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Editorial Note

The Journal of Applied Ethics and Philosophy is an interdisciplinary periodical covering diverse areas of applied ethics. It is the official journal of the Center for Applied Ethics and Philosophy (CAEP), Hokkaido University. The aim of *The Journal of Applied Ethics and Philosophy* is to contribute to a better understanding of ethical issues by promoting research into various areas of applied ethics and philosophy, and by providing researchers, scholars and students with a forum for dialogue and discussion on ethical issues raised in contemporary society.

The journal welcomes papers from scholars and disciplines traditionally and newly associated with the study of applied ethics and philosophy, as well as papers from those in related disciplines or fields of inquiry.

Earlier versions of the papers by Kristin Shrader-Frechette, Michael Davis and Randall Curren published in this present volume of The Journal of Applied Ethics and Philosophy were delivered at the Fourth International Conference on Applied Ethics held in November 2009, and an earlier version of Berislav Žarnić's paper was delivered at the SOCREAL 2010: the Second International Workshop on Philosophy and Ethics of Social Reality in March 2010. Both events were organised by CAEP.

Takahiko Nitta
Editor-in-Chief

Environmental Injustice, Climate Change, and Nuclear Power:

Flawed Standards for Ionizing Radiation

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Abstract

Nations are divided over whether to increase use of nuclear fission to help address climate change. Proponents say atomic energy is carbon free, inexpensive, and safe. However, this paper shows that proponents' claims are scientifically questionable and that, because of flawed standards for ionizing radiation, atomic-generated electricity causes environmental injustice. Correcting and clarifying scientific data, the paper quickly shows that (1) atomic power has roughly the same CO2-equivalent emissions as natural gas, and that (2) it is far more expensive than many renewable-energy technologies. The paper also argues that (3) nuclear fission already has imposed environmental injustice on many minorities, poor people, and children, because of uranium mining, reactor siting, and emissions. (4) Even if one ignores effects on future generations, and even if there are no further nuclear accidents, atomic energy would be unsafe and unjust, because ethically and scientifically flawed radiation-protection standards impose inequitable burdens on radiation workers and children. The paper closes after answering several objections.

Key words : climate change, consent environmental justice, nuclear power, radiation standards

1. Introduction: Nuclear Energy and Climate-Change Controversy

Nuclear reactors currently supply about 6 percent of global energy, down from 7 percent in the 1990s (Toth 2008, 4). On one hand, governments of Finland, France, India, Japan, Russia, South Korea, the UK, the United States, and China support building more reactors (Ansolabehere et al. 2003, 21). They agree with the Intergovernmental Panel on Climate Change (IPCC) that atomic energy could make 'an increasing contribution to carbon-free electricity and heat in the future' (Biello 2009).

On the other hand, governments of Austria, Belgium, Denmark, Germany, Italy, the Netherlands, New Zealand and Sweden reject building any new reactors. These nations have either prohibited, or begun phasing out, nuclear power (Ansolabehere et al. 2003, 2l), although Italy and Sweden may reverse their positions (Deutsch et al. 2009, 5). If the 2005 survey by the pro-nuclear UN International Atomic Energy Agency (IAEA 2005, 18-20) is correct, a majority of people and nations oppose building new nuclear plants; only in South Korea do a majority support new reactors. Even the pro-nuclear US Department of Energy (DOE) admits that nuclear energy is not needed and that currently-available renewable technology could provide 99 percent of US electricity by the year 2020 (NREL 2006).

2. Overview

Who is right about the controversy over using atomic energy to try to help address climate change (CC)? Correcting and clarifying scientific data, the paper quickly shows that (1) atomic power has roughly the same CO2-equivalent emissions as natural gas, and that (2) it is far more expensive than many renewable-energy technologies. The paper also argues that (3) nuclear fission already has imposed environmental injustice (EIJ) on many minorities, poor people, and children, because of uranium mining and reactor siting and emissions. (4) Even if one ignores effects on future generations, and even if there are no further nuclear accidents, atomic energy would be unsafe and unjust, because ethically and scientifically flawed radiation-protection standards impose inequitable burdens on radiation workers and children.

3. Nuclear Energy, Emissions, and Economics

In 2009 a pro-nuclear MIT report claimed atomic energy is 'a practical and timely option for . . . climate-change risk mitigation' (Deutsch et al. 2009, 19). Official US government documents, the US DOE, UK Environment Secretary, and others say atomic energy is needed because it is 'carbon free' (Johnson 2008; Smith 2006). The Japanese agree; the Federation of Electric Power Companies of Japan claims that atomic power helps 'to control global warming problems by not emitting gases, such as carbon dioxide, that contribute to climate change' (Federation of Electric Power Companies of Japan, 2002).

Unfortunately the preceding claims err because they consider only C02-equivalent emissions from reactors themselves. Yet the nuclear-fuel cycle has 13-18 stages, from mining to waste management to decommissioning, most of which release massive amounts of CO2-equivalent gases (Shrader-Frechette 2009a; Sovacool 2008). These emissions help explain why each reactor takes 11 years to 'pay back' energy used prior to start-up, whereas pay-back for natural-gas plants is only 6 months (Shrader-Frechette 2010; 2009b). Once emissions from all fuel-cycle stages are considered, it can be shown that atomic-fission-generated electricity is roughly as carbon-intensive as natural gas. The full-fuel cycle, greenhouse-emissions ratios, per kWhr of electricity, are roughly : coal 60 : gas 9 : nuclear 9 : solar 2 : wind 1 (Sovacool 2008; Shrader-Frechette 2009a; 2010; 2009b).

Nuclear-industry representatives likewise claim atomic power is 'some of the cheapest power available' (Herbst and Hopley 2007, 12), 'cost effective' (WNA 2008), and has 'low operational and maintenance costs' (McKinsey and Company 2007, 62). In Japan, where atomic-energy costs are the highest in the world, the industry group, the World Nuclear Association, claims that fission is still much cheaper than either wind or coal-generated electricity (WNA 2009).

However, market advocates disagree. They say atomic energy is much more expensive than other available options, that the 'excessive costs' of 'uneconomic' nuclear plants are what caused the industry to cancel hundreds of reactors and to order no new US plants since 1974 (Toth 2008, 6; Herbst and Hopley 2007, 5, 124; Cravens 2008, xiv-v). Over two decades, the two top US reactor vendors, GE and Westinghouse, each lost money on every reactor that they delivered for a fixed price (The Economist 2007; Herbst and Hopley 2007, 136). Since then, reactor vendors have built cost-plus plants; nuclear prices have risen substantially; and vendors admit that consumers are still paying for reactor problems of decades ago, when many plants were cancelled after billions of dollars had been spent on them. In the US, nuclear 'ratepayers were left responsible' for 'some of the highest electric rates in the country (Herbst and Hopley 2007, 4-7, 36, 43-4, 179). One alternative? A 2009 Harvard University study showed that globally, wind could supply more than 40 times current worldwide energy uses, and that total Japanese wind resources (for instance) were 3270 terawatt-hours – the equivalent of 372 reactors, each 1000MWe (Lu et al. 2009).

Moreover, the pro-nuclear US DOE says actual wind prices, on average over the last 7 years, are about 4.8 cents/kWh (Cravens 2008, 253; Smith 2006, 70; Aabakken 2005, 37-9; see Makhijani 2007, esp. Appendix C; Fioravanti 1999). However, credit-rating firms say nuclear-energy prices (if one excludes subsidies) are more than 15 cents/kWhr – or more than three times more expensive than wind energy (Moody Corporate Finance 2008; see Makhijani 2008, 2-3; Keystone 2007).

Scientific analyses are even grimmer for nuclear economics. They have shown that, if one uses actual, historical data to correct only 5 counterfactual assumptions (used by the nuclear industry), atomic energy can be shown to be about 12 times more expensive than wind energy. Correcting a *first* assumption, EU studies show that including 100-percent-nuclear-liability-insurance costs (not 2-percent costs, as industry does) could alone raise fission costs 300 percent. One reason full atomic-energy insurance is so expensive is that the pro-nuclear US government calculates the lifetime risk of a core melt for all current US commercial reactors (which are safer than most other reactors in the world) as about 1 in 5 (Makhijani 2007, Appendix A, esp. 192; Shrader-Frechette 2007, 42; Smith 2006, sec. 4.4). It also admits that a worst-case reactor accident could cause $660 billion in damages, excluding medical costs (Smith 2006, 194; Riccio 2001). Given these high risks and full-insurance costs, utilities, governments, and credit-rating firms universally say that no nuclear plants, anywhere, operate in the market, and none would operate without massive government subsidies, typically including a nuclear-reactor-liability limit (e.g., Spurgeon 2008, 423; Slocum 2008; ANS 2005; Heyes 2002, 28; Scully 2002; Rothwell 2002; EIA 1999; Cohn 1997, 80; Brownstein 1994). Yet, almost no government, industry, or university analyses of nuclear-electricity costs include the costs of industry transferring its serious atomic-energy risks to the people. Correcting a *second* erroneous nuclear-cost assumption, by including actual, 15-percent-construction-interest costs (not 0-percent costs, as industry does) could alone raise fission costs another 188 percent. Correcting a *third* erroneous nuclear-cost assumption, by including actual, 10-year-average-reactor-construction-time costs (not 0-year costs, as industry does) could alone increase costs 150 percent. Correcting a *fourth* erroneous nuclear-cost assumption, by using historical-average, 71-percent-load-factor benefits (not 90-95-percent benefits, as industry does) could raise costs 19-36 percent. Finally, correcting a *fifth* erroneous nuclear-cost assumption, by using actual, historical, 22-year-average-plant-lifetime benefits (not 40-year-average benefits, as industry does), could increase fission costs 5 percent. Provided the preceding cost-data are independent, this means that correcting only 5 types of nuclear-industry data-trimming arguably could increase atomic-energy costs 662-679 percent (300+188+150+(19-36)+5), from roughly $0.15 cents/kWhr to nearly $1.00/kWhr – far above all published nuclear-industry-cost estimates (Shrader-Frechette 2010; Makhijani 2008; Keystone 2007).

However, even atomic-energy proponents, like the US DOE, admit that by 2015, US solar photovoltaics (PV) will cost 5-10 cents/kWh, be economically competitive with all energy technologies, and be far less expensive than commercial fission (US DOE 2007). Yet even reactors begun in 2010 would not be operational by 2015, because even the best-case, global-average, reactor-construction time is 11 years, says the US National Academy of Sciences (Smith 2007, 47). This is why, for the latest year for which government data are available (2007), wind energy has been responsible for 60 percent of annual added new US electricity capacity, measured as percentage of peak summer demand (EIA 2009). For all these reasons, atomic energy does not appear to be one of the more economical ways to reduce greenhouse emissions.

Why do nations build uneconomical nuclear plants? Either the nations have not developed renewables, or they are controlled by existing utility special-interests, or they want commercial justifications for continuing their nuclear-weapons programs (Makhijani 2007, 188; Sweet 2006, 193). These are all reasons that, in every nation with nuclear power, it is the most heavily taxpayer-subsidized energy technology (Stoett 2003, 50-1,100; see Herbst and Hopley 2007, 4-7). No nuclear plant anywhere in the world has ever operated on the free market (Parenti 2008, 11; Brown 2008, 24; Thomas 2005). A top industrial-consulting firm, MRG Associates, showed that from 1947 through 1999, the US spent approximately $ 150 billion on subsidies for commercial nuclear, wind, and solar energy, 96.3 percent of which went to nuclear (Goldberg 2000; Smith 2006, 55, estimates $144 billion in nuclear subsidies). Since 2000, this US imbalance has continued (Blair 2008, 10; see Smith 2006, 44-51).

4. Environmental Injustice in Nuclear-related Mining, Reactor Siting, and Reactor Operation

Subsequent sections of the paper also argue that atomic energy is questionable because of inequitable impacts, EIJ. EIJ occurs whenever whenever someone bears disproportionately higher environmental or pollution risks; has less-than-equal access to environmental goods, like clean air; or has less-than-equal opportunity to participate in environmental decisionmaking affecting health and welfare (Shrader-Frechette 2002).

Consider first inequities associated with nuclear-fuel-cycle stage (1), mining uranium. In most major uranium-producing nations of the world (e.g., Canada, Australia, Kazakhstan, Niger, Russia, Namibia, Uzbekistan, USA), indigenous peoples have been harmed by working in unregulated uranium mines, by exposure to uncontrolled uranium wastes, or by substandard uranium mining/processing on their lands, to all of which operations they have failed to give genuine informed consent. In Canada, for instance, all uranium mining is on lands claimed by, or directly affecting, indigenous groups (US ACHRE 1995; Center for World Indigenous Studies 1999; World Information Service on Energy 2008).

In the US, Native-American uranium miners, e.g., Navajos, face 14 times the normal lung-cancer risk, 'most' of which has been caused by their uranium-mining, not smoking (Samet et al. 1984). The US government admits that it failed to require uranium-mine ventilation, failed to disclose radiation risks to Navajo miners, and had 'no plausible justification' for allowing such massive exploitation of Native-American miners (US ACHRE 1995). In 2005, Navajo Nation in the US demanded a moratorium on uranium mining/processing on its lands until ongoing health damages have been assessed and remedied. This has not occurred, and the US government allows no moratorium (Navajo Nation Council 2008).

What about reactor-siting-related EIJ? Are nuclear plants often sited in poor or minority communities? If one examines US census data, from zip codes in which the 104 US nuclear facilities are located (US Census 2000), z tests show apparent EIJ. The 38 commercial nuclear reactors in Southeast US (Arkansas, Alabama, North Carolina, South Carolina, Georgia, Florida, Mississippi, Virginia, Louisiana, and Tennessee) are sited disproportionately in zipcodes having a high percentage of poverty-level residents. Moreover, z tests show that this poverty-area reactor siting has a greater-than-99-percent likelihood of not being due merely to chance ($p<0.001$) (Shrader-Frechette and Alldred 2009).

Moreover, it is likely that similar EIJ occurs throughout the world, wherever reactors are sited. Whenever people are socially, politically, or economically vulnerable, they are likely to experience environmental injustice, mainly because they do not have the educational, political, or economic resources to avoid EIJ (Shrader-Frechette 2002).

Even if nuclear plants were never sited in poor or minority communities, and even if they never caused any accidents, they would cause much EIJ. Their radioactive emissions disproportionately harm children because most reactors in the world are allowed to emit 25 mrems of radiation annually (US CFR 2009, title 10, part 140). These allowed releases have caused statistically-significant increases in US infant and fetal mortality (Mangano 2008; 2000; 2002); in US childhood cancers and leukemias (Hatch and Susser 1990; Moris and Knorr 1990; Clapp et al. 1987; Mangano 2006; Baker and Hoel 2007; Mangano and Sherman 2008); in childhood leukemias near German reactors (Kaatsch et al. 2008; Spix 2008; Michaelis et al. 1992); in childhood leukemias near French nuclear-reprocessing plants (Viel, Pobel, and Carre 1995; Guizard et al. 2001); and in childhood leukemia, child lymphoma, child brain cancer, and cancer generally near English and Scottish nuclear facilities (Gardner et al. 1990; Forman et al. 1987; Watson and Sumner 1996; Gibson et al. 1988; Heasman et al. 1986; Busby and Scott-Cato 1997; Beral, Roman, and Bobrow 1993; Roman et al. 1999; 1993; Shrader-Frechette 2002, 158). Studies also show that, once nuclear reactors are shut down, nearby infant health ailments, cancers, and deaths decrease (Mangano 2002; 2000). In particular, scientists have shown a decreasing leukemia risk, for children under five years of age, with increased distance from nuclear plants (Kaatsch et al. 2008). The upshot? Radiation effects on young people are especially severe, even under supposedly normal operations (Laurier et al. 2008).

However, some industry scientists have objected to the preceding findings of increased negative health effects near normally-operating reactors. They claim a non-experimental, US National Cancer Institute (NCI) study showed no higher cancer rates in US counties having nuclear plants (Jablon, Hrubec, and Boice 1991).

This NCI conclusion is questionable, however, for at least 6 reasons. *First*, because the study used only *countywide data* to examine nuclear-plant-health effects, it biased samples, e.g., by counting residents (of counties without reactors) as non-reactor-radiation exposed, while counting residents (of counties with reactors) as reactor-radiation-exposed. Yet many reactors are at counties' eastern/northern borders, causing downwind radiation mainly in other counties (whose residents were counted as non-exposed), and causing near-zero-upwind radiation in reactor-home counties (whose residents were counted as exposed). Also, because the typical county-wide-study area was 1200 square miles, small doses to distant victims diluted effects on closer, higher-dose victims. Similarly, because half the population examined lived more than 20 miles from reactors, more-harmful effects on closer residents were diluted by lesser effects on far-away residents. *Second*, because the NCI study ignored wind direction, its near-zero-upwind health effects dilute mostly-downwind health harms. *Third,* the NCI study used cancer-mortality, not cancer-incidence, data, despite the fact that premature-cancer-mortality effects can take 40 or more years to appear, and scientists agree that mortality underestimates effects. *Fourth,* the NCI study admitted increased, statistically-significant, radiation-related-mortality risks near some nuclear facilities, yet denied these effects after averaging overall mortality for all facilities. *Fifth,* the study conclusions (no increased cancers in counties with nuclear facilities) are inconsistent, both with well-confirmed, internationally accepted, radiation-dose-response curves that show no safe, non-zero, doses of radiation (NRC/NAS 1991), and with repeated studies (see above) showing increased cancers near normally-operating reactors. *Sixth,* well confirmed studies have shown that every 10-mrems increase in gamma radiation (less than half that released annually by a reactor) can cause a 50 percent increase in risk of cancer for children under age 15 (Hatch and Susser 1990, 549). All these results show the flawed NCI conclusions likely err. They reveal that, even if there are no reactor accidents, the most vulnerable members of society – children – will be victims of environmental injustice.

5. Environmental Injustice from Flawed Radiation Standards for Children

National and international radiation-protection standards also fail to protect children For the same doses of most pollutants, children are at roughly ten-times-higher risk than adults, because their organ, metabolic, and detoxification systems are not fully developed; because of their higher rates of cell multiplication and division; and because their unformed gastrointestinal tracts can absorb far more radionuclides and other pollutants than can those of adults (Makhijani, Smith, and Thorne 2006). Children also take in more air, water, food, and thus pollutants, per body-mass unit, than do adults, and they have higher heart and respiration rates, in part because of their smaller airways. For all these reasons, even in the developed world, adult cancer rates are increasing roughly 1 percent per year while, mainly because of pollutants, children's cancer rates are increasing 40 percent faster, at 1.4 percent per year (CEH 2004; Shrader-Frechette 2007, 15-29).

