Grandfather paradox

A question of time.

Ian Stewart

I didn't turn round.

I knew what was coming. It happened once a year, on his birthday. His choice: moral blackmail, perhaps? I sensed the misty shimmer forming in the corner of the room behind me, the impossible twists in directions that didn't exist, the machinery and its increasingly haggard passenger solidifying from thin air.

On the sideboard was a faded monochrome picture: a confident young man and his beautiful new bride. Without turning, I spoke to the original.

"The answer's still no, Hubert."

"I'm not asking a lot," he pleaded.

"Only murder," I said, fingering the gun in my pocket.

We went through the usual exchange. "If you don't kill me, you didn't get born."

"I was born."

"That's because my causal loop is incomplete," Hubert said angrily. "You've seen the analysis. You know what won't happen if you let me live." I had, and I did, and it made no more sense now than it had when The Beatles were recording *Sergeant Pepper*.

According to family tradition, Grandad had wanted to be an inventor, failed, and ended up running a pub. Actually, one invention had worked. I knew it was true. When a time machine materializes before your eyes, you believe.

Physicists and philosophers always say that time travel into the future is straightforward. It's travelling into the past that creates the paradoxes. Grandad discovered that it's not that simple.

The time machine had been Hubert's only success, an ingenious application of Hamilton's quaternions. He flight-tested it with a short hop into his own future, finding that he and his new bride Rosie were deliriously happy and a baby was on the way. Reassured and proud, he pushed the lever to return to the instant of his departure …

Nothing happened.

The machinery checked out, so he reworked the theory … and discovered a sign error. His machine could travel only into the future. By so doing, he had created a paradox. If he never got back … *who had married Rosie?*

He started skipping ahead a few weeks at a time, in a frantic search for inspiration. He haunted public libraries, boning up on physics and philosophy. As the years flicked by, he came to realize that he could never go back.

He watched his son's christening, then his marriage. He was waiting outside the hospital when I was born. He developed

a 'chronoclastic calculus' of space-time in an attempt to rationalize his fragmented life. Sitting in the back of the chapel at my father's funeral, he suddenly understood what had to be done.

Time travel violates several conservation laws, but the Universe can borrow energy, momentum or matter — provided it repays the debt when the time machine returns to its starting point. Hubert's dual existence broke no laws. So far. But it would if he could create a paradox so blatant that it could not be resolved by repaying what had been borrowed. This was why he kept begging me to kill him.

According to Grandad's calculus, the basis of the Universe is not energy or information, but logic. If I killed him *in my timeline* he would never have invented his machine — so I wouldn't be able to kill him. With its logical basis wrecked, the Universe

would resolve the paradox by excising the time machine, and snap back to a consistent history in which Hubert married Rosie, with all of its consequences.

"You must help me!" he pleaded. His body trembled, his eyes were wild. His life now consisted of closely spaced episodes in which he begged me for death. It was a horrible way to live, and we were both becoming desperate.

Destroying the time machine wouldn't help. Neither would suicide. Chronoclastic calculus allowed logic to be suspended inside the time machine's causal loop, until the loop closed. The agent of his destruction had to be outside the loop, and it had to be a logical consequence of his hypothetical return to his past. That meant my dad, me or my kids … *My kids!*

This had to stop.

Grandad climbed reluctantly into his machine, hesitated, and pulled the start lever. As the machine began to fade, I took the gun from my pocket and shot him. I couldn't risk aiming at the controls: I would have only one chance, and he was a bigger target.

I'd finally realized that his calculus was as defective as his machine. Yes, my timeline contained a grandfather who lived a happy life with his beloved Rosie — but it also contained a grandfather who materialized in a time machine. Hubert's time-travelling causal loop was logically entangled with mine; if the Universe excised him, it would also excise me and my kids. So I trapped Grandad's corpse in a frozen instant where no time passes and logic is suspended.

That faded photograph tells me I am no murderer. It lies. Oh, how it lies!

My grandfather wanted me to kill him, and when no other choice remained … I did.

And that's the only reason why either of us was ever alive. ∎

Ian Stewart is enjoying retirement, which resembles his previous life so closely that it is hard to spot the difference. He is now emeritus professor and digital media fellow at the University of Warwick, UK. Join the discussion of Futures in *Nature* at go.nature.com/QMAm2a

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