The Legacy and Accomplishments of Ron Howard[1]

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The question "What was the most impactful or greatest contribution of knowledge and method by Ron Howard?" has been the subject of much discussion as we think about his legacy. People in the Decision Analysis community, the largest and most recent community with whom Ron interacted, understandably assume that Decision Analysis was the primary or sole regime of Ron's accomplishments or what he thought important. *Au contraire*; Ron was a very multidimensional man, and he himself thought all four of his contribution areas were important, and somewhat interrelated. It is my purpose here to summarize the breadth of contribution, of which some people might not have been fully aware.

I think of Ron's contributions and accomplishments the same way I think of Beethoven's symphonies, all of which are world-class in their own right and deserving of analysis, praise, and emulation on their own. Please don't ask me to "rank order the symphonies" or pick one particular symphony as superior or most impactful. Asking me to pick a favorite or best symphony de facto downplays the profound contribution of the others. When we pick one of his fields, we are "about ourselves," not "about Ron." Ron was complex and multidimensional, like Beethoven, and his accomplishments and legacy were broad, multidimensional, and stretched over decades.

1 How I Met Ron

I came to Stanford with "An Atomic Energy Commission Special Fellowship in Nuclear Science and Engineering," enrolling in the Nuclear Engineering Department, which was part of Mechanical Engineering. Ironically, it was right across the sidewalk from the EES Department on what is today Slavic Language Corner. I had full tuition, books, living expenses, and a small stipend all the way through Ph.D. I didn't have to work or TA. (I like to think the kind U.S. taxpayers got their money back.)

Flash forward two years. One of the guys in nuclear engineering, Jim Goodrich, said, "My mom is the secretary for a guy named Ron Howard in this new department, Engineering-Economic Systems, abbreviated EES. I've taken some classes over there, like linear programming, and it is really neat. Check it out, Dale. Your fellowship allows it. Take Ron's 221 class (probability) and then take Decision Analysis. Give my mom a call if you need a hand registering." I did, and it was the luckiest or smartest decision I ever made. I waltzed into Ron's office and asked his secretary, Louise Goodrich, to help me. She took me to Ron's door, tapped, and said, "I have a new student for you. Dale Nesbitt." He smiled to acknowledge me. I entered Ron's realm through the side door, not through the entry-level Ph.D. program level like others.

My first class, EES 221, was pure probability theory, which Ron taught at the time. I was mesmerized. Like a naïve David oblivious to the size of Goliath, I said, "Hey, I am going to build

[1] Dr. Ronald A. Howard would want us to refer to him as Ron, and I do so lovingly and respectfully.

a probabilistic representation of a nuclear reactor core—extend those equations to be probabilistic!" Yeah, right! I was too caught up in it to realize that would have been the Nobel Prize in physics, an absolutely HUGE problem occupying the ability of a bevy of national laboratory scientists to wrestle to the ground. That thesis idea never materialized (duh), but I discovered Markov Processes, ethics, freedom, and Decision Analysis, and I was all in. I changed departments after qualifying for my nuclear engineering Ph.D., earned a Ph.D. in Ron's department, and never looked back. I still loved nuclear engineering, but I was absolutely smitten with Ron's areas. I was lucky enough to work directly with Ron in all four of his areas, a rare opportunity. That gave me the breadth to write this tribute.

2 Policy Iteration (Ron's Eroica)

To begin the analogy, the early Beethoven symphonies were conceived, written, and played by a vigorous, temperamental young man. For example, the Eroica (Third Symphony) was written in 1802–04, when Beethoven was young. It was brooding, nascent, pathbreaking, and dedicated to Napoleon, whom he hoped would be populist. (He later recanted the dedication when Napoleon's true stripes became visible. Ron laughed when I told him that.) By analogy, Ron conceived and invented Policy Iteration that revolutionized the field of Markov Decision Processes while he was a very young man, like Beethoven. Policy Iteration and Markov Decision Processes were Ron's Eroica. His 1960 book on the subject **Dynamic Programming and Markov Processes** (I recall it was his thesis or closely based on it) is nothing short of a masterpiece, solving a problem that emerged around the time of A. A. Markov and lay unsolved. Policy iteration conceives an ascent algorithm over a finite number of prospective compound decisions, or "policies," that "strictly improves" at every step and necessarily, therefore, must get to a finite end! So simple (after Ron figured it out), so direct, so profound, so revolutionary. Up there with Nash in terms of simple profundity.[2]