Children likewise are well known to be far more sensitive to ionizing radiation than are adults (NRC 2005, 6; Mangano 2008; 2000; 2002; UN SCEAR 1994).

For instance, if infants and adults receive the same thyroid exposure to plutonium-139, the thyroid-cancer risk of the infant will be 33-39 times higher than that of the adult (Makhijani, Smith, and Thorne 2006, 39-40).

Given children's higher sensitivity to ionizing radiation, international and national radiation standards fail to protect them adequately, mainly because they assess radiation hazards in terms of the 'reference-man' model. 'Reference man is defined as being between 20-30 years of age, weighing 70 kg (154 pounds), is 170 cm (5 feet 7 inches) in height, and lives in a climate with an average temperature of from 10º to 20ºC. He is a Caucasian and is a Western European or North American in habitat and custom' (Makhijani, Smith, and Thorne 2006, 9). Yet women cancer risk is roughly double that for men, and children's risk is even higher (NRC/NAS 2006, 15; Makhijani, Smith, and Thorne 2006, 28). The reference-man model also is not fully applicable to, and representative of, Asian people; consequently, the UN has recommended that Asian nations develop more representative radiation-risk models (Metivier and the OECD 2009, 30). At present, organ-dose differences among the Japanese analogues for the 'reference man' vary as much as a factor of 50, showing their problems (Satto et al. 2008). Moreover, the reference-man model focuses only on cancer – ignoring radiation-induced increases in genetic defects, immune-system damage, blood diseases, spontaneous abortion, neonatal mortality, birth defects, and the 25-point-permanent-IQ drop for every Sievert (100 rems) of in-utero-ionizing-radiation exposure during human-brain formation (NRC/NAS 1990, 358-9; ICRP 2005, 32; Makhijani, Smith, and Thorne 2006, 20-22, 43, 76).

US and Japanese occupational-radiation regulations also protect some US and Japanese children less well than adults and many European children. A US female nuclear worker and her fetus are allowed to receive an annual radiation dose of 500 mrems (not 5000 rems that other radiation workers may receive). However, this dose to the fetus is 5 times higher than the 100 mrems annually that members of the public are allowed to receive – and 5 times higher than the 100 mrems annually, that a fetus is allowed to receive in most of Europe, e.g., Germany. In Japan, the fetus of a female radiation worker is allowed to receive 100 mrems/year from internal exposure (e.g., through radiation absorption or inhalation) – but could receive additional external exposure up to 1500 mrem during pregnancy (Saito 2001). Because infants are up to about 38 times more sensitive to radiation than adults (see preceding paragraphs), and because fetuses are even more sensitive than infants, protecting them (at the same level as the US or Japanese public) would require their annual radiation dose to be no more than (1/38)(100 mrems) or 2.6 mrems. Given the US fetal standard of 500 mrems, the US fetus is 500/2.6 or 192 times less protected from radiation than are US adults. US radiation regulations thus may follow the preferences of the powerful, rather than the needs of the vulnerable, especially children (Makhijani, Smith, and Thorne 2006, 33-4, 44). Given the Japanese fetal standard of up to 1500 mrem, the Japanese fetus of a nuclear worker is 1500/2.6 or 577 times less protected from radiation than are Japanese adults. Japanese radiation regulations, like those of the US, thus protect the fetus less well than do many European nations. They also follow the preferences of powerful polluters, rather than the needs of the vulnerable.

6. Environmental Injustice from Flawed Occupational-Radiation Standards

Subsequent paragraphs also show that it is difficult to justify radiation standards for male workers in Japan, the US, and elsewhere, that are 50 times less protective than for members of the public, because workers are unlikely to be able to consent to these higher risks. Both US and Japanese regulations allow members of the public to be exposed to 100 mrems (or 1 mSv) of radiation annually, while male radiation workers may receive 5000 mrems (or 50 mSv) annually; Japanese-female radiation workers may receive 200 mrems (or 20 mSv) annually, (Saito 2001; US CFR 2005, Title 10, Part 20, Sections 1201, 1301). These differences are important, because all non-zero amounts of ionizing radiation are unsafe, and radiation-caused health risks are linear with no threshold for increased harm, at any non-zero dose (LNT) (NRC/NAS 2006, 6). Moreover, the latest empirical data on normal-workplace radiation exposures, from the Interagency Review Group on Cancer (IARC), show that each time 60 workers are exposed to the maximum-annual-occupational dose of radiation, this one exposure, alone, will cause one premature, otherwise-avoidable, fatal cancer (Cardis et al. 2005). In the United States, 1.5 million workers receive annual-occupational-radiation exposures, and 300,000 of these workers are employed in the commercial nuclear industry (Health Canada 2004; Moser 1995; Choi et al. 2001; NIOSH 2001). In Japan, for instance, roughly 75,000 workers are employed in the commercial nuclear industry (ISOE). Yet if radiation workers face much higher health risks, because of their occupational-radiation exposures, they should know about these risks and consent to them – or they are victims of environmental injustice. As later paragraphs argue, two factors that can block their occupational consent are a lack of *individualized* radiation-dose data and a lack of *cumulative* radiation-dose data.

The US, for instance, has little individualized radiation-dose data because, unlike some other developed nations that require workers to have personal-radiation air monitors, the US allows employers to use general air monitors (single, fixed, air samplers for assessing internal radiation dose); the US also allows employers to report only mean radiation exposures for work areas (US CFR 2005, Title 10, Part 20, sections 1201 and 130110). In Japan, however, as in Germany and other nations, nuclear workers have 'personnel exposure monitoring systems' that enable the reactor owners to monitor individual-worker-radiation exposures (UN OECD 2009, 94). That is, 'personal-monitor systems are used [in Japan] to determine the dose received by an individual from external and internal sources' (JAEA 2004, 2). Because the US uses fixed, general-air samplers, however, the US National Council on Radiation Protection and Measurement warns that general air samplers can underestimate radionuclide concentrations and *individual* doses by 3 orders of magnitude, especially if they are located far from highest-exposure employees (NCRPM 1998, Report 127). Workers thus may be unable to know or consent to their precise, individual, radiation doses.

Lack of data on *cumulative* radiation doses likewise threatens occupational-radiation consent because employers are legally required to report only workplace-radiation, not cumulative-radiation, doses. Yet when expressed on a relative-risk scale (NRC/NAS 2006, 6), risk differences associated with the same occupational-radiation dose are much larger at higher cumulative-radiation doses. All other things being equal, prior radiotherapy, for instance, could give a worker a 10-year, average-cancer risk 6 times higher than that of other workers (Hall 2004), even if all received identical workplace doses.

Yet despite various workers' radically different radiation-exposure histories, their employers are not required to give them quantitative information about their different relative-radiation risks. All nations require employers to disclose only average occupational-radiation doses; consequently workers typically have incomplete information about their individual, cumulative, and relative radiation doses and risks (Linkov and Burmistrov 70-75; ICRP 1991). Protecting radiation workers thus relies on one type of information – *average occupational dose* – to achieve *employer compliance* with regulations. Achieving *employee consent,* however, also requires another type of information – *individual cumulative dose.*

If radiation workers misunderstand the different relative risks associated with the same average-occupational-radiation dose, they may be unable to consent to their higher workplace-radiation risks. If so, they do not receive the required protection – the guarantees of free informed consent to risks – demanded by all bioethics codes, like the famous Helsinki Declaration (WMO 2004).

Radiation-worker information and consent also are jeopardized because international/national standards require no overall radiation-dose and risk limits, only limits within single-exposure classes (e.g., medical, occupational, public) and from single sources, like a nuclear power plant (ICRP 1991). Partly because no nation routinely measures cumulative radiation doses and risks from all sources and exposure classes, the US National Academy of Sciences has recommended extensive radiation-data collection and analysis (NRC/NAS 2006, 6).

7. Objections

How might critics respond to these criticisms of radiation-protection standards for children and workers? Although they make no explicit replies, they might claim stronger radioactive-pollution standards for children are not operationalizable or would hurt economic production. Or they might say worker doses are low, despite weaker standards. Consider these objections in order.

The operationalizability objection seems questionable on at least four grounds. *First,* in the last half-century, as radiation has been recognized as more hazardous than previously thought, regulations have forced radiation standards to become 500 percent more protective for members of the public. Because standards have moved from allowed doses of 500 to 100 mrems (Makhijani, Smith, and Thorne 2006, 19-20), they arguably could be tightened further. *Second*, many regulations (e.g., US) mandate that pregnant women be moved to lower-radiation areas during their pregnancy (Makhijani, Smith, and Thorne 2006, 33-34, 44). If so, arguably such protection could be extended to all fetuses/children. *Third,* current radiation-protection standards are based not on operationalizability, but on achieving doses that are ALARA – as low as reasonably achievable, taking into account economic considerations (Makhijani, Smith, and Thorne 2006, 20). Because typical polluters must make radiation-pollution-improvements only if they are cost-effective (e.g., in the US, if improvement costs them less than $1000 to avoid one person-rem of radiation) (Shrader-Frechette 1983, 29), stricter radiation protections for children and workers appear operationalizable, although they may be more expensive. After all, stricter-radiation standards must be operationalizable, because Germany has stricter standards. Thus anyone, who claims more-protective-radiation standards for children or workers are not operationalizable, must show that it is ethically justifiable for polluters to save money, by not controlling radiation that disproportionately harms children. Because polluters gain economically by imposing higher risks on innocent children, it is difficult to see how any such ethical justification could work. Polluters ought to pay the full costs of doing business, and people who use polluting products ought to pay full costs of these products – rather than imposing them on innocent victims. A *fourth* reason to doubt the operationalizability claim is that the US government provides additional protections to children who are research subjects, because it recognizes their medical vulnerability and their political powerlessness (CFR 2007; EPA 2006). Given this fact, the case for better pollution-protection of children appears stronger than for their research protection. Why? Medical research often benefits children directly (CFR 2007; EPA 2006), but radiation pollution does not, especially because there is no safe, non-zero, radiation dose. Exposure merely saves money for polluters.

What about the economics/expense objection? Unfortunately it begs the question whether less-protective-radiation standards for children and workers are worth possible increased economic benefits – and whether utilitarian benefits for many outweigh severe harm and inequity suffered by children and workers. This question-begging is problematic, partly because children are the most vulnerable members of society and hence less able to speak for themselves. Imposing/allowing inequities against the most vulnerable also harms everyone; it damages the common good. Besides, from a purely factual point of view, it is questionable whether weakened radiation-pollution standards for children actually benefit society economically. Is the EU, with 5-times-more-stringent-radiation protections for fetuses than the US (see citations above), therefore 5 times worse off (economically speaking) than the US? Is the EU, with 15-times-more stringent-radiation protections for fetuses than Japan (see citations above), therefore 15 times worse off (economically speaking) than Japan? If not, it is questionable to argue that weaker radiation-pollution control benefits overall society (Phillips 2003; Shrader-Frechette 2007, 26-38).

What about the third objection, that better radiation standards (to promote better radiation-worker-risk disclosure and consent) might not be needed because most occupational-radiation exposures allegedly are low? However, the IARC (see above) study showed that just the allowable, supposedly ‘low’ occupational-radiation doses to 45,000 of current radiation workers are responsible for 1300, otherwise-avoidable, radiation-induced cancers – killing 1 in 11 of them, without any nuclear accidents (Cardis et al. 2005).

Moreover, high-occupational-radiation doses are a special ethical and scientific problem in Japan and in the US, for at least three additional reasons, One reason is that, since 1998, Japan has had the highest average-collective-radiation dose, per reactor, among all nations listed by the United Nations; the US has had the second-highest-average-reactor-radiation dose (UN OECD 2009, 102).

A second problem with the third objection is that reactor-radiation-monitoring is incomplete. As already mentioned, the US does not use personal-radiation monitors and thus underestimates worker doses by up to 300 percent, whereas Japan does use personal-radiation monitors. While recording these individual Japanese doses is better than what is done in the US, the Japanese procedure is flawed because its standards have no external-radiation-dose limit for pregnant women, one more protective than the dose limit for women generally (Saito 2001). Japanese standards allow high levels of external-radiation doses for pregnant women and specify only internal-dose limits for them.

A third problem with the third objection is that Japan, the US, and other nations, like France and Britain, have had massive problems with radiation leaks, dose falsification, and coverup. In Japan, the public ‘does not trust the nuclear-fuel-cycle promotion policy and shows signs of anxiety’ about nuclear technology and radioactive-waste storage (Kugo et al. 2005, 755). One reason for Japanese mistrust? The government does not adequately enforce nuclear regulations (Tanabe, Nakagome, and Kanda 2004). Moreover, there have been repeated illegal, nuclear-related acts. In 2009, for instance, the same radioactive leak occurred at the Rokkasho nuclear-reprocessing plant, as occurred several months before, in 2008; the company also had strewn low-level waste throughout the spent-fuel storage building (CNIC 2009). In 2007, 12 Japanese electric-power companies admitted to 104 different malpractices that include radiation-data falsification and fabrication, deliberately duping safety inspectors, and failure to report problems such as uncontrolled reactor-criticality incidents and emergency reactor shut-downs at places like the Shika, Fukushima, Kashiwazaki-Kariwa reactors (White 2007). In 2002, whistleblowers revealed illegal falsification, concealment of inspection data, and coverup by at least 38 employees of Tokyo Electric Power Company (WISE/NIRS 2002). In 1999, a criticality accident at the Tokai nuclear fuel plant caused the deaths of at least 3 workers, illegal radioactive contamination of at least 667 members of the public, and damages to at least 7000 people, as a consequence of ‘negligence resulting in death’, ‘systemic rule violations, and a lack of safety measures’ (WISE 2005).

In the US, multiple Congressional investigations have revealed that DOE safety violations, dose falsifications, corruption, and persecution of whistleblowers have continued for decades. Consequently, since 1990, US-government-oversight agencies and professional scientific associations have been calling for either external regulation of the DOE or its abolition (Shrader-Frechette 1993). Congress says DOE occupational-dose falsifications also show that some US nuclear-worker doses have been higher than government admits (US GAO 1998, 4). Otherwise, why have the United States and Japan (both of which allow a 50-mSv, annual-radiation dose) not adopted the stricter 20-mSv occupational standard of many other nations – or the 12.5-mSv limit recommended by British authorities (CMARE1986)?

Besides, even if most occupational-radiation doses were low, as the objection assumes, it errs in at least two additional respects. *First*, it presupposes that not everyone has rights to equal protection, that workers can be forced to trade their health for jobs, and that only utilitarian or majority radiation-protection is necessary (the greatest good for the greatest number of radiation workers) (Bentham1970). *Second*, even if occupational-radiation doses were low, the objection wrongly assumes that low-radiation-dose magnitude is sufficient to make doses ethically acceptable. Described by British ethicist G. E. Moore (Moore 1960; Berman 1978; Viscusi 1983), this error is the naturalistic fallacy. Those who commit it attempt to reduce *ethical* questions (e.g., is this particular imposition of increased-workplace-radiation risk just?) to *scientific* questions (e.g., how high is this specific workplace-radiation risk?). The two questions are irreducible because even small risks may be ethically unacceptable if they are easily preventable, imposed unfairly, without adequate compensation, rights violations, and so on. Besides, risk bearers ultimately must judge whether risks are low – by giving or withholding their consent – and this paper has cast doubt on workers' ability to consent.

8. Conclusion

Where do the preceding arguments leave us? If one uses commercial nuclear fission, as a way to address climate change, one faces both technical and ethical problems. The technical problems are that fission is costly and carbon intensive. The ethical problems are twofold. *First,* the fuel-cycle involves environmental injustice in mining, siting, and operation. *Second,* radiation standards themselves allow the worst pollution burdens to be imposed on the most vulnerable groups, especially children and blue-collar workers.

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Engineers and Sustainability:

An Inquiry into the Elusive Distinction between Macro-, Micro-, and Meso-Ethics

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Abstract

There has recently been renewed interest among many concerned with social policy, philosophy of technology, and the social study of technology, in the distinction between macro-ethics and micro-ethics. Those so interested have generally been critical of engineering ethics, especially the classroom and textbook versions, as too much concerned with micro-ethics. Much more should (they claim) be said about macro-ethics. Sustainable development seems to be just the issue for which engineering ethics might deserve that criticism. Most texts in engineering ethics now include nothing about sustainable development as such, though most include something about protecting the environment. Would not engineering ethics have to change dramatically to deal even reasonably well with a "macro-subject" like sustainable development? My answer to that question is: No, engineering ethics can easily deal with sustainable development—insofar as it involves questions of engineering—without substantial change (no more than a few new problems and some background information). I defend that answer by arguing 1) that the micro-macro distinction misses an important intermediate domain in ethics (the "meso"), 2) that engineering ethics, at least when taught in the standard way, that is, as professional ethics, belongs to that intermediate domain, and 3) that what the "macro-ethics" advocates want to include in engineering ethics courses does not seem to be ethics at all (in any interesting sense) or, while ethics, does not seem to be engineering or, while engineering, does not seem to be "macro-ethics". Any problem of sustainable development an engineer might address as engineer belongs to the intermediate domain rather than to either micro-ethics or macro-ethics. The term "macro-ethics" need not appear in discussions of how to incorporate sustainable development into courses and texts in engineering ethics. Indeed, given the conceptual confusion its application to engineering involves, the term should be avoided.

Key words : professional ethics, civil society, John Ladd, political philosophy, morality

There has recently been renewed interest among many concerned with social policy, philosophy of technology, and the social study of technology, in the distinction between macro-ethics and micro-ethics. (See, for example, Son, 2008, and works cited there.) Those so interested have generally been critical of engineering ethics, especially the classroom and textbook versions, as too much concerned with micro-ethics. Much more should (they claim) be said about macro-ethics. Sustainable development seems to be just the issue for which engineering ethics might deserve that criticism. Courses and texts in engineering ethics now include very little about sustainable development as such, though most include a significant amount about protecting the environment. (The only text I know of to include anything about sustainability is Harris, Pritchard, and Rabins, 2009, 193 and 278-280.)

