considering the effect of the forward velocity. Any bicyclist knows that the smaller the velocity, the more unstable it becomes. The novice cyclist learns very quickly to keep the bicycle upright by steering in the direction of the lean to restore the balance. The result of this action is to convert the unbalanced force threatening to topple the bicycle into the centripetal force acting on a mass moving in a circular path. By equating torques, we find that $R = v^2/g \sin(A)$, where R is the radius of the path, v the velocity of the bicycle, g the acceleration due to gravity, and A the angle of lean. For a lean of 0.1 radians and a velocity of 4 m/s, a radius of 16 m will stabilize the lean. A smaller radius will reduce the lean. That this stratagem does not depend in any major way on the details of the bicycle's design explains why many supposedly unrideable bicycles could be ridden after all. It also accounts for the greatly reduced stability at low velocity.

More interesting is the bicycle's behavior sans rider or when the rider has no hands on the handle bars. Consider pushing a bicycle with one hand on the seat. Experience tells you that you can steer the bicycle by making it lean in the desired direction. The front wheel will pivot in that direction. A little thought will show that when the bicycle is made to lean, the force exerted by the ground on the front wheel no longer passes through the steering axis. That exerts a torque on the steering mechanism and turns the handle bars. Now the details of the design become significant. The torque is in the desired direction provided the front wheel contacts the ground behind the point of intersection of the extended steering axis and the ground, typically a distance of around 5 cm. For small angles of lean, the torque is proportional to the sine of that angle. A bicycle ridden "no-hands" is steered by shifting one's weight to make it lean.

The riderless bicycle remains upright by the same sequence of events. If it starts to lean, the front wheel automatically steers in the direction of the lean. If the velocity is sufficiently large, the centrifugal force will reduce the lean, and the caster action will straighten out the steering. The resulting negative feedback keeps the bicycle upright.

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Stellar fusion doesn't stop at helium

In the feature article "Ultracompact Binary Stars" by Gijs Nelemans (PHYSICS TODAY, July 2006, page 26), box 1 all but declares that stars less than 8 solar masses fuse hydrogen into helium, and that's it. Not so: Stars with more than about half a solar mass will go on to fuse helium into carbon and oxygen as well. In fact, the accepted picture of an entire class of stars, RR Lyrae variables, consists of stars less massive than the Sun that burn helium in their cores and hydrogen in a shell.

Plenty of readable descriptions of this are available, from basic but clear,[1] to intermediate,[2] to more advanced.[3]

References

1. V. Trimble, *Visit to a Small Universe*, American Institute of Physics, New York (1992), p. 121.
2. W. K. Rose, *Advanced Stellar Astrophysics*, Cambridge U. Press, New York (1998), p. 19; M. Harwit, *Astrophysical Concepts*, 2nd ed., Springer, New York (1988), p. 15.
3. R. Kippenhahn, A. Weigert, *Stellar Structure and Evolution*, Springer, New York (1990), p. 308.

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Nelemans replies: Thanks to Mason Osborne for the clarification. Indeed, stars that are initially lighter than 8 solar masses also fuse helium into carbon and oxygen and end up with a degenerate carbon–oxygen core. Stars with initial masses of less than about 2 solar masses first develop a degenerate helium core, which in the helium flash is turned into a helium-burning core. Apart from the RR Lyrae stars, several other types, such as subdwarf B stars and horizontal-branch stars in globular clusters, are in the helium-burning-core stage (references in the original article and in Osborne's letter). The point of my simplification in the box text was to distinguish between stars that develop a degenerate core to withstand gravity and more massive stars that do not form such a core. The less massive stars form white dwarfs after losing their hydrogen mantle, and the heavier ones ultimately become neutron stars or black holes.

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TV shows praised for teaching physics

The wonderful item "TV Series Gives Teens Hands-on Experience with Machines" (PHYSICS TODAY, October 2006, page 26) encourages teens to find the satisfaction in making something of their own and seeing it work. Such working-model demonstrations should be encouraged. Recently I saw a young female student from Karnatak University (Karnatak, India) make a working model of a machine to fill overhead water tanks in homes; it had an automatic on–off switch. Such TV shows should be videotaped and shown in every classroom. In fact, video clips of working models would have been a nice and encouraging accompaniment to the article online.

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I was happy to read about the upcoming TV show *Design Squad* and look forward to watching it. I was an enthusiastic viewer of the now cancelled *Junkyard Wars* on the TLC cable channel. The show at least initially did a good job of teaching "stealth science" in a way that was both exciting and educational. I saw it as a way to get young people interested in sciences by active demonstration. Unfortunately, *Junkyard Wars* changed its tone to compete with "reality" shows, which turned me off. The UK version, *Scrapheap Challenge*, is still in production, but apparently no American market is interested in airing it.

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