I first approached Ron to do thesis work under him in Markov Processes because I was blown away by the depth of the field and his contribution. He took a heretofore unsolved problem and cracked it in the simplest, most elegant, most "engineering" sort of way. My thesis solved a derivative problem (decision sensitivity), one I was told Ron worked on but couldn't solve, and he was rankled about it but so constructively positive with me in part because I had solved it. I was so proud that a mind as great as Ron's would notice or care about what I did, but he cared deeply. That is the kind of pedant he was. He cared deeply about the accomplishments of his students (not just me). He was impressed by solutions to heretofore unsolved problems, such as the renowned one by George Dantzig.[3] He cared so much he accepted my thesis defense "with honors." At the feet of giants, we benefit from the crumbs. I learned just how profound Ron's contribution was during my delightful toil under his oversight. Policy Iteration, his Eroica. Was it merely a "start?"

[2] Ironically, Policy Iteration was the exact same thing George Dantzig, the father of Linear Programming, did—iterate over a finite number of vertexes knowing he was improving after each vertex and therefore he would have to end when he reached the optimum vertex. My thesis exploited the direct analogy between Danzig's vertices and Howard's policies. The inestimable Ron quipped during my defense, "Dale, you have taken a problem posed in English, translated it into French, solved it in French, and translated the answer back to English. Couldn't you have just solved it in English?" French meant "linear programming," and he wanted to eliminate it. I said I couldn't. He said, "OK, just checking." These are the kinds of delicious comments Ron made, comments that students had to work their rear ends off to address.

[3] See https://malevus.com/george-dantzig/ for the story of Dantzig's thesis.

Or more? "Was it impactful? Just like the Eroica, Ron's Policy Iteration was highly impactful. Ron's two-volume **Dynamic Probabilistic Systems**, affectionately known as the "frog book," remains a Rembrandt to this day, solving the broadest array of problems in semi-Markov decision processes.[4]

3 Ethics (Ron's Fifth)

The Fifth Symphony was written and played once Beethoven "had a few more miles on him" between 1804 and 1808. This was a powerful work, perhaps the best known of all his music, written while he was entering middle age but with much left to contribute. By analogy, Ron conceived a view of ethics that people in my ethics classes at Stanford have called "simple and revolutionary." Although the roots date back to Immanuel Kant, John Stuart Mill, Jeremy Bentham, and more recently Rawls and others. Ron personalized, focused, and simplified it, a profound contribution. Following are tenets Ron began in "The Ethical Analyst," and we continue now that I teach it:

1. Ethics is about **decisions,** not about thoughts, mindsets, abstractions, states of the world, or philosophies. Ethics is about people, not about "things" (e.g., technologies, products, techniques, capabilities), and focuses on actions and consequences. Without decisions, what does ethics even mean? Ethics is not anthropomorphic. Ethics needs no antecedent adjective to qualify or bound it.
2. Ethics is about **people**, not about "things" (e.g., technologies, products, techniques, capabilities, AI, driving). "Things" or "topics" do not engage in actions or behaviors. Cigarettes don't make decisions. Vaccines don't make decisions. "Science" doesn't make decisions. Viruses don't make decisions (nor do wild animals). People make decisions. Ethics is **not anthropomorphic**.
3. Ethics is ultimately **personal,** related to personal decision-making (or personal contribution to group decision-making). Ethics needs to be driven by a well-crafted ethical code of action. It needs to be written as a Constitution, an allowance for certain actions or behaviors and a disallowance for other actions. You need to think it through before real decisions face you.
4. Ethical codes and ethics must be **actionable**. Abstract, theoretical, hypothetical, or non-actionable concepts don't cut the mustard. "Curing world hunger," "eradicating inequality," or "having lust in your heart" like Jimmy Carter is not what ethics is about (not actionable). Not coercing or not stealing is what ethics is about (fully actionable).
5. Ethics is **not coercible.** Ethics relates to one's own decisions and behavior "when no one is watching, overseeing, or coercing." Ethics is what you do (or do not do) when no one is watching, overseeing, or coercing. The point of ethics is not to bash others on ethical behavior but to formulate what is ethical for you to do and what is not. The very idea of coercing others to do the right thing is oxymoronic.