By "sustainable development", I mean (roughly) improvement in material conditions that "meets the needs of the present [justly] without compromising the ability of future generations to meet their own needs [in the same way]." (Kates et al. , 2005, 9-10.) What could be more "macro-ethical" than problems concerned with social justice, the environment, and the material welfare of all humanity, now and in the future as far as humans can plan? Would not engineering ethics have to change dramatically to deal even reasonably well with a "macro-subject" like sustainable development?

Though these two questions may seem rhetorical, they are not. My answer to the first is that sustainable development is no more or less macro-ethical than many other questions now a routine part of courses in engineering ethics. My answer to the second question is that engineering ethics can easily deal with sustainable development—*insofar as it involves questions of engineering*—without substantial change (no more than a few new problems and some background information). I shall defend this double answer here by arguing 1) that the micro-macro distinction misses an important intermediate domain in ethics (the "meso"), 2) that engineering ethics, at least when taught in the standard way, that is, as professional ethics, belongs to that intermediate domain, and 3) that what the "macro-ethics" advocates want to include in engineering ethics courses does not seem to be ethics at all (in any interesting sense) or, while ethics, does not seem to be engineering or, while engineering, does not seem to be "macro". Any problem of sustainable development an *engineer* might address *as engineer* belongs to the intermediate domain rather than to either micro-ethics or macro-ethics; the same for any engineering organization addressing the problem as an organization of engineers. Those advocating more "macro-ethics" in courses in engineering ethics are confused about what engineering ethics is. It is not about technological decisions as such but about decisions engineers make as engineers (an agent-centered study rather than an object-centered one). The term "macro-ethics" need not appear in discussions of how to incorporate sustainable development into courses and texts in engineering ethics. Indeed, given the conceptual confusion its application to engineering involves, the term should be altogether avoided.

Though my argument here is entirely about engineers, there is nothing in it that could not, with small changes, be applied to other technological professions (architects, biologists, computer scientists, or the like) urged to treat macro-ethics in a course in professional ethics.

Micro, Macro, and the Great in-Between

The distinction between micro-ethics and macro-ethics seems to have been constructed on the model of a fundamental distinction in economics. (The source of the distinction typically cited, Ladd, 1980, 156, explicitly claims to be adopting the distinction from economics.) Micro-economics is the study of markets. Its subject is the making, selling, and buying of goods by individuals, households, partnerships, corporations, and other market agents. Macro-economics is, instead, the study of the economy of a state or geographical region; its concern is national income, money supply, taxation, balance of payments, government expenditure, and the like. Micro-economics is treated in one set of economics courses; macro-economics in another. The distinction between macro and micro in economics seems to date from the 1930s (http://en.wikipedia.org/wiki/ Macroeconomics. Accessed March 23, 2009). For a good description of the micro-macro distinction in economics and of some of the important disanalogies with the distinction in practical ethics, see Brummer (1985).

When Ladd brought the micro-macro distinction into applied ethics in 1980, there was a closer analogy between economics and ethics than there is today. Three decades ago, (philosophical) ethics was still largely concerned with decisions of mere individuals; political philosophy, with decisions of government; and other sorts of decision (most of what we now call "applied ethics") were only beginning to win much attention—within philosophy or outside. Ladd himself had argued strenuously against the possibility of organizations, especially corporations and bureaucracies, being either moral agents or owed moral obligation. For Ladd, ethics was about what individuals should do; ethical standards, the same for each individual whether acting alone or in concert with others (Ladd, 1970). Today most of us recognize families, businesses, trade associations, professions, religions, charities, private universities, and other voluntary groups as distinct moral entities. The collective term now in vogue for these entities is "civil society".

Over the last three decades, civil society has become increasingly important in our thinking about "society", that is, the largest and most inclusive number of human beings living together for mutual benefit. That thinking has concerned both what society is and what it should be. Consider two recent articles by the strongest advocate of macro-ethics, Joseph Herkert. Herkert (2001) offered a table listing five versions of the micro-macro distinction—including Ladd's. By Herkert's count, three of the five recognized an intermediate category between individual ethics and "social ethics", though each did it in a different way (Herkert, 2001, *405)*. Herkert counts Ladd as one of the three recognizing an intermediate category. That, I think, is a mistake. Ladd (1980), 155, is quite clear that "there is no special ethics belonging to professionals". (See also the extended explanation of that claim, Ladd, 1980, 156.) Having eliminated the space for professional ethics, Ladd's micro-macro distinction cannot divide it. (A similar list, omitting Devon, appears in Herkert, 2003, 163-167. No reason is given for the omission.)

Herkert (2005), 374, proposed Herkert's own version of the distinction. It divided civil society down the middle:

> Engineering ethics can be viewed from three frames of reference—individual, professional and social—which can be divided into "microethics" concerned with ethical decision making by individual engineers and the engineering profession's internal relationships, and "macroethics" referring to the profession's collective social responsibility and to societal decisions about technology.

Though Herkert clearly is aware of the importance of civil society (the profession), just as clearly he has a problem making civil society fit the micro-macro distinction. One sign of that difficulty is that, in his version of the distinction, part of professional activity (the "internal") ends up on one side of the divide while the rest (the external or "social") ends up on the other.

When I pointed out (in an email) how arbitrary it seemed to divide civil society in this way, comparing his approach unfavorably to Solomon's *threat* to cut the disputed baby in half, Herkert responded (email, April 13, 2009):

> I don't have any difficulty at all in making this distinction. The internal and external relations of the engineering profession are very different. In fact, it is this difference that drew me to the micro/macro distinction in the first place.

Herkert went on to link his attraction to the distinction to his experience working on "macro issues" with the IEEE (Institute of Electrical and Electronic Engineers). That experience is substantial. See, for example, Herkert (1998). So, his response is not to be taken lightly. The response relies, however, on observations concerning how professional societies (sometimes) conduct themselves, not on judgments concerning how they *should* conduct themselves, that is, on fact, not ethics. Herkert (1998) makes a good case for his conclusion that the IEEE and other engineering societies have failed to support sustainable development but, more relevant here, makes that case without any use of the term "macro-ethics".

The chief problem with the micro-macro distinction in ethics is not that the analogy with the similarly-named distinction in economics is not close (though that is a problem). Nor is the problem that the distinction in fact does little or no useful work (though that too is a problem). The chief problem is that the distinction tends to hide an important fact, the crucial role of civil society in defining what we mean by engineering *ethics*. "Ethics" has many senses in English. Four seem relevant here: ethics-as-ordinary-morality, ethics-as-moral-theory, ethics-as-theory-of-the-good-society, and ethics-as-special-standards. Among interesting senses that do not seem to be useful here are: ethics-as-domain-of-problems (those problems that someone might propose a new moral standard to resolve); ethics-as-actual-moral-practice (positive morality); and ethics-as-moral-ideal (aspirational ethics). Which of the relevant senses is (or should be) primary when we speak of "engineering ethics"?

Ordinary morality consists (more or less) of those standards all rational persons (at their rational best) want all others to follow even if that would mean having to do the same: don't lie, don't cheat, keep your promises, help the needy, and so on (rules, principles, ideals, and the like). Ethics-as-ordinary-morality is about what individual rational agents should or should not do, the domain of *micro*-ethics.

Ethics-as-moral-theory (moral philosophy) is the attempt to understand morality as a rational undertaking. Its focus is therefore also micro-ethics. Ethics-as-theory-of-the-good-society is, in contrast, about how *society*—in its widest sense—should be organized to achieve the good. It may go beyond what ordinary morality requires, recommends, or forbids. It is, therefore, an undertaking distinct from ethics-as-ordinary-morality. Indeed, the attempt to define the overall organization of society, to make recommendations concerning international relations, constitution, government, and laws is usually called "political philosophy" (or "political theory"). Every definition of macro-ethics includes this political domain (whether or not it includes any part of civil society).

The division between micro and macro is quite old (even if the terms are not). It corresponds to the division between (what we now call) Aristotle's *Nicomachean Ethics* and his *Politics* (what, for Aristotle, was one work, not two). Aristotle has, I believe, almost nothing to say about civil society even though his own Lyceum is a good example of the sort of institution that might have made up Greek civil society. Indeed, like Plato, Aristotle would probably reject the micro-macro distinction for the opposite reason I have. For Aristotle, the micro-macro distinction divides what should be treated together. Individuals do not exist except in society, and society does not exist without individuals. For Aristotle, morality cannot be a matter of individual decision, since mere individuals do not exist (except as gods or beasts).

Ethics-as-special-standards, the last of my four senses of "ethics", consists of those morally permissible standards of conduct all members of a *group* (at their rational best) want all others in the group to follow even if that would mean doing the same. It resembles ethics-as-theory-of-the-good-society insofar as it concerns more than the conduct of individuals. It is, however, different from ethics-as-theory-of-the-good-society insofar as the groups in question are not "political societies" but members of civil society, that is, those organizations (associations, institutions, corporations, or the like), including political parties and special interest groups, free to exist under constitution, government, and law but not required to. Ethics-as-special-standards stands between micro-ethics (individuals) and macro-ethics (society at large). For purposes of brevity and to bring out its intermediate status, I shall hereafter refer to ethics in this fourth sense as "meso-ethics".

Meso-ethics is part of morality but not part of *ordinary* morality. How is that possible? If, for example, I join a club having certain (morally permissible) rules, I have (all else equal) implicitly promised to follow those rules. Since ordinary morality includes a prima facie obligation to keep promises, I have a prima facie moral obligation to follow the club's rules. Insofar as the club's rules are morally binding on me, they are now part of morality. But insofar as they do not apply to everyone, only to members of the club, those rules are special standards. In this way, meso-ethics can be both part of morality (because morally binding) and distinct from ordinary morality (because its standards are special).

Engineering Ethics as Meso-ethics

Engineering ethics is a kind of meso-ethics even when concerned with sustainable development—as I shall now show. Consider this engineering problem:

> You, a mechanical engineer, are helping to design an office printer (with copier, scanner, and fax included). Sales are expected to be 10,000 or so. The specifications require that the device be able to print on one side or two but not which should be the default setting. Single-side is the customary default, but that default seems to you an invitation to waste paper. Should you recommend two-sided printing as the default? (Anke Van Gorp, 2005, 16.)

The decision "you", the individual engineer, will make is whether to *recommend* one design or another, that is, it is a decision within an organization (a part of civil society), as most engineering decisions are. You may have to defend the recommendation at higher levels. You will certainly have to win the organization's cooperation to build the printer as you wish. That is one respect in which the decision in question is meso rather than micro: the engineer's decision is part of a process by which a voluntary organization makes a morally significant choice. There are two others.

First, mechanical engineers are, according to their code of ethics, supposed to "consider environmental impact in the performance of their professional duties" (ASME, 2009, Fundamental Canon 8). Changing the default setting looks like a good way to do that: save trees, save on the pollution necessary to turn trees into paper, and save on the pollution necessary to get the paper from manufacturer to printer. The change in default should cost the engineer's employer virtually nothing; the new printer will require new software anyway. If customers do not mind, the change should be a painless improvement in the printer. Engineers are supposed to incorporate improvements into their designs whenever possible at reasonable cost. This certainly seems to be an improvement. The engineer's decision, if approved, will then probably change the state of the art in her company—and perhaps among printer manufacturers generally. In this respect, an individual engineer never acts as a mere employed individual but as one engineer setting standards for the rest.

Second, the engineer's decision will, if approved, impose (a little) sustainable development on anyone who unthinkingly uses the printer. Only those who take the trouble to change the setting each time they use the printer will be able to print in a less sustainable way (that is, wastefully). Given that most office printers have several users, the number of people the engineer's decision directly affects could be several times 10,000, few of them engineers or employee's of the engineer's employer. That is a significant *social* effect.

The effect, being social, may appear macro-ethical rather than meso-ethical. It is not. The effect would be achieved entirely without change in law, regulation, or governmental policy. What is not the work of law, regulation, or governmental policy is not macro-ethical (in any interesting sense). The term "macro-ethical" is not an indication of mere scale of effect but of the primary agent (political society rather than civil society or individuals).

Or, at least, the term *should* not be an indication of mere scale of effect. The price of reducing the micro-macro distinction to one of mere scale is that many ordinary engineering decisions, including the one concerned with the printer default, would become macro-ethical; much of engineering ethics, as now taught, would also concern macro-ethics; and much of the micro-macro criticism of engineering ethics would be trivially false.

The effect of the new default is also plainly not micro-ethical. The engineer in question could not achieve that social effect as an individual, say, as a mere inventor (though she could conceive the improvement acting alone). She could only achieve that social effect as part of civil society, that is, as an engineer working for the company in question—or, with a different set of facts, in some other engineering role. In such a context, the engineer's ethical problem is neither a micro-problem, what a mere individual should do, nor a macro-problem, what a citizen, official, or other agency of government should do, but a meso-problem, what an engineer as such (a member of civil society) should do. That is true even when engineers try to change government policy. As long as they are acting *as engineers*, whether as individual engineers or as agents of some association or interest group, they are acting as members of civil society (whatever effect they have). The same is true when a voluntary organization of engineers acts in its corporate capacity. Though political society may treat it as an individual (a corporate person), its members must treat it as *their* organization—at least while *they* are acting as engineers. (By "acting as engineers", I mean claiming whatever respect, authority, or power comes from being recognized as engineers rather than, say, as chemists, lawyers, or professors.)

Consider, then, what Herkert (2005), 374, has to say about the sorts of issues that are micro and macro:

> Microethical issues in engineering include such matters as designing safe products and not accepting bribes or participating in kickback schemes. Macroethics in engineering includes the social responsibilities of engineers and the engineering profession concerning such issues as sustainable development and product liability.

One lesson we could draw from the printer example is that Herkert (2005) is simply wrong about sustainable development's status as macro-ethical. Issues of sustainable development can occur in engineering in exactly the same way as issues of safety, be subject to similar professional standards, and seem to require the same sort of design work. There is nothing inherently macro about sustainable development. Another possible lesson, the one Herkert himself prefers, is that he could have been clearer about what he meant (private communication, April 13, 2009). For Herkert, it seems, the decision becomes macro when engineering societies, or the profession as a whole, rather than individual engineers or groups of engineers working for a single employer, must address it. I still disagree. The engineers in question, that is, the engineering society, are still supposed to be acting according to their professional standards (which are, by definition, meso-ethical). Professional societies are part of the profession, not above or beyond it; they are bound by the same professional standards. I shall return to this point later.

The decision to use two-sided printing as the default setting—whether categorized as micro, macro, or meso—is an *ethical* decision in the special standards sense. The engineer in question got her job (we may suppose) in part by claiming (truthfully) to be a mechanical engineer. To claim to be a mechanical engineer rather than, say, someone good at designing mechanical devices, is to claim to be a member in good standing of a certain profession, in other words, to be a mechanical engineer reliably working as mechanical engineers are supposed to work. To work as mechanical engineers are supposed to work is in part to work as the profession's code of ethics requires. To get and keep a job by giving the impression that one will work in a certain way gives one a prima facie moral obligation to work in that way (an obligation arising from implied promise or justified reliance). To get and keep a job by claiming to be a member of a certain profession also puts the profession's reputation at risk, giving one another source of moral obligation (one arising from fairness, that is, the standard requiring one not to claim the benefits of a voluntary morally permissible practice while declining the burdens that make those benefits possible). (For an extended defense of this claim, see Davis, 1991)

The special standards of engineering ethics are, therefore, as morally binding as obligations arising from membership in a club—even though, like the moral obligations arising from club membership, engineering's special standards are morally binding only on some moral agents, engineers. Engineering ethics is at least *in part* meso-ethics.

So, Ladd (1980), 156, seems to have jumbled together propositions the status of which are quite different:

> Any association, including a professional association, can, of course, adopt a code of conduct for its members and lay down disciplinary procedures and sanctions to enforce conformity with its rules. But to call such a disciplinary code a code of ethics is at once pretentious and sanctimonious. Even worse, it is to make a false and misleading claim, namely, that the profession in question has the authority or special competence to create an ethics, that it is able authoritatively to set forth what the principles of ethics are, and that it has its own brand of ethics that it can impose on its members and on society.

Ladd has jumbled together a profession having "its own brand of ethics" (which I just demonstrated it can have) with "setting forth what the principles of ethics are" (that is, with philosophical ethics) and with "imposing" its own brand of ethics on society (something quite different from either). What I claim is that engineering ethics is for engineers and no one else. Engineers no more set forth the principles of ethics or impose new standards on society when they adopt a code of engineering ethics than I do when I make a promise to you. They impose the standards on themselves and no one else—though, of course, their following those standards may affect others (and, indeed, are designed to benefit both themselves and others).

An Objection

The printer example may seem too easy a decision to count as an ethical *problem*. If so, it may also fail to show that problems of sustainable development can arise as ordinary problems of engineering ethics. I therefore think it worth noting some ways in which the decision to recommend two-sided printing as the default setting might be difficult enough to count as a problem.

Sticking with custom tends to be risk-free in most organizations; recommending a change, a gamble. If the change in default setting is accepted and works, the individual engineer may gain in authority, pay, and promotion. But if it is rejected or does not work out, she may lose in all those ways. There is no guarantee the change will work. Consumers may reject the printer in part at least because of the change. The history of technology has many instances of "sure things" that—like "new Coke" or Microsoft Vista—failed. In addition, the actual contribution to sustainable development of the new default setting may not be what it now seems likely to be. If most users of the present equivalent of the printer in question already recycle paper or routinely change from the default setting to two-sides, the new default may simply be a convenience for users, while failing as a contribution to sustainable development. As engineers know, the world often does not work as it "should".

