Gliding Turns, anatomy of a simple maneuver
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After a student learns how to adjust the glider's pitch attitude to maintain the desired airspeed the next task is how to make turns. The Joy of Soaring, a book written by Carle Conway for the SSA, speaks about the 5 "undesired side effects of the turn". The undesired side effects are present in every turn we make and all the training manuals I've read speaks to them to various degrees.

The first side effect is called "adverse yaw". Adverse yaw is caused by the use of the ailerons to bank into or out of the turn. The downward moving aileron creates more lift on that wing and this increase in lift also creates more drag on that wing. This creates a yaw opposite from the direction of the desired turn. The rudder must be used in a coordinated fashion to overcome this adverse yaw to streamline the fuselage while the ailerons are being used to change the bank angle. When rolling into or out of the bank, the greater the deflection of the ailerons (stick position) the greater the rate of roll (i.e. the rate of change of the bank angle). Correspondingly, a greater amount of rudder must also be used to counteract the increased adverse yaw. The yaw string is used to determine the amount of rudder needed to maintain 'coordinated' flight.

The second side effect is called the "diving tendency". The diving tendency is caused by the glider's need for the wing to create more total lift as the bank angle is increased. In level flight the glider is trimmed for a certain angle of attack (AOA). As the wings are banked the glider wing needs to create more lift and at the trimmed AOA the only way to do that is to increase the speed, thus the 'dive' (i.e. the glider maintains the trimmed AOA and tries to increase the speed). But the pilot wants to maintain the speed and so needs to increase the AOA so that the total amount of lift is increased to support the glider in the turning bank. The pilot does this by increasing the back stick pressure to increase the AOA. In shallow banked turns this effect is not very noticeable but becomes more noticeable as the angle of bank is increased.

The third side effect is the "overbanking tendency". This is caused by the fact that when established in a turn the outside wing is flying faster than the inside wing. This causes the outside wing to create more lift and more drag (more about that in a minute). The increase in lift on the outside wing tends to cause the glider to 'overbank'. The overbanking tendency is not prevalent in shallow banked turns, and in fact the glider in a shallow banked turn tends to shallow out unless a little 'inside' aileron is held. This is caused by the dihedral of the wing. In the medium banked turn this dihedral cancels the overbanking tendency and neutral ailerons can be maintained. But in steep banked turns the overbanking tendency requires the pilot to hold 'outside' aileron to keep the glider from increasing its bank.

The fourth side effect is the "yaw against the direction of the established turn". This is caused by the fact that the outside wing has more drag on it because of its increased speed. Once established, in all turns, a minimal amount of inside rudder must be used to counteract this effect. One must be cautioned to not use too much inside rudder so as to avoid 'skidding' the turn, use just enough to keep the yaw string straight. In most thermaling turns we attempt to maintain a 45° bank. This bank has been determined to be the most efficient for thermaling. It requires the use of a small amount of outside aileron and a small amount of inside rudder to maintain coordinated stable flight while in the turn.

The last side effect is the "increase in stalling speed" while in a turn. This is due to a number of factors while the glider is turning. The main factor is the need to increase the total amount of lift that the wing is producing. This increase amount of lift is necessary to counteract an increase in the 'load factor' that the glider wing must support. As discussed before we do this by increasing the AOA. Since the glider is flying at a higher AOA in a turn we are closer to the AOA necessary for the glider to stall. Therefore, a smaller reduction of airspeed will result in a stall. The stall speed increases as the square

root of the load factor (i.e. 45° bank increases the stall speed about 20% and a 60° bank increases the stall speed 40%).

Before beginning any turn the pilot must clear the airspace that he/she is about to turn into. This is a critical first step habit that must be learned from the very first turn that a pilot makes (the law of primacy). Always look around to clear every turn to avoid a collision with another aircraft. Continued clearing must be made as long as the turn is continued while maintaining the bank and pitch angle along with the proper coordination of the controls.

When training instructors talk about shallow, medium and steep banked turns. While there is no specific definition of the degrees of bank it is generally accepted that a bank of less than 20° is considered to be shallow, 20° to 40° medium and greater than 40° as steep. We use shallow banked turns while demonstrating the ability to fly in slow flight. We use medium banked turns while making normal maneuvers and we use steep banked turns while flying in thermals. When establishing a bank the amount of bank angle is determined by how long you hold the controls in that position. After establishing the bank that you want, the controls should be returned to a near neutral position. This position of the aileron and rudder controls is determined when the bank angle is constant and the yaw string is straight. In steep banked turns the correct position is usually found to be inside or 'bottom' rudder and outside or 'top' aileron for coordinated flight.

In addition to the 5 side effects it is also necessary to understand other flight characteristics such as stability and aerodynamics and what effect they have on the glider while in turning flight. The more a pilot understands the behaviors of the glider the better equipped he will be to recognize and react to abnormal occurrences. Even though turning flight is a relatively simple maneuver, it requires a thorough understanding of the principles of flight. This is but a brief review of some of those principles and further study is always beneficial. Seek out further instruction from your favorite instructor during recurrent training such as a flight review or the FAA WINGS Program which can be found at FAASafety.gov.