures of the axle pieces being heat treated by eye so that on bright days they were bound to get the axles hotter, before quenching, than on cold days and that herein lay most of the trouble. So he said to Mr. Nash, "If you will just use pyrometers to tell what the temperature really is instead of guessing, your troubles will be over." Mr. Nash saw that this was so and thanked Ket for the suggestion. Ket said, "All right Charley, I learned that in our laboratory and now I want that dollar." And Mr. Nash signed the contract.

Q. Doctor, how does what you have been telling us apply to an every day article such as a refrigerator? How does science in industry apply to the refrigerator itself?

A. Well, in the first place, no savage has the slightest conception that he possesses the ability to make things cold by applying power but with the development of the science of thermodynamics.

Q. Well, Doctor, that sounds like a $64 word.

A. Yes, all of that, as I was saying with the development of this science, it became quite clear to one versed in this science that a machine like the engine of James Watt made to run backwards in principle could absorb power and pump heat out of things which is all one needs to do to make things cold. This is refrigeration. The household refrigerator is the embodiment of this scientific idea.

Q. Is then air conditioning nothing more or less than a glorified refrigerator?

A. In a sense, yes, but had that been all there was to it, the cooled dining car that ran from Columbus to Cincinnati in the 1860's would have been a success. Unfortunately, its designer knew nothing about humidity nor how unpleasant a person could be in air so humid that his perspiration would not dry. It was over half a century later before science understood these simple facts so that refrigeration could be expanded to give comfort in hot weather which is a simple definition of air conditioning. But even this was not quite enough. Reversing the principle of Watt's steam engine is not enough. Steam doesn't work well backwards. One has to use a substance with properties quite different than water to get results in refrigeration. In the early days of artificial ice making, ammonia gas was used exclusively as the refrigerant. Later with the advent of household units, SO_2 became very popular, also methylchloride. One trouble of applying such things to air conditioning was that if there was a leak, even a small one, people's lives were in danger. A new refrigerant was needed—one that was neither toxic nor combustible. Mr. Kettering saw that such a substance was essential to the development of air conditioning. So, one morning, he called me up and told me to get to work on this problem. With the aid of Dr. A. L. Henne the problem was solved by using dichlorodifluoromethane.

Q. I think that one should be worth $65.

A. Well, Paul, as a matter of fact, it turned out to be worth many millions and gave comfort to many millions more. So that today by the application of science to the improvement of refrigerants, a brand new industry came into existence, and air conditioning in theaters, restaurants, railroad cars, stores, office buildings, is well nigh universal. However, it has been terribly disappointing to see the American public fail to make more use of it in their homes. It is my feeling that had we been willing to raise our standard of living to the air conditioned level during the early 30's much of the depression unemployment could have been avoided.

Q. All right Dr. Midgley, you have explained the application of science to the common refrigerator. Now let me ask you how some lesser known science, such as say Entomology or bug study, can be applied to industry?

A. I see you too started on the $64 words.

Q. Doctor, I think it's catching.

A. As a matter of fact, Entomology has not played a very important part in what we call industry. Maybe we use some exterminators in the woolen goods industry and maybe we don't. I don't know. Yet if we look at the whole, Entomology is important. Many insect pests must be eradicated or at least controlled for successful farming. This is done largely by the use of chemicals called insecticides which constitute a fair portion of our normal peacetime production of chemical goods.

Q. Well, that answers my question, Doctor, and now getting back to the factory, what has science done towards the fabrication of metals, the making of steels and alloys? How does science work here?

A. Suppose we start at the beginning. Primitive man was unacquainted with the properties of metals. It is supposed that some ancient person used some sort of copper ore to blanket a fire. Later he discovered some particles of copper in the ashes and observed that here was a stone which could be fashioned by hammering and hence he could make arrowheads, knives and the like which were better than the chipstone implements he had been used to and so it went. Individual discoveries passed on from generation to generation building up a craft of metal work. For example, take the much vaunted steel of Damascus. Was this the result of science? No. Damascus steel actually was one of the poorest steels known to the ancient world. It was too hard and brittle for practical use so the blacksmiths of Damascus took small rods of steel and small rods of wrought iron, wound these together and hammered them into a single rod. These rods in turn were twined with others and the whole welded together by hard work. The result was a sword or a knife that could be sharpened to a razor edge and was held together by the tough wrought iron. No one else could make as good a sword. Today we would take the brittle steel of Damascus, analyze it, probably find too much phosphorous, add what would be needed to remove the phosphorous, in the furnace operation add some nickel, tungsten and vanadium and without any blacksmithing turn out knives, swords or razor blades that would make any Damascan green with envy. This is science.

Q. Using scientific methods, what have been some of the modern day developments in the fabrication of metals?

A. Well, you might call the railroad one, the Golden Gate Bridge another, the three hundred mile an hour airplane one more, telephone communication still another and so on ad infinitum.

Q. Along with steel, Dr. Midgley, rubber has contributed much to modern living standards. Where does science enter into the making of rubber?

A. It is said that Christopher Columbus took back a piece of rubber on his first voyage and this was the first contact that white men had with this very valuable material. Be that as it may, rubber was not of much value until Charles Goodyear

by applying research methods, discovered that rubber would combine with sulphur to give the remarkable resulting product with which we are all familiar. This was about a century ago. Since then other scientists, principally chemists, have added to the knowledge of and the utility of this material. The importance of vulcanized rubber to modern life cannot be over-emphasized. Without it we would have no automobiles, no electrical industry, no air brakes, no golf balls or airplanes, suspenders or erasers, faucet valves or garden hose. All of which depend upon this product of science. Again to emphasize its value, the Kaiser did not start the war in 1914 until his advisors told him that Germany could make synthetic rubber. They were wrong and Germany lost. Hitler made more certain. Today Germany supplies its own needs of synthetic rubber; product of science. We, on the other hand, have been a bit backward. Our hope is now that our scientists will catch up.

Q. What would you say, Dr. Midgley, in summing up the role of science in industry?

A. Industry is science. The two are inseparable, Siamese twins, except that some science would go on without industry but no industry could live long without science. Management which neglects science is neglecting its business and failure will be the ultimate reward. New applications of science mean success and it will always be so.