I chose the printer example because its simplicity made it easy to discuss. It is far from the only example of a question of sustainable development arising as part of ordinary engineering. Here's another, one obviously belonging to a substantial category of harder decisions:

> The sales department has asked you, a mechanical engineer in charge of a design team, to design a "self-opening wastebasket for the kitchen". Your employer already makes kitchen wastebaskets that are open at the top, that have swinging covers, and that have step-on levers to raise the cover. You ask why these are not good enough. The sales department responds that some consumers object to the open basket in the kitchen because they do not like looking at rotting food. They object to the swinging lid because it sometimes catches the hand as the user is withdrawing it. The step-on levered lid, while avoiding these problems, tends to fail because the lever sticks or breaks. Your team considers the problem and determines that the wastebasket should have an electric eye to send a signal to a small motor when a hand is close to the basket's lid. The motor will raise the lid; gravity, close it. There will be an on-off switch to allow, for example, for turning off the electric eye at night. Given the amount of water in a typical kitchen, a plug-in basket would risk electric shock or electrocution. The electric eye and motor must rely on batteries (probably four class A). Batteries are, however, not good for the environment. Many end up dumped where they can leak toxic chemicals into the ground water. All batteries depend on a manufacturing process that tends to be hard on the environment. The self-opening wastebasket is plainly not a sustainable technology. Should you propose telling the sales department to forget it?

Is Macro-ethics Ethics?

I have so far shown that micro-ethics and meso-ethics are both ethics—in the ethics-as- morality sense (though meso-ethics is a special form of it). Now I want to argue that macro-ethics, *as applied to engineers or their organizations*, is not ethics in this sense. Because defenders of macro-ethics sometimes admit as much, this point may seem trivial. It is not, as I will now show.

One way in which defenders admit as much is that they sometimes *propose* macro-standards rather than report them. For example, citing Langdon Winner, Herkert (2005), 375, asserts, "Our moral obligations must...include a willingness to engage others in the difficult work of defining what the crucial choices are that confront technological society and how intelligently to confront them." The use of "must" here at least implies that "our" moral obligations do not now include the obligation in question (even though they should). The accompanying argument seems to me to make that clear.

Here Herkert (and Winner) show one *dis*advantage of emphasizing macro-ethics. Many codes of engineering ethics now include a provision imposing (something like) the obligation in question, for example, "Engineers shall endeavor to extend public knowledge, and to prevent misunderstandings of the achievements of engineering" (ASME, 2009, Criteria 7.a). The obligation in question is an actual ethical obligation of engineers to inform the public, rather than a merely desired one, but its source is meso rather than macro. (Neither government nor any other organ of political society imposed this obligation on engineers; they took it on themselves.) Herkert's emphasis on macro-ethics seems to have blinded him to the resources that meso-ethics provide to make the claim on engineers that he actually wants to make, that is, that they should "engage others in the difficult work of defining what the crucial choices are that confront technological society and how intelligently to confront them."

The second way in which advocates of macro-ethics admit, in effect, that macro-ethics is not ethics-as-morality (ordinary or special) is that much they describe as macro-ethics is in fact information, not ethics of any kind. Here again Herkert is instructive. He praises Lynch and Kline for advocating an approach:

> grounded in the history and sociology of engineering, [that] is to provide increased attention to "culturally embedded engineering practice," that is, institutional and political aspects of engineering such as "contracting, regulation, and technology transfer." Knowledge of such non-technical, but nonetheless "ordinary" engineering practice, they argue, would provide engineers with the insight to anticipate safety problems before they escalated into technological disasters. (Herkert, 2005, 377)

I agree that such knowledge should be included in any engineering ethics course (and have long included it in mine). But what is recommended, however desirable, is simply information about practice, not anything ethical in *any* of our four senses. Herkert seems to have confused macro-ethics with knowledge-of-society-relevant-to-ethical-decisions.

Is there any use of "macro-ethics" in the advocates' repertoire that does concern ethics in any of our four senses? Yes, and Herkert provides a few. Here's a typical one of them:

> Political scientist E. J. Woodhouse is another scholar who notes that engineering ethicists have traditionally overlooked macroethical issues. Chief among these overlooked areas, he argues, is the problem of overconsumption. (Herkert, 2005, 377)

I agree that overconsumption (using more resources than necessary) is a problem that has not received much attention from engineering ethicists, but I deny that it is (in any non-trivial way) at once a *macro*-ethical problem (that is, concerned with political decisions) *and* the proper subject of *engineering ethics*. I have just presented two ordinary engineering ethics problems, the printer default and the self-opening wastebasket, that are in fact about overconsumption (as well as about sustainable development). There is no reason why engineering ethics textbooks and courses could not include more like them—except the sacrifices necessary to make room. (For more on such practical constraints, see Davis, 2006.) But, like engineering ethics problems generally, these are, or so I just argued, meso-ethical, not macro-ethical. Their existence provides no support for including *macro*-ethical problems.

But (Herkert might respond), those two problems in fact illustrate what is wrong with contemporary engineering ethics. The two are presented as problems for one or a few engineers, working for a business, not as problems for the engineering profession as a whole or society as a whole. That response is in part right, but mostly wrong in an important way.

That response is right insofar as problems of what society as a whole should do simply do not, on my account, belong in engineering ethics (because they do not pose engineering problems but problems for social decision, that is, decisions engineers as such do not make). That, however, is not a weakness of engineering ethics as such. Such problems belong in political philosophy, philosophy of technology, technology assessment, or the like. The problems are legitimate but not every legitimate problem belongs everywhere. For example, ethical problems of ordinary health-care administration, though legitimate ethical problems, do not belong in an engineering ethics course. They are, as such, not problems about what engineers, as engineers, should do. This is a fundamental point about a reasonable division of intellectual labor, not about which questions are important.

That brings me to the way in which the response is mostly wrong. There are problems closely related to these excluded problems that could be, probably should be, and may well be a routine part of engineering. Consider the self-opening wastebasket again. Suppose the design team recommended dropping the project and the sales department rejected that recommendation. The engineers might then proceed with designing the basket in the environmentally destructive way they sketched—but they need not. They might instead consider going higher in the organization to reverse the sales department's decision. They might also consider going outside the organization to have a professional society such as the American Society of Mechanical Engineers (ASME), or some international association such as the International Standards Organization (ISO), adopt standards to prevent such wasteful technology. The engineers might even consider going to one or another governmental department, such as the Environmental Protection Agency (EPA) or Congress to seek restraining regulations. All this they could do *as individual engineers* or *as part of an engineering organization*, not as mere individuals or citizens, because the engineers are, as their code of ethics says, supposed to "consider environmental impact and sustainable development in the performance of their professional duties" (ASME, 2009, Fundamental Canon 8). Indeed, presenting themselves as engineers, rather than as mere individuals or citizens, is likely to be more effective. If they do present themselves as engineers as they appeal upward, then what began as a local problem of a few engineers soon becomes a problem about the role of engineers or an organization of engineers in society. There is nothing in engineering ethics as now conceived to rule that out. In fact, current standards of engineering ethics seem (with a minimum of interpretation) to rule it in. The problem, though meso-ethical for engineers, would, of course, be macro-ethical for citizens, EPA administrators, members of Congress, and the like. They would have to act as citizens or officials.

I see nothing novel in this move from the first particular decision to later decisions of policy at the organizational, professional, or governmental level. It is, in fact, a routine part of any engineering ethics course I teach. I give my students a seven-step decision procedure which makes that clear. The last step is:

7. *Make final choice (after reviewing steps 1-6), act, and then ask*: What could make it less likely you would have to make such a decision again?
   - What precautions can you take as individual (announce policy on question, change job, etc.)?
   - What can you do to have more support next time (e.g., seek future allies on this issue)?
   - What can you do to change organization (e.g., suggest policy change at next dept. meeting)?
   - What can you do to change the larger society (e.g. work for new statute or EPA regulation)?

This is the 2008 (improved) version of the procedure. The latest published version appeared more than a decade ago in: Davis (1997), 374-375. That others who teach engineering ethics have adopted this method (or something like it) suggests to me that what I do is a widespread practice in such courses. Herkert's response to this criticism confirms the point: "This is pretty close to my position, except I don't think the involvement of engineers needs to begin with a dispute over a design." (Email, April 13, 2009.) I agree with Herkert that the engineer's involvement need not begin with a dispute over a design but might instead begin when an engineer identifies a possible improvement in a process she oversees, volunteers engineering services to the Environmental Defense Fund, decides to use weekends and a garage to develop a better wastebasket, or runs for the U.S. Senate citing among her qualifications her status as an engineer. My disagreement with Herkert here is largely about theory, not about what we would like to see engineers doing.

The problem with the macro-ethics critique of engineering ethics is, then, that it systematically confuses two sorts of problem, one concerned with social policy as such (macro) and the other concerned with the part engineers as such (even when organized) should take in helping to make social policy (meso). Behind the confusion may be a picture of social institutions, especially engineering societies and government, as acting more or less independently of the individuals composing them. Such a picture may be useful for some purposes, such as political science or social theory, but not engineering ethics. Insofar as social institutions operate independently of the human beings constituting them, they belong to the realm of necessity; they operate according to scientific laws, responding to various social "forces" including law and public opinion, but not to ethical standards as such. For that reason, I think it appropriate for a course in engineering ethics to consider ways in which various professional organizations and employers could be made more responsive to the ethical concerns of engineers—but only if that consideration includes ways in which engineers, whether ordinary engineers or officers of engineering societies, could help to achieve that responsiveness.

Those who argue that engineers should engage macro-ethical problems more tend to overlook how much routine engineering already engages those very problems as meso-ethical problems—and how much more effective engineers can be when they speak as engineers (rather than as individuals, citizens, or government officials). Consider, for example, the enormous array of technical standards ASME, IEEE, and other engineering societies have developed for design, manufacture, and disposal of various forms of technology. In the end, if sustainable development is to become a living practice, it will have to be transformed from an abstract idea into thousands, perhaps millions, of technical standards. Government may impose some of those standards. But if the future resembles the past, most will be the work of the engineering profession itself, of individual engineers and of the organizations they establish, populate, and administer.

Concluding Remarks

There is an irony in the argument I have been making. For more than two decades, I have tried to convince those interested in engineering ethics that the subject is not *micro*-ethics, that is, ordinary moral problems in which engineers happen to be the individuals involved. Engineering ethics concerns moral problems only engineers have, the problems that arise in a certain kind of (meso) institution or organization, a profession. Those who advocate macro-ethics are often trying to make much the same point for certain problems. When that is what they are trying to do, all I have to say against them is that they could do it better by just saying that engineering ethics is a kind of professional ethics—rather than "individual" or "personal" ethics. (See, for example, Hudspith , 1991.)

Often, however, those advocating macro-ethics seem to be making a different point. They want to change the subject from professional ethics to social policy. These advocates are my primary target here. They are as confused about engineering ethics as an economist would be about his subject if he wanted to devote a substantial part of a course in micro-economics (say, Theory of Auctions) to questions of taxation or unemployment.

There is no reason why problems of sustainable development cannot be a routine part of any ordinary course in engineering ethics. But, to be a course in engineering ethics, the problems discussed will have to be problems engineers have to resolve as engineers, not as mere individuals, citizens, or public officials, problems of the sort I have discussed here. Of course, nothing here is meant to rule out other courses, courses not purporting to be engineering ethics, in which questions of social policy, constitutional reform, consumer movements, or the like are the primary concern.

Ethics is about certain decisions and the standards that should guide them. Engineering ethics is about the decisions of engineers as such, whether individual engineers or organizations of them, not about the decisions of anyone else. We will have little trouble including more problems of sustainable development in engineering ethics so long as we remember that and work accordingly.

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Sustainability in the Education of Professionals

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Abstract

The paper argues that professional schools have an obligation to provide their students an education in sustainability and the ethics of sustainability, and it identifies some general principles that should guide such education. The argument, in outline, is that professional schools and their faculties have an obligation to provide a sound professional education that will enable graduates to do good work in a profession, a sound professional education requires curricular attention to the contexts of professional practice and the ethical aspects of good work, sustainability is an important and pervasive aspect of the context of current and future professional practice, and the ethics of sustainability is one ethical aspect of good work. Part I is devoted to fleshing out this argument; Part II addresses the scope of sustainability education in the professions and principles that can serve as starting points for instruction in sustainability ethics. The paper concludes that sustainability education in the professions should be partly scientific and technical and partly societal and ethical. It should provide a systemic understanding of sustainability and sustainable best practices, and a broad perspective on the professional's work and the social dynamics and politics of sustainability. It should treat the ethics of sustainability as an integral aspect of the ethics of the profession.

Key words : sustainability, professional education, sustainability ethics

Sustainability is in vogue and increasingly referred to in connection with higher education and professions such as engineering, architecture, forestry management, and business administration. There are movements within some of the professions to incorporate principles of sustainability within their norms and codes of professional practice, and to call upon professional schools to do far more to educate their students in principles and methods of sustainable practice (see, e.g., Engineering Council UK 2009). UNESCO has meanwhile, in its announcement of a Decade of Education for Sustainable Development (DESD: 2005-2014), called upon higher education to provide sustainability research, teaching, and contributions to wider DESD implementation (UNESCO 2005; see Curren 2009b, 26 ff.). The response from universities has been significant, but for the most part confined to the management of facilities and operations (see Everett 2008; National Wildlife Federation 2008; Orr 2010). Is the United Nations wrong in thinking that a more robust educational response is called for?

It should be obvious to an informed observer that the impact of human activity on the Earth is immense, is closely linked to the growth of the world economy, and is well on its way to creating a less hospitable planet (see McNeill 2000; UN Foundation 2005; IPCC 2007; Dodds 2008, 17 ff.; Speth 2008, 46, 55-7; WWF 2008). Current business practices incorporate the work of diverse professionals and they have cumulative, long-term consequences for future generations, in the form of accumulating damage to the ecosystems on which human well-being depends – damage barely contemplated a generation ago, yet increasingly likely to be irreversible. The work of professionals contributes to this damage and to the likelihood of irreversible loss of ecosystem capacity and harm to future generations. This is enough reason for the professions, their member organizations, and the professional schools that facilitate their work, to make an honest assessment of their responsibilities with respect to sustainability. Debates about the magnitude of environmental damage and the extent to which economic growth may provide compensating benefits will no doubt continue (see Lomborg 2001), but professional responsibility is scarcely compatible with *assuming* that environmental skeptics are right. In the face of potentially *irreversible* and *catastrophic* consequences, taking responsibility for ones actions requires a quality of empirical sobriety and analytical seriousness that is not yet widely in evidence. Reasonable people recognize that they have a duty not to harm others, and they bear the information costs associated with taking reasonable precautions to avoid doing harm to others. This would be true with respect to the harms associated with climate disruption, loss of ecosystem capacity, and mass extinctions, even if the prospect of irreversible and catastrophic consequences did not warrant "far more aggressive [environmental regulatory] measures than would otherwise seem justified" (Sunstein 2007, 177; cf. 197, where "sustained efforts to reduce greenhouse gases" are endorsed).

The emerging field of *sustainability studies* is without question very far from having sorted out the basic conceptual and ethical terrain. It has barely identified the starting points of an *ethic of sustainability* (see Curren, 2010; Raffelle and Selinger 2010). This is regrettable, but it doesn't justify inaction. Acceptance of personal responsibility not to harm others through one's work – a duty basic to the self-concept of any profession – is no more hostage to antecedent articulation of a code of ethics than it is to legal regulations. Acceptance of personal and professional responsibility is more plausibly construed as *requiring* collective action to articulate, adopt, and disseminate a code of ethics adequate to the realities and context of current practice.

In what follows, I will argue that professional schools have an obligation to provide their students an education in sustainability and (so far as possible) the ethics of sustainability, as an integral part of the professional education they provide. Having made that argument, I will outline the general principles that should guide such education. The argument, in outline, is that it is fundamental to education that it promotes development conducive to students' *flourishing*, and fundamental to professional education in particular that it should enable graduates to do *good work* in a profession; that understanding the *context* in which one lives and works is essential to flourishing and doing good work, and *sustainability* is an important and pervasive aspect of that context; that the administration and faculty of professional schools have an *obligation* to provide all that is fundamental to a sound professional education, including instruction in the ethical dimensions of doing good work in the profession. Part I is devoted to fleshing out this argument; Part II addresses the scope of sustainability education in the professions and principles that can serve as starting points for instruction in sustainability ethics.

I. The Argument

1. It is fundamental to education that it promotes development conducive to students' flourishing. I begin with a philosophical thought experiment. Let us suppose it is our job to specify the nature and purpose of society's basic institutions, and to do this in a fair and impartial way. To try to ensure impartiality, let us suppose that we know only general truths about human existence, not our own individual attributes and circumstances. From behind this "veil of ignorance," what kind of society would we choose to live in? What would its institutions *exist for*? The answer I think we would converge on is that the institutions of society would exist to enable us all to live well. Surely, whatever we might disagree about, we would agree – and it would be rational for us to agree – that the basic point of having institutions would be to enable us all to live well.

Knowing some general facts about human existence, we would agree upon the need for at least a few basic institutions, including *educational* ones. We would agree on this knowing that people must be enabled to develop in certain ways in order to live well, and with the understanding that *educational institutions are inherently ones that promote forms of development conducive to living well*. To say that educational institutions are inherently ones that promote forms of development conducive to living well is not yet to distinguish them from other such institutions, however. *Educational* institutions are distinguished by the fact that they promote such development by initiating learners into practices that *express human flourishing* – practices through which they can fulfill diverse human potentials and satisfy related psychological needs for *competence*, *autonomy*, and *positive relationships* with others (see Deci & Ryan 2000; Curren 2009c). Diverse practices, from reading and writing to the creative and productive arts and discipline-based forms of critical inquiry, provide opportunities to find satisfaction in the development and expression of capabilities. This is conventionally referred to as developing one's potential, and is associated with ideas of growth, human flourishing, well-being, and satisfaction. The mastery of such practices contributes to economic, civic, and social opportunity, enabling those who are good at them to do *good work*: work that creates something of value, serves society, gives scope to workers' abilities, judgment, and sociability, and satisfies their corresponding needs for competence, autonomy, and positive relationships (for a related conception of good work, see Gardner, et al. 2002).

Initiation into the practices of rational self-criticism or critical thinking is especially salient to *effective agency* or the prudent conduct of one's life (Curren, 2006; cf. Brighouse 2000, 65 ff.; Lipman 2003, 210 ff.). There are three basic aspects of agency, or being an actor in the world – the goals and values we act from, our abilities, and the beliefs we rely on – and there are three corresponding forms of self-reflection through which we can examine and take responsibility for ourselves. Engaging in these forms of self-examination allows us to selectively overcome the limitations and self-defeating aspects of our thought patterns, understanding, abilities, motivation and preferences. It makes us freer by degrees and more effective in our efforts to live well and do good work. Providing education in the practices of critical thinking, including *ethical* self-examination, is thus an important aspect of the social and educational enterprise of providing students with substantial opportunities to live well.