[4] Apparently the new U.S. Air Traffic Control system is a large Markov model built by a Stanford professor and his team. Arguably, that system rides astride the broad shoulders of Ron and the other pioneers who ultimately delivered to us a the fully functional Markov Decision Process solution. From Ron (and successors) to all of us! That is a pretty profound contribution; the sheer size is mind-bending. Right there inside the 1960 book and the frog book.

6. Ethics is intrinsically **rational and self-interested**. Think about the intrinsic and extrinsic rewards to ethical behavior. Ethical behavior is not "lambs to the slaughter" but likely is rewarded by ethical behavior on the part of others. If someone does you a good turn, are you more likely or less disposed to be unethical toward them? (Axelrod in "The Evolution of Cooperation" underscored this.) Statistically, not deterministically, speaking. "Good psychology," no remorse, is sufficient reward.
7. Ethics is about **right and wrong**. On this point, there can be no equivocation, no weasel wording, no qualification. Right and wrong. "Ethics" means "character" in Greek. The right thing to do, and, importantly, the wrong thing to do.

I personally rode the broad shoulders of Ron Howard to get to where I am in ethics. Ethics was Ron's Fifth Symphony.

4 Coercion-Free Society (Ron's Pastorale)

The Sixth Symphony, the peaceful, contented Pastorale, was written and played as Beethoven "got a lot of even tougher miles on him" in about 1808. He was into middle age by then. Increasingly frantic about losing his hearing, he experienced a brief respite with an ephemeral easing of his looming hearing problem. He was ebullient and penned the Pastorale, quite different from anything that he had done before. And so it was with Ron, who began his Coercion-Free Social Systems/Design of a Free Society right after ethics. In our conversations as Ron and I wrote about freedom together, I came to see a bunch of people comprising a "society," a group, scurrying around, each with their own little private "microeconomic" decision trees. In a truly free society, they could make any decision or "policy" in their trees they wanted. That's freedom, baby! Nothing or nobody to coerce or thwart you and your tree, as long as you didn't

- Deceive
  - Self
  - Others
- Steal
- Harm
- Coerce
- Impose Risk
- Violate the Covenant

Ron used a mantra, his literal Constitution, for a free society: "Peaceful, honest people have the right to be left alone." I might extend it to "Peaceful, non-deceiving, non-coercing, covenant-honoring people have the right to be left alone," but it loses the simplicity of Ron's "Constitution." His very definition of freedom is NO COERCION of peaceful, honest people, and it was an absolute. And we knew what coercion meant, either: (1.) forcing you to take an alternative in your tree that you would not on your own volition take, or (2.) preventing you from taking an alternative in your tree that you would on your own volition take. Make you do something you do not want to do or prevent you from doing something you do want to do.

