Is everything in our universe knowable?—mathematical proofs provide an answer. On the possibility of transgenic maize being planted in Mexico, "It seems paradoxical to argue that it is necessary to protect the genetic background of corn when, for 6000 years of traditional breeding, we have protected only alleles important for humankind." And finer points of firearm regulation and safety issues are discussed.

Limits to Our Knowledge

In his Editorial "Endless pathways of discovery" (14 Jan., p. 229), Floyd E. Bloom writes, "[T]he most remarkable conclusion to emerge from this exercise was the realization [(*1*)] that in the millennium we are about to leave, humanity's knowledge of its place in the universe has moved from St. Thomas Aquinas's view that knowledge was of two types—that which man could know and that which was 'higher than man's knowledge' and not to be sought through reason—to the belief begun with Newton's *Principia* that our universe and all within it are indeed knowable." In this century Kurt Gödel showed in his incompleteness theorem (*2*) that there are true statements that cannot be proved to be true, and Alan Turing (*3*) showed that an analogous problem lies at the foundation of the mathematics behind computing machines. Gregory Chaitin (*4*) has provided new proofs of these theorems based on information theory and has argued that such incompleteness is natural and widespread. To say that there are true statements that cannot be proved is to say that there are some things that we just cannot know, that are beyond human reasoning (*5, 6*)—which brings us full circle, back to Aquinas.

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References

1. A. Lightman, *New York Times Magazine*, 19 September 1999, p. 94.
2. K. Gödel, *Monatsh. Math. Phys.* **38**, 173 (1931).
3. A. M. Turing, *Proc. London Math. Soc.* **42**, 230 (1937).
4. G. J. Chaitin, *Int. J. Theor. Phys.* **22**, 941 (1982).
5. ———, *Algorithmic Information Theory* (Cambridge Univ. Press, Cambridge, 1988).
6. H. P. Yockey, *Information Theory and Molecular Biology* (Cambridge Univ. Press, New York, 1992).

Transgenic Maize in Mexico: No Need for Concern

According to pre-Hispanic traditions, gods gave native Mexicans the first maize seeds and from then on, and for thousands of years, maize has been a vital element to the Latin American cultures. Biologically, maize is an orphan plant and has only one relative, the annual teosinte (*1*). Morphologically the two are similar, but they differ strikingly in the pistillate inflorescence (what becomes the cob). For our discussion, the most notable difference is that the maize cob is solid, whereas the teosinte cob is brittle and comes apart at maturity. Molecular analysis has shown that maize was domesticated in the Balsas River drainage (Mexico) 6000 years ago (*2*). Primitive cobs found in caves and other archaeological sites share the same characteristics: they are of small size and are, invariably, solid. This is of major importance—viable seeds can only be released by mechanical means (basically by humans). Maize does not disperse itself and therefore does not exist as a free species in nature.

The effect of maize genes in teosinte plants. The solid cob (top) is from a hybrid plant, and its seeds must be dispersed mechanically, unlike the seeds of teosinte (bottom).

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Recently, some biotechnology companies have requested authorization to plant and market transgenic maize in Mexico. Several ecological groups have raised concerns about the potential risks of introducing such plants to Mexico, where maize originated. The main concern regarding the possible effects on the native maizes and relatives has little if any scientific basis; it is more related to cultural factors rather than biological ones. Arguments stating that maize is genetically fragile are weak. It seems paradoxical to argue that it is necessary to protect the genetic background of corn when, for 6000 years of traditional breeding, we have protected only alleles important for humankind. Even if we decide to protect the actual genotypes, there should be no need for concern. Any transgene transferred inadvertently to native maizes can be removed from the progeny by selecting against the incorporated trait. Maize is always under strong artificial selection, and therefore natural selection has no practical meaning for the species.

On the other hand, transgenes cannot be established in a natural population of teosintes. Any teosinte recipient of maize pollen is at risk of transmitting to its progeny the trait of not being able to release its seeds, just as in maize (see the figure at left). The transference of an allele from teosinte to maize is a natural process. The opposite can only happen if the hybrid seeds are mechanically released. Still, fixation of a (trans)gene or allele in a teosinte population would be impossible if it did not confer an evolutionary advantage to the species. The *bt* gene, for example, would most likely not confer any advantage to teosinte because pests are not a natural selection factor in the wild. The transgene would be lost like the thousands that never conferred adaptative advantages to the recipient plants.

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References

1. W. C. Galinat, *Maydica* **30**, 137 (1985).
2. R.-L. Wang *et al.*, *Nature* **398**, 236 (1999).

Firearms the Target

Several aspects of the arguments Susan B. Sorenson presents in her Policy Forum "Regulating firearms as a consumer product" (*Science*'s Compass, 19 Nov., p. 1481) warrant comment. To begin with, the number of motor vehicle deaths she cites is due to accidents, whereas the number of deaths by firearms includes deaths from homicides, suicides, legitimate shootings by police officers and private citizens in defense of themselves or others, and accidents. These are not equivalent statistics.

Regarding "smart guns," or personalized guns, the proposed laws mandating these guns exclude law enforcement officers at their own request because they need a reliable weapon and one that can be used by a fellow officer in an emergency. In addition, the collaboration between the National Institute for Justice and handgun manufacturers has led to the conclusion

that these handguns would be very expensive, and the technology is not yet mature or reliable enough to incorporate into handguns.