Educational institutions play other roles in enabling people to flourish or live well, of course. They are foundational to a well-ordered society; foundational to civic life and productive public debate; foundational to people knowing the truth about the world they must function in. Higher education is foundational to these goods in ways that build on the fundamental work of developing students' capabilities, dispositions, and judgment. Moreover, of all the institutions we have, universities are the best equipped to survey the condition of humanity on this planet, take a long view, and enable us to live prudently in the face of systemic risk.

2. It is fundamental to professional education that it should enable graduates to do good work in a profession. This follows more or less directly from the foregoing. As a form of education, professional education has all the features noted above. As institutions of society that play roles in enabling *all* members of society to live well, professional schools are to develop the capabilities of students in ways that serve the interests of both students and society. They do that, most obviously, by enabling their graduates to do good work in the context of the professions they prepare them for.

Good work is good for both the professional and for society, and it is a product of skill or artistry in the practices of the profession and good judgment grounded in acceptance of responsibility for the quality and consequences of the work done. Professions are generally understood to aim at public goods, in some sense of the term "public good" – goods that have social benefit beyond their direct benefits to individual clients, at any rate. Medicine aims at health and law at justice, and health and justice are plausibly conceived as having benefits beyond those accruing to the patients and litigants themselves, even if not everyone receives the medical and legal help they need. Professions are also, paradigmatically if not universally, grounded in systematic bodies of knowledge and shaped by traditions of practice and evolving norms of excellence, artistry, and integrity. *Responsible* professional practice is answerable to clients directly served, to the wider public, and to these norms of excellence and integrity. Norms of professional integrity encompass the requirements of both common morality – beginning with a general duty to take care not to harm others – and the ethical commitments specific to the profession (Applbaum 1999; Davis 1999, 20-21; Curren 2008). They define the nature of good work as much as norms of excellence and artistry do.

3. Understanding the context in which one lives and works is essential to flourishing and doing good work. Flourishing requires a measure of success in developing one's human potentialities and exercising them in accordance with norms of excellence and integrity, guided in significant measure by one's own judgment. Good work requires much the same forms of success, achieved within the parameters and demands of a work environment. Success of these kinds is not possible if the judgment relied on is not informed by an understanding of the contexts of action.

4. Sustainability is an important part of the context in which present and future professionals will live and work. Sustainability is best understood as a quality of human activities or practices, the aggregate of human activities or practices being sustainable, or environmentally sustainable (I will assume for present purposes that the two are equivalent), if and only if it is compatible with the long-term stability and integrity of the ecosystems on which those human activities or practices fundamentally depend. Ecological Footprint Analysis provides a widely cited, if imperfect, measure of sustainability (Wackernagel & Rees 1996). It estimates global sustainability by comparing the global flow of natural resources through human uses and back to the environment as waste, with the aggregate of biologically productive land and marine areas that would be required to produce that flow of resources and absorb those wastes. Dividing the former by the latter produces an estimate of the environmental sustainability of the global "human footprint." The human ecological footprint may be regarded as a measure of systemic social and economic risk, manifested in the depletion of accumulated products of past ecosystem activity – such as soil, forests, ground water aquifers, and fossil fuels – and impairment of the natural systems that provide *ecosystem services,* such as nutrient cycling, clearing of wastes, climate and flood regulation, and production of food, fresh water, materials, and fuels.

The human ecological footprint is estimated to be already about 30% beyond what is sustainable and growing so rapidly that it will be *double* the capacity of natural systems by the mid-2030s (WWF 2008; Dietz, Rosa, and York 2007). This implies that sustainability is a very important part of the *current and foreseeable* context of human existence and professional practice. The Millennium Ecosystem Assessment, a comprehensive set of reports produced by 1350 scientists from 95 countries, found that 60% of the world's ecosystems are being damaged by overuse and are increasingly likely to suffer permanent loss of capacity (UN Foundation 2005). Permanent loss of capacity is already evident in the collapse of fisheries, declining fresh water availability, desertification, and accelerating climate disruption (see IPCC 2007; Dodds 2008; Speth 2008). Ocean fish populations have declined 90% since the advent of industrial deep sea fishing in the 1950s. An estimated 40% of the world's people now live in "water stressed" regions, and 65% are likely to do so by 2025. Large-scale desalinization has already begun, but this will provide a very limited solution at best; it would reportedly require about 23 times all of current global energy use to desalinate (by evaporation) the amount of water used globally (Dodds 2008, 25). Fifty million acres each year – the equivalent of the state of Nebraska – are lost to urban encroachment or become too degraded for crop production. Climate related changes that had not been anticipated for many decades are already occurring now, and some of these changes involve feedback mechanisms that will accelerate climate change. The retreat of sea ice, accelerating decay of organic matter in soil, decline of forests killed by drought and pests, and release of methane from melting permafrost are prime examples.

Humanity is meanwhile approaching the first systemic energy transition it has faced since the 1850s, and on a scale that dwarfs that transition: the human population is about 6 times what it was in 1850 (having grown from about 1 billion to the current 6.9 billion) and per capita energy use is 6 to 7 times higher (Goodstein 2004; Dodds 2008). Scaling up the needed alternatives to fossil fuels fast enough to avert a crisis will be a challenge. Bjørn Lomborg and others argue that human societies have become much richer and will likely continue to do so, and that the history of commodities in market economies shows that they become more plentiful and cheaper over time (Lomborg 2001, 70 ff, 350-52). It may be, as Cass Sunstein says, that within the two-hundred year time scale in question, "Most generations are richer and more informed than those that preceded them" (Sunstein 2007, 190), measured by income, consumer goods, and a variety of welfare indicators. But this scarcely shows that worries about environmental degradation, resource scarcity, and associated risk to human well-being are inconsistent with "the history of the human race" (Sunstein 2007, 190). The historical and archaeological records suggest that countless civilizations have flourished as long, or longer, than ours and collapsed, owing at least in part to environmental and resource problems (Redman 1999; McAnany & Yoffee 2010). Catastrophic transitions and discontinuities are compatible with growing wealth across generations, and are obscured by optimistic projections of how much richer "we" are likely to be in the future. The growing per capita wealth that Lomborg and Sunstein refer to is consistent with growing ecological debt and risk.

The risks are already serious enough to warrant major adaptations in how we live and work, and our wisdom in managing these risks will make a world of difference to the well-being of billions of people and untold members of other species. The work of diverse professionals and the institutions that educate them will play an important determinative role in preserving or undermining the prospects of human and non-human well-being in the decades ahead, and this implies that sustainability is indeed a very important aspect of the context of professional practice, and one determinative of whether the work of professionals is indeed *good* work.

5. The administration and faculty of professional schools have an obligation to provide all that is fundamental to a sound professional education, including instruction in the ethical dimensions of doing good work in the profession. I have argued that education as such promotes development conducive to students' flourishing, including their ability to do good work, and that it is fundamental to *professional* education that it should enable graduates to do good work *in a profession*. I have also argued that norms of professional integrity are partly definitive of good work in a profession. Professional schools constitute themselves by charter, and represent themselves to the world, as institutions that prepare students for careers in specific professions. In so constituting and representing themselves, they assume an obligation to do this *well*, in not only its technical aspects but also its ethical aspects. It is an obligation they delegate essentially to their *faculties*, subject to the oversight and facilitative capacity of academic administrators.

In their work on professorial ethics, Peter Markie and Brain Schrag have argued that professors accept a delegated responsibility for their institution's academic program and mission. Schrag observes that:

> Traditionally, and in most educational institutions, the Board of Directors delegates to the faculty the responsibility for the institution's formal educational program… Faculties stand in relation to the educational program as trustees (Schrag 2000, 232).

Markie argues similarly that:

> Each university is founded on a commitment to [intellectual advancement and knowledge], and having made this commitment for itself, each makes a related one to students…. We [faculty] make the university's two commitments our own when we accept a faculty appointment (Markie 1994, 16).

Markie examines the implications of this for the responsible conduct of teaching, and Schrag adds some important observations about the faculty's "responsibility for the social fabric of the academy: the culture necessary for it to be a community of learners" (Schrag 2000, 235). One essential function of this academic culture is the cross-disciplinary production of what Ernest Boyer calls "scholarship of integration and application" (Boyer 1990), and Schrag asserts a critical but neglected connection between such scholarship and teaching. Faculty, he says, "must learn from their colleagues in other disciplines in order to liberally educate students by teaching the connections between bodies of knowledge and the integration of knowledge" (Schrag 2000, 234).

The implications of this for an interdisciplinary topic such as sustainability are clear: faculty members are not at liberty to ignore interdisciplinary subjects of importance to the instructional program of their school, believing they have obligations only to their department or field of specialization. They have collective responsibility for the academic program of their school, which requires their participation in ongoing cross-disciplinary conversation, adaptation of their own teaching and redirection of a portion of their scholarship in support of teaching as required by fair terms of collegial cooperation in providing a sound academic program, and cooperation with administration in the design of programs and direction of hiring to provide a sound academic program. The argument I am making does not require that we specify what would constitute fair terms of collegial cooperation in providing a sound academic program, but they would plausibly involve fair equality of opportunity for advancement within the institution's academic community, an expectation that more privileged faculty members should have correspondingly greater responsibilities, and collective decisions mediated by an academic counterpart of public reason.

Interdisciplinary "scholarship of integration and application" in support of a sound academic program is clearly no less important in a professional school dedicated to preparing students for professional practice, than in a college of arts and sciences. The adaptation of professional practice to changing circumstances must be anticipated and provided for, drawing on the foundational disciplines and specializations that are relevant. Faculty members prepared to work creatively across established boundaries are crucial to this, and academic administrators have an important role to play in facilitating the work of faculty. Integrity in university teaching and administration is grounded in a delegated responsibility for the fundamental mission of the institution, and involves conscientiousness and judicious commitment to that mission (see Curren 2008, 2009a). I have argued that the fundamental mission of a professional school is to provide a sound professional education, focused on doing good work in the profession.

6. Professional schools and their faculties have an obligation to provide their students an education in sustainability, including the ethics of sustainability, as an integral part of the professional education they provide. This follows from the preceding points: Professional schools and their faculties have an obligation to provide a sound professional education, a sound professional education requires curricular attention to the contexts of professional practice and the ethical aspects of good work, sustainability is an important aspect of the context of current and future professional practice, and the ethics of sustainability is one ethical aspect of good work. All that remains to be said is this: If the ethics of sustainability is an inescapable component of responsible decision-making in the professions, it should be addressed in professional school curricula.

Professionals bear a moral burden to avoid doing harm to the natural systems on which human well-being depends and avoid perpetuating public reliance on systems at increasing risk of failure. The universities that educate them have important corresponding responsibilities. Given how much is at stake, we have abundant reason to hope and expect that a deep, systemic understanding and moral clarity about sustainability would guide the practice of all professionals, and that universities would do what they can to ensure this. What is at stake is both a requirement of educational integrity, as I have argued, and a universal educational entitlement (Curren 2009a; Curren 2009b, 39-42). All of us have vital moral and prudential interests at stake in sustainability, and we can scarcely begin to protect these interests without being educated in the sustainability facts of life.

A further argument could be made on the premise that principles of justice have a claim on institutions, even in non-ideal circumstances; i.e., even in societies which are themselves less than fully just. Universities play a major role in distributing social and economic opportunity, and they typically acknowledge their obligation to do so fairly, at least with regard to admissions criteria and standards for awarding degrees. One might insist, as Harry Brighouse has in a recent paper, that justice in distributing opportunity requires more than this, that it concerns not just the students universities admit and reject, but those who never have a chance to go to college at all (Brighouse 2009). As universities work to advance the competitive advantage of their own students, should they not seek to educate and encourage them toward work that benefits the less advantaged, thereby nudging the society a bit closer to satisfying Rawls's Difference Principle (Rawls 2001, 42-43)? Brighouse does not address *intergenerational* requirements of social justice, but these are no less important, especially if the actions of today's graduates may contribute to a potentially catastrophic and irreversible decline of future opportunity. Intergenerational justice requires that each generation act so as to preserve equal opportunity to live good lives across generations (Barry 2003, 492). The importance of this, and its ramifications for the work of universities, is hard to overstate. Academic communities can and should pursue disciplinary and interdisciplinary sustainability research, teaching and mentoring to orient students to the challenges of sustainability and encourage career paths compatible with a sustainable future, and should manage university facilities and operations in accordance with environmental best practices.

The competitive context of higher education is quite real, and many academic leaders and faculty members remain resistant to doing more than the necessary minimum demanded by sustainability-minded students, but the role of universities in producing knowledge in the public interest and preparing professionals to conduct themselves with integrity do not vanish in a competitive context.

II. Sustainability Education in the Professions

What is an education in sustainability? It will be partly scientific and technical. Members of professions should have a systemic understanding of sustainability, understand the bearing of their work on sustainability, use sustainable best practices, and be prepared to kept abreast of and participate in innovations in sustainability. But the scope of an education in sustainability must be wider than this – as wide as the obstacles to sustainability. Sustainability education in the professions will be partly societal and ethical; it will address human obstacles to sustainability and the principles of sustainability ethics that define responsible practice. It will provide a broader perspective on the professional's work and the social dynamics and politics of sustainability. It will not be a marginal add-on, but will infuse the curriculum, scholarship, facilities, and operations of professional schools (see Orr, 2004, 2010). Only in this way will it measure up to the challenges and stand a chance of success. The sections that follow address the societal and ethical dimensions of sustainability education in the professions.

1. Sustainability education in the professions should address the human obstacles to sustainability and how those obstacles may be overcome. The human obstacles to sustainability include limitations of individual rationality, limitations of collective rationality, aspects of culture, aspects of corporate practice, and failures of governance (see Curren 2009b). In brief:

We find it hard to comprehend that things could soon be very different from how they have been. Indeed, we seem to heavily discount evidence that things cannot go on as they have.

We are susceptible to magical thinking. We seem to act on the expectation that things will simply work out, that markets will generate innovations sufficient to solve the problems, always in time and on a sufficient scale.

We procrastinate. We may see the wisdom of addressing sustainability problems but delay getting started, at each moment preferring current consumption to a specific investment in the future. Swept along choice by choice we may eventually find it is too late to secure something of fundamental importance to us.

We are irrationally acquisitive and irrationally discount future costs. We perceive pleasant things as having more value when they are just out of reach than when they are distant or already in our possession – so much so, that coming into possession of desired objects typically leaves people less happy than they were beforehand (see Kasser 2002). We are correspondingly prone to irrational discounting of future costs associated with current consumption.

Competitive rationality yields collective ruin. Individuals and enterprises seek their own good by striving for advantage in competing for desirable positions and striving to enhance the advantages of the positions they have. Positional advantage-seeking is individually rational, but contributes to excessive aggregate consumption. To the extent that unsustainability arises from the uncoordinated pursuit of competing interests, it is a *collective action problem* requiring a regulatory solution.

Culture shapes our ecological footprint. Our cultures encourage unsustainable growth and consumption and make many consumption decisions all but invisible.

Advertising encourages irrational consumption. Advertising contributes to overconsumption by inducing people to purchase goods and services they don't need. It does this, informed by psychological research demonstrating causal relationships between anxiety, acquisitiveness, and unhappiness (Kasser 2002; Schor 2004), using ploys that reinforce the psychological, social, and cultural obstacles to sustainability already enumerated.

Industry employs an array of strategies to deny and downplay environmental costs. Industry efforts to shape public perceptions extend far beyond advertising and are generally less visible and harder to guard against. For many years, the tobacco industry waged a secret campaign to dispute the evidence that tobacco is addictive and causes cancer and other diseases, waging that campaign through public relations (PR) firms, front organizations such as The Advancement of Sound Science Coalition (TASSC), and industry scientists posing as independent guardians of "sound science" in the public interest. The aim was to "create an illusion of scientific controversy" through distortions of standards of evidence, distorted presentation of industry sponsored research, and suppression of competing research through corporate-university partnerships, legal maneuvering, and attacks on independent scientists (Horowitz 2007, 317; Oreskes and Conway 2010). To disguise the fact that TASSC was a tobacco industry creation, its agenda was broadened to other domains of allegedly unsound science, such as epidemiology and climatology. The strategies and language of "sound science" continue to be used by industry front groups, often in the service of "greening" corporate images (see Schrader-Frechette 2007, 67; Oreskes and Conway 2010). These efforts contribute to public confusion about the health effects of pollution, the strength of scientific consensus on climate change, and other matters pertaining to sustainability.

A sober assessment of the human obstacles to sustainability suggests that it will never be achieved unless the limitations of individual and collective rationality are effectively addressed through education and systemic coordination. A greater attunement to evidence, stronger critical thinking, and a better understanding of relevant science and history would strengthen individual understanding and rationality in matters of sustainability. Even this would not be sufficient, however, for irrationality arising from dynamic and competitive choice problems is best addressed through mechanisms of social coordination. An education in sustainability should address the social dynamics that create a need for coordination, and the strategies of coordination – of governance – available. Individual and private sector efforts can play a critical role in achieving sustainability, but it is inconceivable that they will be sufficient without government action and binding *global* agreements on carbon emissions and other environmental problems (see Speth and Haas 2006). An understanding of these human and social dimensions of sustainability can inform many aspects of the work and career choices of professionals, including the stances they take on behalf of industry in the public sphere.

2. Instruction in the ethics of sustainability should focus on principles of harm, cooperation, opportunity, and detrimental reliance. Moral clarity about sustainability is important and it is best achieved through instruction focused on principles and their application to cases. Sustainability ethics is the domain of ethics pertaining to every sphere and feature of human activity as they bear on the capacity of civilization, and the natural systems it relies on, to provide a suitable quality of life indefinitely into the future (see Curren 2010). Its distinctive central concern is living in a way consistent with an acceptable future. But what are its defining principles?

Many aspects of the way affluent residents of the global North live already cause harm to others through the destructive overuse of ecosystems and release of pollutants that impair health, impair water availability and food production, and reduce rural and coastal land value by causing drought and inundation. The World Health Organization estimates that climate disruption already causes 150,000 deaths each year (WHO 2007), and many thousands more suffer economic losses and displacement as the land they occupy becomes too arid and damaged to sustain life. The most basic and important principle of sustainability ethics is thus:

> *Do no harm*: It is wrong to harm others by impairing their free enjoyment of their property, health, or liberties.