In discussions with Ron about the book we were working on (in advanced draft when we lost him), we agreed that it isn't just lying, stealing, and harming that are unacceptable. It extends to self-

deception, coercing others, imposing risk, and breaking the covenant in place, if any. It is about group as well as individual decision-making. It is about the cooperative game theory solution by the great John Nash, which I taught Ron to appreciate. Ron came to realize that a free society is a cooperative game between all members of the society, precisely akin to the Nash cooperative game. I presented to him repeatedly Nash's famous 1950 paper and showed him the proof and interpretation repeatedly. I wrote about it in our coauthored draft. One day, he paused and looked at me: "Yep, that's it. The light went on for me," he said one afternoon. "Where did you get that stuff, Dale?" I told him I thoroughly read, reread, and internalized Nash, and I read and internalized Howard's lectures, and I interpreted Nash's and Ron's thinking as quite similar. He seemed blown away: "I was wrong about Nash. I didn't take the time to understand. Thank you for helping me understand. Too bad he didn't make the effort to interpret." I told him, "Ron, Nash became schizophrenic not long after his third of three papers in 1953, and he was disabled by severe mental illness permanently ever after until he died, with his wife, in an automobile accident on the New Jersey Turnpike in 2015 at age 86. He never had the chance, like Schubert's unfinished symphony. He left that to you and me."

Ron's notion of a free society focuses on group as well as individual making. Every coalition within every free society must be in a cooperative, uncoerced game. The impact of this type of thinking is yet to be fully realized and appreciated, but that doesn't diminish the profundity of Ron's thinking about the definition of freedom as well as its realization. Nash and Harsanyi recognized it, but they didn't fully pursue it to the degree Ron and I did. Freedom and Society is Ron's Pastorale symphony, every bit as worthy as the Eroica and Fifth.

5 Decision Analysis (Ron's Ode to Joy Ninth)

Decision Analysis, which occupied half or more of his professional life, was Ron's Ode to Joy, Beethoven's long and majestic Ninth, written between 1822 and 1824 when he had "one heck of a lot of miles on him," by then stone deaf but able to write and perform music notwithstanding! Long, brooding, and dark at first and bursting into joyous light, the Ninth touches everyone's heart and mind. Like herpes zoster, it never leaves your central nervous system, just like Decision Analysis. Ron didn't invent decision theory; John von Neumann is credited. Einstein apparently once quipped that "John von Neumann is the cleverest man I ever knew." Ron developed, articulated, popularized, extended, and almost cult-ized what the cleverest man Einstein ever knew initiated, and he called it Decision Analysis. Ron was certainly my John von Neumann, the cleverest man I ever knew. His Ninth Symphony (Decision Analysis) has indeed been an Ode to Joy, not to mention profound intellectual and professional advancement. We celebrate the Ode to Joy (Decision Analysis), but we do not do so at the expense of the Eroica, Fifth, and Pastorale. We celebrate Decision Analysis, but not at the expense of ethics, coercion-free social systems, and Markov Decision Processes. (Ron himself continually interconnected them.) We must not be snobbish if we only have familiarity with Decision Analysis; we should be broad in our appreciation of what Ron contributed. Musical scholars embrace the Eroica, Fifth, Pastorale, and Ninth because each individually has so much to offer. We, as Ron Howard scholars, ignore nothing. We embrace Policy Iteration, ethics, coercion-free social systems, and Decision Analysis alike.

At the retirement celebration for Ron in 2018, we organized the tributes according to the four symphonies, not just the Ninth (Decision Analysis). Just as classical music analysts analyze the

contributions of ALL of Beethoven's symphonies to western music and don't try to exclude all but one, I think we underserve Ron by excluding or ignoring areas other than Decision Analysis. To do so understates the man. It understates the field. It understates the contribution. It understates the intellect. It understates the accomplishment. It understates what he thought was important. It understates the love. It understates the interconnections. It understates his heart. He truly "loved this stuff." Just because someone didn't work with Ron in anything other than Decision Analysis doesn't mean they shouldn't know the depth of his contribution. I consider myself one of the luckiest students Ron had; I had the opportunity to work with Ron in all four fields, to learn all four symphonies. In a word, wow! None is better or worse than the other. They all intertwine and contribute to mankind. All of Ron's symphonies have enriched me and others. Ron interconnected his own fields.