As for the public opinion poll that was conducted, 1204 people seems a very small sample size to use in extrapolating to the adult population of the United States, and the sample was not representative of the general population (and, yes, I do understand statistics and population sampling). The sampling population consisted of people who owned telephones, who were home to answer them, who chose to answer them, and who chose to spend 15 to 20 minutes answering questions—not necessarily a group representative of the general population. The response rate was only 60.5%. About 40% of the proposed sample population chose not to participate. This part of the sample represents another large population to which the sample data statistics do not necessarily apply.

But even assuming that the methodology is correct, Sorenson's conclusions are not. Because of persistent government and media propaganda extant demonizing guns and placing the blame for all kinds of societal ills on firearms, and the publishing of so many half-truths and lies about guns and their social impact, the average citizen in this country could not have an informed, considered opinion about gun-anything. For example, people "know" that guns kill thousands of children every year. It's true, if you define a child to be anyone under 20 years old. However, from the age distribution of fatalities, most deaths are homicides and legitimate police shootings. There are relatively few "children" killed by gunfire. In fact, there are significantly more children who die from accidents in bathtubs and swimming pools than from gunfire. As another example, people "know" that the "Brady Bill" has prevented x thousand felons from obtaining guns (I use "x" because the number changes with the politician and his or her current agenda). The implication of this statement is that x thousand criminals are now unarmed and the country is safer. But criminals don't usually go to legitimate licensed dealers to buy firearms. They go to a street dealer and buy a gun stolen from any of a variety of sources. What J. Doe, citizen, doesn't know is that it is a federal felony for convicted felons to attempt to buy a firearm, and not one of these felons has been prosecuted.

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The 32,436 deaths per year from firearms that Sorenson refers to seems alarming, but nevertheless, deaths by firearms should be divided into three groups: homicide, suicide, and accident. In the first two groups, the shooting is intended, and most of these deeds would probably be performed by other means if no guns were available. The only group for which deaths could be possibly prevented by security mechanisms is accidents. But in my experience, most of these accidents happen because owners do not follow basic security rules for handling and keeping guns (for example, keeping guns out of the reach of children, or never pointing a gun at people, even if it is believed to be unloaded). Only a few accidents are the result of inadequate security mechanisms on guns, because nearly all modern western guns have sophisticated security mechanisms.

A better way of avoiding accidents with guns would be to ensure that all gun owners know and follow basic security rules for the handling and keeping of guns, instead of forcing the gun industry to develop more complicated security mechanisms. The main reason for accidents with guns or cars is carelessness, which no mechanism could ever guard against.

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Response

Oefelein and Birner suggest that motor vehicle crashes are an adequate comparison for firearm-related injuries only if the injury is unintentional (that is, "accidental"). This view is not consistent with well-supported and widely accepted public health approaches. The National Center for Health Statistics, which publishes mortality data for the United States, reports data by firearms overall and divided by the manner of death, namely, suicide, homicide, and unintentional (accidental) deaths. This approach is generally similar to that used in efforts to reduce motor-vehicle-related injuries. Initial work focused on the special aspects of each type of incident—the driver, the backseat occupant, the pedestrian, the bicyclist—and on the behavior of the driver—à la the "nut behind the wheel." A major step forward occurred when the focus shifted away from differences and toward commonalities among the injuries as well as away from the driver and toward the motor vehicle itself. The U.S. car manufacturers, initially resistant to the change, now tout the safety features of their vehicles.

Motor vehicle safety research documented the fact that human behavior is difficult to change with even the best of education efforts. Birner's suggestion of training gun owners in the safe handling and storage of firearms faces the same problem. Surveys have found that firearms training has no effect on how people store their guns. One national study (*1*) found that gun owners who had undergone training were more, not less, likely to store their guns in an unlocked location and loaded with ammunition.

Given that human behavior is difficult to change, it might be useful to consider other options, including safety standards, magazine disconnects, loaded chamber indicators, "childproofing," and personalized handguns. Proposed legislation appropriately recognizes, as do both Oefelein and myself, that personalized handguns are in development rather than currently available. Technology is not without its limits, and substantial effort will be invested in engineering a reliable handgun that can be fired only by an authorized user.

Oefelein also questions the methodological basis for the entire enterprise of survey research, a task that cannot be addressed within the confines of this brief response. The sampling, weighting, and statistical tests used for the survey discussed in the Policy Forum are all long-established scientific methods [for example (*2, 3*), which include discussions of nonresponse in telephone surveys].

Finally, Birner and I probably can agree that a substitution of methods will occur among persons who are highly motivated to destroy themselves or others, and that such persons would include those who conduct contract ("for hire") homicides and those who suffer from chronic mental illness. These types of deaths are a relatively small portion of homicide and suicide deaths in the United States. A few related points are worth mentioning. First, alcohol, which affects judgment, is involved in a substantial portion of homicide and suicide deaths. Second, most homicides in the United States occur in the context of an argument, not another crime. Third, when persons who attempted suicide have recovered from the depression or acute disappointment that precipitated the suicide attempt, they usually are quite glad to be alive. Case fatality data indicate that if a gun rather than another method were used in these situations, an assault—whether self- or other-inflicted—is likely to be lethal. Survival is the paramount concern.

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References

1. D. Hemenway, S. J. Solnick, D. R. Azrael, *J. Am. Med. Assoc.* **273**, 46 (1995).
2. R. M. Groves, *Survey Errors and Survey Costs* (Wiley, New York, 1989).
3. R. M. Groves *et al.*, Eds., *Telephone Survey Methodology* (Wiley, New York, 1988).