In the absence of *intent* to harm, it is however not always clear what *risks* of harm may be ethically imposed on others, especially when the risks are incremental and widely dispersed. In the face of distant harms that are predictable but not readily assignable to identifiable individuals, many who impose risks on a large scale are inclined to resist regulatory and treaty regimes that would define thresholds of *excessive risk* linked to mechanisms of enforcement. This in itself is arguably a serious moral breach, and industry resistance to cooperation in defining publicly acceptable thresholds of risk and systems of accountability should be regarded as a serious failure of corporate and professional ethics. The relevant principle may be defined as follows:

> *Seek fair terms of cooperation:* Actors whose actions affect each other are obligated to cooperate in negotiating fair terms of engagement, including what will and will not be recognized as *wrongful* impairments of each other's free enjoyment of their property, health, and liberties.

This supplements the *do no harm* principle, which can be amended in light of it to say:

> *Do no harm**: It is wrong to harm others by impairing their free enjoyment of their property, health, or liberties, *intentionally, by imposition of excessive risk, or by imposition of risks for which*

one refuses to negotiate fair limits.

The application of these principles to tangible harms mediated by pollution and other ecologically destructive practices is relatively straightforward. Less straightforward is the wrongness of actions that diminish *opportunity* to live well or simply impose *systemic risk*. The preservation of opportunity to live well in the future is arguably the defining concern of sustainability, and we are surely justified in objecting to practices that cause growing systemic risks to the ecological systems that underpin such opportunity. To capture these distinctive concerns, we need to acknowledge some such principles as these:

Preserve opportunity: Intergenerational justice requires that each generation act so as to preserve into the foreseeable future opportunity to live well.

Do not subject others to detrimental reliance: Do not induce others by words, acts, or omission, or cause them by act or omission, to be in a position of reliance on systems, services, or resources that cannot be relied on without exposure to systemic risk to their fundamental interests.

The first of these should be clear in principle, if not in application. The second is intended to identify imposition of risk *per se* as a form of wrong, and to focus on the kinds of *systemic* risks that are presumably at stake in discussions of sustainability: risks that whole ecosystems will collapse or that fundamental energy, food, or transportation systems will suffer sharply declining capacity before sustainable alternatives can be scaled up to meet basic needs.

Some such principles as these should form the core of instruction in sustainability ethics in professional schools, and illustrative cases should be discussed throughout the curriculum. Individuals in their professional capacities have many corresponding obligations, including ones not to mislead the public about the true environmental costs of products and corporate activities. Advertisers and lawyers employed as corporate public relations professionals have much to answer for, since they play a leading role in such obfuscation and in inducing and perpetuating detrimental reliance on unsustainable resources and systems, at the cost of not only future generations, but the interests of all of us now alive whose interests depend on the future. Fossil fuel companies that target pricing or investments to discourage the development of alternatives to their products, or promote misinformation campaigns about climate disruption to discourage action to limit the use of their products, are guilty of violating principles of cooperation, opportunity preservation, detrimental reliance, and harm – inasmuch as preventable pollution associated with their products causes health problems, acid rain, and harms associated with climate disruption. Any large-scale business that has the capacity to profitably develop and market products more conducive to global sustainability than its current products, and fails to do so, is arguably in violation of the principle of detrimental reliance.

Conclusion

My principal aim in this paper has been to argue that professional schools have an obligation to provide their students an education in sustainability, including the ethics of sustainability, as an integral part of the professional education they provide. I have offered general guidance on the character of the education in sustainability that might be appropriate, providing some starting points for further consideration. What is needed is for the faculties of professional schools to develop sustainability curricula that incorporate principles of sustainability ethics and domain-specific case studies, and for the member associations of the various professions to incorporate principles of sustainability into their codes of professional practice and support the work of professional schools as they move forward in addressing matters of sustainability.

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A Logical Typology of Normative Systems

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Abstract

In this paper, the set-theoretic approach in the logical theory of normative systems is extended using Broome's definition of the normative code function. The syntax and semantics for first order metanormative language is defined, and metanormative language is applied in the formalization of the basic principles in Broome's approach and in the construction of a logical typology of normative systems. Special attention is given to the types of normative systems which are not definable in terms of the properties of singular sets of requirements (e.g. the realization equivalence of codes, the social compatibility of codes, and the compatibility of codes issued by different normative sources). Examples are given of the application of the typology in the interpretation of philosophical texts. Von Wright's hypothesis on the connection of logical properties of normative systems, conceived set-theoretically, with standard deontic logic is proved by introducing the translation function between the metanormative language and the restricted language of standard deontic logic. The translation reveals that von Wright's hypothesis must be appended. The problems of narrow and wide scope readings of the deontic conditionals and of the meaning of iterated deontic operators are addressed using the distinction between relative and absolute normative codes. The theorem on the existence of a realization equivalent absolute code for any relative code is proved.

Key words: deontic logic, metaethics

1. The Set-Theoretic Approach to Normative Systems

What use can one make of the logic of intentionality (i.e. the logic of propositional attitude reports) in predicting and explaining human behaviour if in reality this logic can fail? For example, the logic of belief requires any agent not to have contradictory beliefs, and yet in reality agents' inconsistent belief systems abound. The status of the logic of intentionality has been a puzzling issue, since two intuitions on the nature of the laws of logic seem to collide. On the one hand, the laws of logic are construed as unavoidable in reality. On the other hand, it is well known that the laws of the logic of intentionality may fail in human theoretical and practical reasoning. The standard solution assigns a normative role to the logic of intentionality.

John Broome has developed a general metanormative perspective which provides a fruitful framework for the logical analysis of intentionality. In general, according to Broome, a normative source (e.g. rationality) may accord with reality and then the corresponding property (e.g. the property of being rational) is realized. Broome's distinction between normative sources and normative properties fits in well with the thesis of "normative essentialism" proposed by Zangwill (2005). Zangwill has put forward the thesis that the essence of the mental is to be subject to norms, not to conform to them. Using Broome's conceptual distinction, one might rephrase Zangwill's thesis as follows: the mental is essentially subjected to the requirements of normative sources, and it accidentally might conform to them, in which case some normative property becomes instantiated.

There has been a long debate on the logical character of normativity and on the normative character of logic. I will not argue for the logicality of the normative, or for the normativity of the logical. Rather, I will focus on the typology of normative systems in order to provide a formal explication of the different senses that the statements ‘a normative system is logical’ and ‘a logical system is normative’ may have. For the purpose of explication, I will rely on a set-theoretical approach in the logical theory of normative systems. The approach was introduced by Alchourrón and Bulygin (1998) who represented the force of the norm by the membership of its norm-content in a set (normative system); later von Wright (1999) discussed the approach as a possible interpretation of deontic logic; and, more recently, Broome (2007b) generalized the approach by treating the sets of norm-contents as values of code functions. The relevant quotation is reproduced below with minor alterations in symbols in order to match the signature that will be used later throughout this text.

> We must allow for the possibility that the requirements you are under depend on your circumstances. Here is how I shall do that formally, using possible worlds semantics. There is a set of worlds, at each of which propositions have a truth value. The values of all propositions at a particular world conform to the axioms of propositional calculus. For each source of requirements s, each person i and each world w, there is a set of propositions $k_{\mathsf{s}}(i,w)$, which is to be interpreted as the set of things that s requires of i at w. Each proposition in the set is a required proposition. The function k_{s} from i and w to $k_{\mathsf{s}}(i,w)$ I shall call s's *code* of requirements. (Broome, 2007b, 14)

Broome’s approach bears significant resemblance to the concept of the normative system proposed by Alchourrón and Bulygin (1998).

> We can now define the concept of a normative system as the set of all the propositions that are consequences of the explicitly commanded propositions. (Alchourrón and Bulygin, 1998, 391)

Broome’s concept of a code of requirements is more general in several respects. First, codes are ternary functions (taking as arguments a normative source, an agent and a world) and sets of requirements are their values. So, one can quantify over variables in the code function and obtain new concepts on that basis. Second, sets of requirements can be related to Alchourrón and Bulygin’s normative system as their special case, namely as values of a deductively closed absolute code. The significant resemblance between the two notions consists in the fact that in both cases the force of a requirement (or a norm) is represented by the membership of the requirement-content (or the norm-content) in some set (in the code of requirements and in the normative system, respectively). Therefore, propositions, and not requirements, make a set of requirements, and, similarly, propositions, and not norms, constitute a normative system.

Remark 1 *Broome does not explicate the notion of normative source but introduces it by way of examples (survival, prudence, and rationality). I will not give an explication of the notion of normative source either, but will give a sketch of the distinction that was implicit in my thoughts and that was used for an explication of the relation between the normative and the logical (see Definitions 2). Normative sources are: formal and material. Formal normative sources regulate relations between intentional states, either within one category (e.g. theoretical rationality) or between categories (e.g. practical rationality). Material normative sources are those that require a specific content to be present in an intentional state. I posit the theoretical type of normative source as requiring certain beliefs, and the practical type of normative source as requiring certain desires and decisions or intentions.*

2. The Language of Norm Contents

In order to give a first order translation for Broome’s functional approach, some preliminary steps must be taken. Metanormative theory speaks about a language in which norms are stated. Therefore, my starting point is $\mathcal{L}_n$, the language in which the norms and conditions of their application are expressed. By $\mathcal{L}_n$ I will denote a language of propositional modal logic with the following modalities: B_i for ‘i believes that’, D_i for ‘i desires that’, I_i for ‘i intends that’. Later, I will give reasons for reducing the “language of intentionality” to only three modalities.

The normative language $\mathcal{L}_n$ is built over the base language of propositional logic $\mathcal{L}_{PL}$ with modalities added.

Definition 1 *Let* $i \in A$, $X = B, D, I$, *and* $p \in \mathcal{L}_{PL}$.
The formulas of language $\mathcal{L}_n$ *are:*

$$\varphi ::= p \mid [X_i]\varphi \mid \neg\varphi \mid (\varphi_1 \wedge \varphi_2).$$

The definitions of truth-functional connectives are standard.

Considered in isolation, language $\mathcal{L}_n$ is not committed to any particular logic. Still, if a subset of $\mathcal{L}_n$ has a logical property definable within some particular logic l, then that property will be noted as ‘l-property’.

Remark 2 *The sentences of* $\mathcal{L}_n$ *whose main operator is* $[B_i]$, $[D_i]$, *or* $[I_i]$ *will be termed ‘modals’.*

Definition 2 *The set* lit($\mathcal{L}_\text{n}$) *of quasi-literals with respect to propositional logic is the smallest subset of* $\mathcal{L}_\text{n}$ *containing the set of propositional letters and their negations, and the set of modals and their negations.*

Let us extend language $\mathcal{L}_\text{n}$, itself a standard modal propositional language, to language $\mathcal{L}_{\text{n}(\omega_1)}$ of a variant of infinitary logic, which has the same symbols as $\mathcal{L}_\text{n}$, but in $\mathcal{L}_{\text{n}(\omega_1)}$ the infinitary conjunction symbol $\bigwedge$ is applied to countably infinite subsets of the set of quasi-literals lit($\mathcal{L}_\text{n}$). See (Keisler, 1971) for a full-blown infinitary logic.

Definition 3 *Let* $p \in \mathcal{L}_\text{n}$ *and* $x \subseteq \text{lit}(\mathcal{L}_\text{n})$.
The formulas of language $\mathcal{L}_{\text{n}(\omega_1)}$ *are:*

$$\varphi ::= p \mid \bigwedge x \mid \neg\varphi \mid (\varphi_1 \wedge \varphi_2).$$

Let us also extend the deductive system $\vdash_\text{pl}$ of propositional logic to an ad hoc variant of infinitary propositional logic $\vdash_{\text{pl}(\omega_1)}$ containing the rules of $\vdash_\text{pl}$ and the additional rules for the countable conjunctions of quasi-literals. According to the grammar of $\mathcal{L}_{\text{n}(\omega_1)}$, the introduction and elimination rules for $\bigwedge$ are applicable to the sets of quasi-literals only. For $x \subseteq \text{lit}(\mathcal{L}_n)$,

1. $\Gamma, \bigwedge x \vdash_{\text{pl}(\omega_1)} p$ for all $p \in x$,
2. if $\Gamma \vdash_{\text{pl}(\omega_1)} p$ for all $p \in x$, then $\Gamma \vdash_{\text{pl}(\omega_1)} \bigwedge x$.

On the side of semantics, the definition of the truth assignment h is extended in an obvious way: $h(\bigwedge x) = \mathbf{t}$ iff $h(p) = \mathbf{t}$ for all $p \in x$.

Proposition 1 shows that the ad hoc system $\vdash_{\text{pl}(\omega_1)}$ is a conservative extension of $\vdash_\text{pl}$.

Proposition 1 *For* $x \cup \{p\} \subseteq \mathcal{L}_\text{n}$, *if* $x \vdash_{\text{pl}(\omega_1)} p$, *then* $x \vdash_\text{pl} p$.

Proof The proof will be sketched. Assume $x \vdash_{\text{pl}(\omega_1)} p$. The deductive system $\vdash_{\text{pl}(\omega_1)}$ is sound, as can be easily checked. Therefore, $x \models_{\text{pl}(\omega_1)} p$. Then also $x \models_\text{pl} p$ thanks to the coincidence of the semantic definitions for sentences in $\mathcal{L}_\text{n}$. Finally, $x \vdash_\text{pl} p$ by the completeness of the propositional logic. □

3. Metanormative Language

In order to achieve technical clarity, I will define a first-order metanormative language $\mathcal{L}_\text{meta}$ in which variables of different sorts range over different objects in the domain.

$\mathcal{L}_\text{meta}$ has the following extra-logical vocabulary:

individual constants for normative sources, for agents and for worlds: $\text{s}, \text{s}_1, \ldots, \text{a}, \text{a}_1, \ldots, \text{v}, \text{v}_1, \ldots$;

symbols for the code of requirements function, for the propositional logic consequence function, and for the axiomatic basis of a modal logic function: k^3, Cn^1, l^1;

symbols for functions generating sentential forms of the object language: neg^1, conj^2, infconj^1 and a set of symbols $\text{mod}^1_{\text{B}i}$, $\text{mod}^1_{\text{D}i}$, $\text{mod}^1_{\text{I}i}$ for each $i \in \{\text{a}, \text{a}_1, \ldots\}$;

symbol for the function extracting quasi-literals from a given set: lt^1;

a ternary predicate symbol for the relation of an agent i having a property corresponding to a source s in a world w (normative property predicate): K_s;

a binary predicate symbol for the relation of membership: $\in^2$.

Additionally, we may introduce a dispensable part of vocabulary containing monadic predicate symbols expressing properties of being a normative source, of being an agent, of being a sentence in $\mathcal{L}_\text{n}$, of being a possible world: Source^1, Ag^1, Sen^1, W^1.

Variables comprise:

general variables ranging over everything: $x, x_1, \ldots, y, y_1, \ldots, z, z_1, \ldots$;

sorts of variables:

$\mathsf{s}, \mathsf{s}_1, \ldots$ ranging over $\{x \in \text{D} \mid \text{Source}(x)\}$
$i, i_1, \ldots$ ranging over $\{x \in \text{D} \mid Ag(x)\}$
$p, p_1, \ldots, q, q_1, \ldots$ ranging over $\{x \in \text{D} \mid \text{Sen}(x)\}$
$w, w_1, \ldots$ ranging over $\{x \in \text{D} \mid W(x)\}$.

The shorthand notations for neg(p), conj(p,q), $\text{mod}_{\text{B}i}(p)$, $\text{mod}_{\text{D}i}(p)$, $\text{mod}_{\text{I}i}(p)$, infconj($x$) are $\ulcorner\neg p\urcorner$, $\ulcorner(p \wedge q)\urcorner$, $\ulcorner[\text{B}_i]p\urcorner$, $\ulcorner[\text{D}_i]p\urcorner$, $\ulcorner[\text{I}_i]p\urcorner$, $\ulcorner\bigwedge x\urcorner$. For ease of reading, Quine quotes will be used also for the standardly defined connectives.

Example 1 $\ulcorner p \to q\urcorner$ *stands for* neg(conj(p, neg(q))).

A sole variable written between Quine quotes is the same as the variable itself. Sometimes this redundant notation will be (ab)used in order to highlight sentence variables and sentence functions within a formula.

Definition 4 *Let* c *stand for an individual constant,* v *for any variable,* f^n *for a function symbol and* P^n *for a predicate symbol.*
The terms are:

$$t ::= \text{c} \mid \text{v} \mid f^n(t_1, \ldots, t_n).$$

The atomic formulas are:

$$p ::= P^n(t_1, \ldots, t_n).$$

The formulas of $\mathcal{L}_\text{meta}$ *are:*

$$\varphi ::= p \mid \neg\varphi \mid (\varphi_1 \wedge \varphi_2) \mid \forall \text{v}\ \varphi.$$

Definition 5 *Sentences of $\mathcal{L}_{\text{meta}}$ are formulas of $\mathcal{L}_{\text{meta}}$ with all the variables bound.*

The purpose of metanormative language is to enable talking: about the syntax of sentences in $\mathcal{L}_{\text{n}(\omega_1)}$, about the properties that the sentences and their sets can have in different logics (most notably "world logic" and "intentionality logics"), about the semantics of sentences in $\mathcal{L}_{\text{n}(\omega_1)}$, i.e. about sentence-world relations. The basic ontology for the code functions requires: normative sources, agents, worlds and sets of sentences. Besides the set of agents and the set of normative sources, all other objects in the domain are constructed using sentences of the normative language: the worlds are theoretically identified with pl-maximal consistent sets of $\mathcal{L}_{\text{n}(\omega_1)}$ (see Definition 6); code values are logic free sets of sentences; axiomatic bases of logics are sets of substitutional instances of the sentences in a given set; and sentences **are** sentences.