Ron's contributions to Decision Analysis were literally seminal, from life-and-death decision-making to influence diagrams to quality of decisions to the Howard/Abbas book, a masterpiece. The specific contributions would take too much space to enumerate here, and they are obvious to all of us who studied or taught Decision Analysis. I don't focus on Decision Analysis as much here because it is more widely known to today's audience, and so many others have articulated that more completely and carefully.

6 Ron Howard, the Gestalt

Which Beethoven symphony was the best? The most impactful? The very question is a non sequitur. Which was the more revolutionary? No answer. Which Beethoven symphony had the most impact? No one agrees. Again, a non sequitur. Which one is the prettiest? If you had an elevator pitch, which one would you mention? No answer. I don't want people to have to choose. I want people to know all about the Eroica, the Fifth, the Pastorale, and the Ode to Joy. They were all world-class, just as Ron's Policy Iteration, ethics, freedom, and Decision Analysis contributions represented "the cleverest man I ever knew," Ron Howard. I don't want to striate his greatness. I want to articulate it and revel in it. Ron himself interconnected his greatness.

If Ron were to receive a Nobel Prize for something he did, I dare conjecture it would be Policy Iteration, the stuff he did as a very young man. His Eroica. Here is a man that cracked the most important problem in a field that persisted for years before he cracked it. Once he had cracked it, he searched for other truly hard problems of equal worth. He was done with that one, just a bit of mopping up to do before moving on to at least equal and more earnest challenges. He found other hard problems worthy of his attention. We are so glad that he did.

And through it all, Ron was humble, diffident, supportive, and downright loving. He could debate, and debate hard, with people. He could challenge, and challenge hard, with people. He could intimidate, and many were intimidated. He did it to teach you, not merely to dominate you, I came to see. If he regarded you as an aspiring peer, he treated you as a peer. (I always received that treatment from Ron, I surmised, because my doctoral work was an unsolved problem that he himself had tried to solve. I marveled at the way he treated Amos Tversky, for whom he had infinite respect.) Some were extremely intimidated, and some were vanquished. The advantage of that, to me, is the incentive it sets up for you: you'd better darn well prepare before entering a technical discussion with Ron. That alone was as didactic as anything. You knew you had to have your

intellectual act together before having a discussion with Ron. Those discussions, with me, ran well into the evening. I adored them.

7 Ron and I Were Friends

Ron had a penchant for being boldly direct, and surprising you with it. Always thoughtful, and enjoying our friendship, Ron asked, "I sense we've become good friends. Dale, what does the word 'friend' mean to you?'" Jeez, I said to myself, such a Ron Howard question! Gets right into your viscera. Now I gotta think!

"Ron, while teaching ethics, I have given that question a lot of thought based on concepts I learned from you. **You are my friend if I get utility from being with and interacting with you.** And friendship carries an element of **"revealed preference" that you get utility being with and interacting with me.** Friendship is mutually egoistic at its core; both friends get utility and the perception that the counterparty likewise gets utility."

He gasped. "God, that is simple. Perfect. I LOVE that; an ethical egoist definition." Ron and I agreed we were dear friends by that definition, a definition that he eagerly adopted. I spent hours gaining utility from my interactions with Ron, and so I observed did he. We were indeed friends.

Ron became almost a cult-like figure at Stanford. Was he a Svengali? Absolutely not. He was a kind, loving, and diffident pedant and friend. People followed him and worked with him because they wanted to. Volunteerism was important to Ron.

I once said to Ron, "Ever since the first class I took from you, EES 221, probability, way, way back in time, you gave me a fatigue headache every time I talked to you. You always pepper me with all these hard questions. I love you for it, but why do I masochistically keep coming back for more?" He laughed, "Dale, there is no one I would rather give a headache to, and I am glad you enjoy it." We laughed. He wanted me to learn when I was six decades old, the same as when I was two decades old. What a lifetime gift Ron gave. Thank you for your intellectual symphonies, my friend.

And now, let's go to the Symphony, and carry along the "frog book" under our arm!