Definition 6 *A set x is maximally consistent in the logic $\vdash_{\text{pl}(\omega_1)}$ iff $x \subseteq \mathcal{L}_{\text{n}(\omega_1)}$, and $x \nvdash_{\text{pl}(\omega_1)} \bot$, and for all $y \in \mathcal{L}_{\text{n}(\omega_1)}$ it holds that if $y \notin x$, then $x \cup \{y\} \vdash_{\text{pl}(\omega_1)} \bot$.*
The set of possible worlds is the set

$$\text{MaxCon}(\mathcal{L}_{\text{n}(\omega_1)}) = \{x \mid x \textit{ is max. consistent in } \vdash_{\text{pl}(\omega_1)}\}.$$

Modelling constraints This kind of modelling imposes several constraints. The modal axioms for belief, desire or intention do not hold in some possible worlds, and so any kind and any measure of failure in their logics may occur.

> What sets a limit to the amount of irrationality we can make psychological sense of is a purely conceptual or theoretical matter—the fact that mental states and events are the states and events they are by their location in a logical space. (Davidson, 2004, 183)

The worlds characterized by an extreme "amount of irrationality" on the side of an agent i are admitted in the modelling. This fact should not be interpreted as a violation of Davidson's thesis, but rather as an unrealistic but harmless and dispensable theoretical possibility.

The T axiom ($\Box p \rightarrow p$) poses a more serious threat to the modelling that keeps modality and the world apart. If modalities obeying reflexive axiom T are allowed, then possible worlds, being defined as maximal consistent sets in propositional logic, would become intuitively impossible. For example, although $\{p, [\text{K}]_i\neg p\}$ is a pl(ω_1)-consistent set, we do not want to have it included in any world since no false proposition may be known as a true proposition. Since the corresponding T axioms seem to constitute an important part of the meaning of verbs of knowledge and of action, epistemic and praxeological modalities must be excluded from the language of norms $\mathcal{L}_{\text{n}(\omega_1)}$. The forthcoming analysis does not depend on the inclusion of "T modalities", so this strategy may be adopted as a provisional method.

Von Wright (von Wright, 1963) defined the content of a norm as "that which ought to or may or must not be or be done". Normative language $\mathcal{L}_{\text{n}(\omega_1)}$ departs from von Wright's definition by taking norm-content to be *the psychological state or relation of psychological states that ought to or may or must not be present in the mind of the norm addressee on a particular occasion*. The reduction and the switch may seem drastic, but there is a rationale for it: the requirement that agent i knows that p could be replaced by $p \rightarrow [\text{B}_i]p$, and a required action to see to it that p could be replaced by the required intention, i.e. $[\text{I}_i]p$.

Logical properties of sets of requirements

Broome (2007b, 35) claims that code values are closed under pl-equivalence, i.e. if p and q are equivalent in propositional logic, then p is a member of a set of requirements just in case q is a member. He seems to tacitly hold that this congruence property constitutes the whole of the logic of "source requirements". Broome is not isolated in adopting the congruence rule (i.e. closure under equivalence): a recent proponent is Lou Goble (2009). Broome (2008, 129) bases the acceptability of the congruence principle on the argument of the absence of contrary evidence, while Goble (2009, 483) takes it for granted since: "[it] seems [to be] a minimum requirement for a logic of ought." On the other hand, Alchourrón and Bulygin (1998) propose an approach that is both more restrictive and more permissive. First, contrary to Broome's weak congruence logic, Alchourrón and Bulygin argue that there is no logic of norms since the existence of a norm depends on the empirical fact of promulgation. Second, they claim that there is a logic of normative systems since the set of norm-contents is deductively closed. By contrast, in Broome's approach there is no general logic for a set of requirements except congruence, while deductive closure is merely a special case. Then again, following Alchourrón and Bulygin, one may think about a set of requirements as void of any logic and only later introduce the set closed under congruence as a special type. In this respect, I will follow Alchourrón and Bulygin's proposal because of its higher level of generality.

If rationality is a normative source or if rationality is presupposed by some normative sources, then some logic for rational relations between intentional states will be needed. Being restricted in no way, a code function may also deliver sets having particular logical properties. So, it is convenient to introduce sets of sentences in $\mathcal{L}_{\text{n}(\omega_1)}$ which obey or contain some modal logic. By doing so, one can explicate the rational relations in terms of logic and define the type codes whose output has certain logical properties with respect to some logic of the modal operators (Definition 9).

Definition 7 *Any function g from $\mathcal{L}_{\mathrm{n}} \subset \mathcal{L}_{\mathrm{n}(\omega_1)}$ to $\mathcal{L}_{\mathrm{n}(\omega_1)}$ is a restricted substitution function iff*

- $g(p) \in \mathcal{L}_{\mathrm{n}(\omega_1)}$ *if p is a propositional letter*
- $g(\neg p) = \neg g(p)$
- $g(p \wedge q) = (g(p) \wedge g(q))$
- $g([\mathrm{X}_i]p) = [\mathrm{X}_i]g(p)$ *for* $\mathrm{X} = \mathrm{B}, \mathrm{D}, \mathrm{I},\ i \in \mathrm{A}$.

The set Sb *is the set of all restricted substitution functions.*

Remark 3 *The restriction in the domain of substitution functions is due to the fact that infinite conjunctions are not allowed to embed.*

Definition 8 *The set of all substitutional instances of sentences in a given set* $x \subseteq \mathcal{L}_{\mathrm{n}}$ *is the set* $\mathrm{l}(x) = \{q \mid \exists p \exists f(p \in x \wedge f \in \mathrm{Sb} \wedge f(p) = q)\}$.

Definition 9 *The set* $\mathrm{Cn}(\mathrm{l}(x)) = \{y \mid \mathrm{l}(x) \vdash_{\mathrm{pl}(\omega_1)} y\}$ *is the logic for axiomatic basis x.*

Definition 10 *Let* $\top_{[\mathrm{X}_i]}$ *denote*

$$((p \vee \neg p) \leftrightarrow q) \rightarrow [\mathrm{X}_i]q,$$

and let $\mathrm{K}_{[\mathrm{X}_i]}$ *denote*

$$[\mathrm{X}_i](p \rightarrow q) \rightarrow ([\mathrm{X}_i]p \rightarrow [\mathrm{X}_i]q).$$

A set $\mathrm{Cn}(\mathrm{l}(x))$ *is a normal logic for a set of modal operators* $\mathrm{o}/x \subseteq \{[\mathrm{X}_i] \mid \mathrm{X} = \mathrm{B}, \mathrm{D}, \mathrm{I},\ i \in \mathrm{A}$, *and* $[\mathrm{X}_i]$ *occurs in some* $p \in x\}$ *iff*

$$\mathrm{Cn}(\mathrm{l}(\{\top_y \mid y \in \mathrm{o}/x\} \cup \{\mathrm{K}_y \mid y \in \mathrm{o}/x\})) \subseteq \mathrm{Cn}(\mathrm{l}(x)).$$

First order structure for metanormative language

The domain for metanormative language $\mathcal{L}_{\mathrm{meta}}$ comprises the following objects: normative sources, $x \in \mathsf{S}$; agents, $x \in \mathrm{A}$; sentences, $x \in \mathcal{L}_{\mathrm{n}(\omega_1)}$; sets of sentences (code values, and axiomatic bases for logics), $x \subseteq \mathcal{L}_{\mathrm{n}(\omega_1)}$; worlds, $x \in \mathrm{MaxCon}(\mathcal{L}_{\mathrm{n}(\omega_1)})$.

Definition 11 $\mathrm{D} = \mathsf{S} \cup \mathrm{A} \cup \mathcal{L}_{\mathrm{n}(\omega_1)} \cup \wp\mathcal{L}_{\mathrm{n}(\omega_1)}$ *where* $\mathsf{S} \neq \emptyset$, $\mathrm{A} \neq \emptyset$, $\mathsf{S} \cap \mathrm{A} = \emptyset$.

Definition 12

$$\mathcal{I}(f)(x_1, .., x_n) = \begin{cases} y, \text{ if } \langle x_1, .., x_n, y\rangle \in \mathcal{I}(f), \\ \text{undefined, otherwise.} \end{cases}$$

Definition 13 *Function* $\mathcal{I}$ *gives the following interpretation for the vocabulary of* $\mathcal{L}_{\mathrm{meta}}$:

(interpretation of names of sources) $\mathcal{I}(\mathrm{s}_i) \in \mathsf{S}$;

(interpretation of the code function symbol) $\mathcal{I}(\mathrm{k})$ *is a function:*

$$\mathsf{S} \times \mathrm{A} \times \mathrm{MaxCon}(\mathcal{L}_{\mathrm{n}(\omega_1)}) \rightarrow \wp\mathcal{L}_{\mathrm{n}(\omega_1)};$$

(interpretation of the function symbol for an axiomatic basis) $\mathcal{I}(\mathrm{l})$ *is a function:* $\wp\mathcal{L}_{\mathrm{n}(\omega_1)} \rightarrow \wp\mathcal{L}_{\mathrm{n}(\omega_1)}$, *such that for any* $x \subseteq \mathcal{L}_{\mathrm{n}(\omega_1)}$

$$\mathcal{I}(\mathrm{l})(x) = \{f(p) \mid p \in x \wedge f \in \mathrm{Sb}\};$$

(interpretation of the pl*-consequence function symbol)* $\mathcal{I}(\mathrm{Cn})$ *is a function:* $\wp\mathcal{L}_{\mathrm{n}(\omega_1)} \rightarrow \wp\mathcal{L}_{\mathrm{n}(\omega_1)}$, *such that for any* $x \subseteq \mathcal{L}_{\mathrm{n}(\omega_1)}$

$$\mathcal{I}(\mathrm{Cn})(x) = \{y \in \mathcal{L}_{\mathrm{n}(\omega_1)} \mid x \vdash_{\mathrm{pl}(\omega_1)} y\};$$

(interpretation of sentence form function symbols) $\mathcal{I}(\mathrm{neg})$, $\mathcal{I}(\mathrm{conj})$, $\mathcal{I}(\mathrm{mod}_{\mathrm{X}})$ *for* $\mathrm{X} = \mathrm{B}_i,\ \mathrm{D}_i,\ \mathrm{I}_i$, $\mathcal{I}(\mathrm{infconj})$ *are functions:* $\mathcal{L}_{\mathrm{n}(\omega_1)} \rightarrow \mathcal{L}_{\mathrm{n}(\omega_1)}$, *such that*

$$\mathcal{I}(\mathrm{neg}) = \{\langle x, y\rangle \mid y = \neg{}^\frown x\}$$
$$\mathcal{I}(\mathrm{conj}) = \{\langle x, y, z\rangle \mid z = ({}^\frown x^\frown \wedge^\frown y^\frown)\}$$
$$\mathcal{I}(\mathrm{mod}_{\mathrm{X}}) = \{\langle x, y\rangle \mid y = [\mathrm{X}]^\frown x\}$$
$$\mathcal{I}(\mathrm{infconj}) = $$
$$= \left\{ \langle x, y\rangle \;\middle|\; \begin{array}{l} x \subseteq \mathrm{lit}(\mathcal{L}_{\mathrm{n}}) \wedge \\ y = \bigwedge{}^\frown\{{}^\frown seq(x)(1)^\frown,^\frown \\ \ldots^\frown,^\frown seq(x)(n)^\frown,^\frown \ldots^\frown\} \end{array} \right\}$$

where $^\frown$ *is a concatenation operation, and where* $seq \in \prod x$, *while* $\prod x$ *denotes the set of functions f* $: \mathbb{N} \rightarrow x$, *such that* $f(i) \neq f(j)$ *for each* $i, j \in \mathbb{N}$;

(interpretation of the function symbol for the extraction of quasi-literals) lt *is the function:* $\wp\mathcal{L}_{\mathrm{n}(\omega_1)} \rightarrow \wp\mathcal{L}_{\mathrm{n}(\omega_1)}$, *such that for any* $x \subseteq \mathcal{L}_{\mathrm{n}(\omega_1)}$, $\mathcal{I}(\mathrm{lt})(x) = \{y \mid y \in x \wedge y \in \mathrm{lit}(\mathcal{L}_{\mathrm{n}(\omega_1)})\}$;

(interpretation of "normative property predicate")

$$\mathcal{I}(\mathrm{K}_{\mathsf{S}}) \subseteq \mathrm{A} \times \mathrm{MaxCon}(\mathcal{L}_{\mathrm{n}(\omega_1)});$$

(interpretation of membership predicate)

$$\mathcal{I}(\in) = \{\langle x, y\rangle \mid x, y \in \mathrm{D},\ x \in y\};$$

(interpretation for "superfluous predicates")

$$\mathcal{I}(\mathrm{Source}) = \mathsf{S}$$
$$\mathcal{I}(A) = \mathrm{A}$$
$$\mathcal{I}(\mathrm{Sen}) = \mathcal{L}_{\mathrm{n}(\omega_1)}$$
$$\mathcal{I}(\mathrm{W}) = \mathrm{MaxCon}(\mathcal{L}_{\mathrm{n}(\omega_1)}).$$

Definition 14 $\mathfrak{M}_{\mathrm{mn}} = \langle \mathrm{D}, \mathcal{I}\rangle$.

Definition 15 *Variable assignment g in* $\mathfrak{M}_{\mathrm{mn}} = \langle \mathrm{D}, \mathcal{I} \rangle$ *is a (possibly partial) function g, such that for any variable v*

$$g(v) \in \mathrm{D} \textit{ iff } v \in domain(g).$$

For sorts of variables: (source variables) $g(v) \in \mathsf{S}$ *if* $v = \mathsf{s}, \mathsf{s}_1, \ldots$*; (world variables)* $g(v) \in \mathrm{MaxCon}(\mathcal{L}_{\mathrm{n}(\omega_1)})$ *if* $v = w, w_1, \ldots$*; (sentence variables)* $g(v) \in \mathcal{L}_{\mathrm{n}(\omega_1)}$ *if* $v = p, p_1, \ldots, q, q_1, \ldots$*; (agent variables)* $g(v) \in \mathrm{A}$ *if* $v = i, i_1, \ldots$*. The variable assignment g is appropriate for formula p iff all free variables of p are in the domain of g .*

Notation 1 *The empty variable assignment* $g_\emptyset$ *is undefined for any variable: range*$(g_\emptyset) = \emptyset$*.*
By $g_{[x/d]}$ *we denote the variable assignment that differs from g at most by assigning* d *for x:*

$$g_{[x/\mathrm{d}]}(v) = \begin{cases} \mathrm{d}, \textit{ if } x = v \\ g(v), \textit{ otherwise.} \end{cases}$$

Definition 16

$$[\![t]\!]_g^{\mathfrak{M}_{\mathrm{mn}}} =$$
$$= \begin{cases} \mathcal{I}(t), \textit{ if t is an individual constant} \\ g(t), \textit{ if t is an individual variable} \\ \mathcal{I}(f)([\![t_1]\!]_g^{\mathfrak{M}_{\mathrm{mn}}}, \ldots, [\![t_n]\!]_g^{\mathfrak{M}_{\mathrm{mn}}}), \textit{ if t is } f(t_1, \ldots, t_n). \end{cases}$$

Definition 17 *(Satisfaction) Let g be an assignment in* $\mathfrak{M}_{\mathrm{mn}}$ *which is appropriate for p. Suppose, successively, that p is* $P(t_1, \ldots, t_n)$, $\neg\varphi$, $(\varphi \wedge \psi)$*, and* $\forall v \varphi$*.*

$$\mathfrak{M}_{\mathrm{mn}} \models P(t_1, \ldots, t_n)\ [g]$$
$$\textit{iff } \langle [\![t_1]\!]_g^{\mathfrak{M}_{\mathrm{mn}}}, \ldots, [\![t_n]\!]_g^{\mathfrak{M}_{\mathrm{mn}}} \rangle \in \mathcal{I}(P)$$
$$\mathfrak{M}_{\mathrm{mn}} \models \neg\varphi\ [g]$$
$$\textit{iff not } \mathfrak{M}_{\mathrm{mn}} \models \varphi\ [g]$$
$$\mathfrak{M}_{\mathrm{mn}} \models (\varphi \wedge \psi)\ [g]$$
$$\textit{iff } \mathfrak{M}_{\mathrm{mn}} \models \varphi\ [g] \textit{ and } \mathfrak{M}_{\mathrm{mn}} \models \psi\ [g]$$
$$\mathfrak{M}_{\mathrm{mn}} \models \forall v \varphi\ [g]$$
$$\textit{iff for all } \mathrm{d} \in \mathrm{D}, \mathfrak{M}_{\mathrm{mn}} \models \varphi\ [g_{[v/\mathrm{d}]}].$$

Definition 18 *(Truth in a metanormative model) Formula* φ *is true in* $\mathfrak{M}_{\mathrm{mn}}$ *iff* $g_\emptyset$ *satisfies* φ *in* $\mathfrak{M}_{\mathrm{mn}}$*:*

$$\mathfrak{M}_{\mathrm{mn}} \models \varphi \textit{ iff } \mathfrak{M}_{\mathrm{mn}} \models \varphi \quad [g_\emptyset].$$

4. Typology of Sets of Requirements and Code Functions

The use of code functions enriches the discriminative power of the logical theory of normative systems. On the one hand, in the functional approach, one may define the properties and relations of sets of requirements as in other set theoretic approaches. On the other hand, unlike other set theoretic approaches, quantifying over different argument positions in the code function makes it possible for the functional approach to introduce a number of interesting type distinctions.

First, I will give definitions for some interesting logical properties that are "local", i.e. properties of sets of requirements. In each definition, the *definiendum* introduces both an informal expression and a new predicate of language $\mathcal{L}_{\mathrm{meta}}$. The unbound variables are assumed to be universally quantified.

Definitions 1 *A set of requirements* $\mathrm{k}_{\mathsf{s}}(i, w_1)$ *is* pl-*congruent,* $\mathrm{CG}_{\mathrm{pl}}(\mathrm{k}_{\mathsf{s}}(i, w_1))$*, iff*

$$\forall p \forall q \begin{pmatrix} \ulcorner p \leftrightarrow q \urcorner \in \mathrm{Cn}(\varnothing) \rightarrow \\ (p \in \mathrm{k}_{\mathsf{s}}(i, w_1) \leftrightarrow q \in \mathrm{k}_{\mathsf{s}}(i, w_1)) \end{pmatrix}.$$

A set of requirements $\mathrm{k}_{\mathsf{s}}(i, w_1)$ *is* pl-*consistent,* $\mathrm{CS}_{\mathrm{pl}}(\mathrm{k}_{\mathsf{s}}(i, w_1))$*, iff* $\exists w_2\, \mathrm{k}_{\mathsf{s}}(i, w_1) \subseteq w_2$*.*

A set of requirements $\mathrm{k}_{\mathsf{s}}(i, w_1)$ *is* pl-*deductively closed,* $\mathrm{DC}_{\mathrm{pl}}(\mathrm{k}_{\mathsf{s}}(i, w_1))$*, iff* $\mathrm{k}_{\mathsf{s}}(i, w_1) = \mathrm{Cn}(\mathrm{k}_{\mathsf{s}}(i, w_1))$*.*

A set of requirements $\mathrm{k}_{\mathsf{s}}(i, w_1)$ *is consistent in logic* $\mathrm{l}(x)$*,* $\mathrm{CS}_{\mathrm{l}(x)}(\mathrm{k}_{\mathsf{s}}(i, w_1))$*, iff*

$$\exists w_2\, \mathrm{Cn}(\mathrm{l}(x) \cup \mathrm{k}_{\mathsf{s}}(i, w_1)) \subseteq w_2.$$

A set of requirements $\mathrm{k}_{\mathsf{s}}(i, w_1)$ *is a logic,* $\mathrm{LG}(\mathrm{k}_{\mathsf{s}}(i, w_1))$*, iff* $\exists x\, \mathrm{k}_{\mathsf{s}}(i, w_1) = \mathrm{Cn}(\mathrm{l}(x))$*.*

A set of requirements $\mathrm{k}_{\mathsf{s}}(i, w_1)$ *is deductively closed with respect to logic* $\mathrm{l}(x)$*,* $\mathrm{DC}_{\mathrm{l}(x)}(\mathrm{k}_{\mathsf{s}}(i, w_1))$*, iff*

$$\exists y\, \mathrm{k}_{\mathsf{s}}(i, w_1) = \mathrm{Cn}(\mathrm{l}(x) \cup y)).$$

A set of requirements $\mathrm{k}_{\mathsf{s}}(i, w_1)$ *is material (not formal) in logic* $\mathrm{l}(x)$*,* $\mathrm{MT}_{\mathrm{l}(x)}(\mathrm{k}_{\mathsf{s}}(i, w_1))$*, iff*

$$\exists y (y \neq \emptyset \wedge y \neq \mathrm{l}(x) \wedge \mathrm{k}_{\mathsf{s}}(i, w_1) = \mathrm{Cn}(\mathrm{l}(x) \cup y)).$$

Second, more "global" properties are obtained through universal generalization over agents and worlds. In this way, the corresponding properties of normative sources may be defined. Such a list of the logical properties of normative sources follows with the focus on more general logical properties. Therefore, pl-properties of the sources will be omitted. Additionally, I will use existential generalization to introduce the notion of an achievable source, a notion that is critical to the theory that separates normative sources from normative properties, since only an achievable source can define a property.

Definitions 2 *A normative source* s *issues an* $\mathrm{l}(x)$*-consistent code iff* $\forall i \forall w\, \mathrm{CS}_{\mathrm{l}(x)}(\mathrm{k}_{\mathsf{s}}(i, w))$*.*

A normative source s *is formal iff* $\forall i \forall w\, \mathrm{LG}(\mathrm{k}_{\mathsf{s}}(i, w))$*.*

A normative source s *issues an* $\mathrm{l}(x)$*-deductively closed code iff* $\forall i \forall w\, \mathrm{DC}_{\mathrm{l}(x)}(\mathrm{k}_{\mathsf{s}}(i, w))$*.*

A normative source s *is material with respect to logic* $\mathrm{l}(x)$ *iff* $\exists i \exists w \mathrm{MT}_{\mathrm{l}(x)}(\mathrm{k}_{\mathsf{s}}(i,w))$.

A normative source s *is achievable iff* $\exists w \mathrm{k}_{\mathsf{s}}(i,w) \subseteq w$.

Third, some of the logical properties of normative systems are not definable in terms of the properties of a sole set of requirements. A comparison between sets of requirements leads to the introduction of new conceptual distinctions. In this way, the difference between relative and absolute sources becomes visible. Finally, for the determination of the equilibrium properties of a normative system, the social logic of normative sources must be taken into account (see Section 7.), and, therefore, the notion of social consistency is introduced below.

Definitions 3 *A normative source is world-relative iff* $\exists i \exists w_1 \exists w_2 \mathrm{k}_{\mathsf{s}}(i,w_1) \neq \mathrm{k}_{\mathsf{s}}(i,w_2)$.

A normative source is agent-relative iff

$$\exists w \exists i_1 \exists i_2 \mathrm{k}_{\mathsf{s}}(i_1,w) \neq \mathrm{k}_{\mathsf{s}}(i_2,w).$$

A normative source is world-absolute (world-invariant) iff it is not world-relative.

A normative source is agent-absolute iff it is not agent-relative.

A normative source is socially $\mathrm{l}(x)$*-consistent iff*

$$\forall i_1 \forall i_2 \forall w \, \mathrm{CS}_{\mathrm{l}(x)}(\mathrm{k}_{\mathsf{s}}(i_1,w) \cup \mathrm{k}_{\mathsf{s}}(i_2,w)).$$

Fourth, thanks to quantification over sources, the relations between codes issued by different sources can be defined. I will give only two definitions of the kind, namely those that will be used in the rest of this article.

Definitions 4 *Normative sources* s_1 *and* s_2 *are realization-equivalent iff*

$$\forall i \forall w (\mathrm{k}_{\mathsf{s}_1}(i,w) \subseteq w \leftrightarrow \mathrm{k}_{\mathsf{s}_2}(i,w) \subseteq w).$$

Normative sources s_1 *and* s_2 *are* $\mathrm{l}(x)$*-compatible iff*

$$\forall w \, \mathrm{CS}_{\mathrm{l}(x)}(\mathrm{k}_{\mathsf{s}_1}(i,w) \cup \mathrm{k}_{\mathsf{s}_2}(i,w)).$$

The typology put to work

The terms defined above, or ones constructed in a similar fashion, can be applied in the interpretation of philosophical texts. Let us begin with antique philosopher, Epictetus (c. 50–c. 120).

> [...] instruction consists precisely in learning to desire each thing just as it happens. (Epictetus, 1925, 93)

The $\mathcal{L}_{\text{meta}}$ translation gives:

$$\forall i \forall w (\ulcorner \mathrm{D}_i p \urcorner \in \mathrm{k}_{\mathsf{inst}}(i,w) \rightarrow \ulcorner p \urcorner \in w)$$

where inst names the normative source of instruction and where modal operator D_i stands for 'agent i desires that'.

Let us consider a modern text in which the author treats rationality as a normative source that issues a world-absolute logical code.

> It is obvious enough that there are norms of rationality that apply to thoughts. If we believe certain things, logic tells us there are other things we ought or ought not to believe at the same time; decision theory gives us an idea of how the beliefs and values of a rational man must be related to each other; [...] (Davidson, 2004, 97)

Let ratio refer to the normative source of rationality. A likely $\mathcal{L}_{\text{meta}}$ translation for the first clause of the second quoted sentence states that the normative source of rationality is deductively closed with respect to the doxastic D axiom:

$$\forall i \forall w \, \mathrm{DC}_{\mathrm{l}(\{\ulcorner \mathrm{B}_i p \rightarrow \neg \mathrm{B}_i \neg p \urcorner\})}(\mathrm{k}_{\mathsf{ratio}}(i,w)).$$

Another plausible $\mathcal{L}_{\text{meta}}$ translation is a stronger one that maintains that rationality is a formal normative source which includes the doxastic D axiom:

$$\forall i \forall w \, (\mathrm{LG}(\mathrm{k}_{\mathsf{ratio}}(i,w)) \land \mathrm{l}(\{\ulcorner \mathrm{B}_i p \rightarrow \neg \mathrm{B}_i \neg p \urcorner\}) \subseteq \mathrm{k}_{\mathsf{ratio}}(i,w)).$$

In the next example there is an interplay between the world logic, pl-logic, and some logic of intentionality, some $\mathrm{l}(x)$ logic (such as the one in the previous example requiring consistency of belief contents).

> Rationality is principally concerned with coherence among your attitudes such as your beliefs and intentions, whereas morality, prudence and other sources of normativity are rarely concerned with those things. Rationality has a domain of application where it is pretty much on its own. Examples of conflict between rationality and other sources of requirements tend to be farfetched... (Broome, 2007a, 164)

The last sentence of the citation could be interpreted as a claim that any consistent normative source issues a code that is compatible with one issued by rationality; or, stated more concisely, that the normative source of rationality is maximally compatible:

$$\forall \mathsf{s} \forall i \forall w (\mathrm{CS}_{\mathrm{pl}}(\mathrm{k}_{\mathsf{s}}(i,w)) \rightarrow \mathrm{CS}_{\mathrm{l}(x)}(\mathrm{k}_{\mathsf{s}}(i,w) \cup \mathrm{k}_{\mathsf{ratio}}(i,w))).$$

Metanormative interpretation also reveals the hidden thesis implied by the claim on the maximally compatible character of rationality. Rationality, at least in the "horizontal sense" (Zangwill, 2005) of the word, deals with formal relations between intentional states and therefore it cannot be maximally compatible unless other sources are consistent in the logic defined by the axiomatic bases for the modal part of their language. In other words, normative sources must obey the logic of the language in which their requirements are stated. This claim is rather strong, as the next section will show, for it holds only for ideal normative sources.

5. Deontic Logic and the Typology of Normative Systems

Consistent and deductively closed codes seem to play an important role in the philosophical understanding of basic normative concepts. For example, deontic KD logic without iterated deontic modalities may be conceived as the theory of a specific type of code, namely of a consistent pl-deductively closed code. This type has been discussed in the literature. For example, Alchourrón and Bulygin define "the concept of a normative system as the set of all the propositions that are consequence of the explicitly commanded propositions" (Alchourrón and Bulygin, 1998, 391), and that concept corresponds to the concept of a deductively closed set of requirements (see section 4.). Although Alchourrón and Bulygin allow for a normative system to be inconsistent, they consider inconsistency as a serious defect that needs to be cured. So, inconsistent normative systems are only transient states in the development of the system. To Alchourrón and Bulygin's concept of a consistent normative system there corresponds the concept of a set of requirements that is both deductively closed and consistent.

Von Wright has pointed out the connection between deontic logic and the set-theoretical approach:

> . . . classic deontic logic, on the descriptive interpretation of its formulas, pictures a gapless and contradiction-free system of norms. (von Wright, 1999, 32)

In order to investigate von Wright's thesis, a translation between metanormative language and the language of classical deontic KD logic will be introduced and used for a precise determination of the relationship between KD logic and the typology of sets of requirements.

Definition 19 *Let $p \in \mathcal{L}_{PL}$ be a formula of propositional logic.*
Formulas of restricted language $\mathcal{L}^{O}_{KD}$:

$$\varphi ::= p \mid Op \mid Pp \mid \neg\varphi \mid (\varphi_1 \wedge \varphi_2).$$

Let us introduce the translation τ^1 from the restricted language $\mathcal{L}^{O}_{KD}$ to the metanormative language $\mathcal{L}_{\text{meta}}$, with O$p$ and Pp standing for 'i in v has an s-obligation (s-permission) to p'.

Definition 20 *Function τ^0 maps sentences from the fragment $\mathcal{L}^{O}_{KD} \cap \mathcal{L}_{PL}$ to the set of sentential variables and sentential function terms of $\mathcal{L}_{\text{meta}}$:*

$$\tau^0(a) \in \{p, p_1, \ldots, q, q_1, \ldots\} \quad \textit{for propositional letters } a \in \mathcal{L}_{PL}$$
$$\tau^0(\neg\varphi) = \neg\tau^0(\varphi)$$
$$\tau^0((\varphi \wedge \psi)) = (\tau^0(\varphi) \wedge \tau^0(\psi)).$$

Definition 21 *Translation $\tau^1 : \mathcal{L}^{O}_{KD} \rightarrow \mathcal{L}_{\text{meta}}$*

$$\tau^1(p) = \ulcorner\tau^0(p)\urcorner \in \mathrm{v} \qquad \textit{if } p \in \mathcal{L}_{PL}$$
$$\tau^1(O\varphi) = \ulcorner\tau^0(\varphi)\urcorner \in \mathrm{k_s}(\mathrm{a},\mathrm{v})$$
$$\tau^1(P\varphi) = \neg\ulcorner\tau^0(\neg\varphi)\urcorner \in \mathrm{k_s}(\mathrm{a},\mathrm{v})$$
$$\tau^1(\neg\varphi) = \neg\tau^1(\varphi)$$
$$\tau^1((\varphi \wedge \psi)) = (\tau^1(\varphi) \wedge \tau^1(\psi)).$$

Example 2

$$\begin{aligned}
&\tau^1(Pp \leftrightarrow \neg O\neg p)\\
&\Leftrightarrow \tau^1(Pp) \leftrightarrow \tau^1(\neg O\neg p)\\
&\Leftrightarrow \neg\ulcorner\tau^0(\neg p)\urcorner \in \mathrm{k_s}(\mathrm{a},\mathrm{v}) \leftrightarrow \neg\,\tau^1(O\neg p)\\
&\Leftrightarrow \neg\ulcorner\neg\tau^0(p)\urcorner \in \mathrm{k_s}(\mathrm{a},\mathrm{v}) \leftrightarrow \neg\ulcorner\tau^0(\neg p)\urcorner \in \mathrm{k_s}(\mathrm{a},\mathrm{v})\\
&\Leftrightarrow \neg\ulcorner\neg p\urcorner \in \mathrm{k_s}(\mathrm{a},\mathrm{v}) \leftrightarrow \neg\ulcorner\neg\tau^0(p)\urcorner \in \mathrm{k_s}(\mathrm{a},\mathrm{v})\\
&\Leftrightarrow \neg\ulcorner\neg p\urcorner \in \mathrm{k_s}(\mathrm{a},\mathrm{v}) \leftrightarrow \neg\ulcorner\neg p\urcorner \in \mathrm{k_s}(\mathrm{a},\mathrm{v})\\
&\Leftrightarrow \top.
\end{aligned}$$

There are two interpretations of conditional obligation in standard deontic logic. *N-scope* interpretation (narrow scope interpretation) reads conditional obligation as 'if p is the case, then q ought to be the case', i.e. $p \rightarrow Oq$. *W-scope* interpretation (wide scope interpretation) puts the entire conditional within the obligation range: 'it ought to be the case that: if p is the case, then q is the case', i.e. $O(p \rightarrow q)$. The narrow scope formula, i.e. $p \rightarrow Oq$, is translated by τ_1 as $p \in \mathrm{v} \rightarrow q \in \mathrm{k_s}(\mathrm{a},\mathrm{v})$. The wide scope formula, i.e. $O(p \rightarrow q)$, is translated by τ_1 as $\ulcorner p \rightarrow q\urcorner \in \mathrm{k_s}(\mathrm{a},\mathrm{v})$. There is a tendency for a natural language speaker to regard N-scope and W-scope expressions as equivalent. The impression of equivalence in meaning is justified by two theoretically derived facts. First, any code $\mathrm{k_s}(i,w)$ has its conditionalized variant $\mathrm{k_s}^{cond}(i,w)$ and the following proposition holds (the unbound variables are assumed to be universally quantified):

$$\forall w \left(\begin{array}{c} \underbrace{(p \in w \rightarrow q \in \mathrm{k_s}(i,w))}_{\text{N-scope}} \\ \leftrightarrow \\ \underbrace{\ulcorner \bigwedge \mathrm{lt}(w) \rightarrow q \urcorner \in \mathrm{k}_{\mathsf{s}}^{cond}(\mathrm{a},w)}_{\text{W-scope (generalized)}} \end{array} \right).$$

In other words, for any code function requiring consequent of an obligation conditional, there is a coordinated code function that requires the entire conditional. Second, a code and its conditionalized variant are realization equivalent (see Section 6.for a more detailed exposition). Therefore, from the behaviouristic point of view or from the perspective of the normative properties being realized, there is no difference between the two codes.

Standard deontic logic translated into metanormative language

The principles of standard deontic logic hold under the translation τ^1:

- mutual definability, $\mathrm{P}p \leftrightarrow \neg\mathrm{O}\neg p$, holds for any set of requirements (see Example 2);
- the "gaplessness" condition $\mathrm{P}p \vee \mathrm{O}\neg p$ translates to $\ulcorner\neg p\urcorner \notin \mathrm{k_s}(\mathrm{a,v}) \vee \ulcorner\neg p\urcorner \in \mathrm{k_s}(\mathrm{a,v})$ and that condition, obviously, is satisfied by any set of requirements whatsoever;
- the K axiom becomes $\ulcorner p \rightarrow q\urcorner \in \mathrm{k_s}(\mathrm{a,v}) \rightarrow (p \in \mathrm{k_s}(\mathrm{a,v}) \rightarrow q \in \mathrm{k_s}(\mathrm{a,v}))$ and that condition holds for any pl-deductively closed set;
- the D axiom translates to $p \in \mathrm{k_s}(\mathrm{a,v}) \rightarrow \ulcorner\neg p\urcorner \notin \mathrm{k_s}(\mathrm{a,v})$ and that is just another way of stating pl-consistency.

According to our translation scheme, von Wright's claim that classical deontic logic "pictures a gapless and contradiction-free system of norms" should be appended: classical deontic logic pictures a system of norms that is deductively closed, too, while gaplessness condition is vacuously satisfied.

One may ask whether these properties provide an adequate description of a formally sound set of requirements or whether the description provided by, some or other, deontic logic is sufficiently fine grained. For example, the τ^1 translation for D does not allow $[\mathrm{B}_i]p \wedge \neg[\mathrm{B}_i]p$ to enter the set of requirements, but it does allow $[\mathrm{B}_i]p \wedge [\mathrm{B}_i]\neg p$. So, the question arises whether the consistency property of a set of requirements is a property that is connected to the world logic, or rather a property that a set inherits when it obeys the logic of its contents, i.e. the logic of intentionality.

Although iterated deontic operators receive no translation in the scheme proposed above, one may extend the line of thought by giving additional translation rules for language of standard deontic logic restricted to a maximum of two iterations of deontic operators, treating iterated deontic modalities as a sequence of heterogeneous operators and introducing the distinction into the syntax.

Definition 22 *Let $p \in \mathcal{L}_{\mathrm{KD}}^{\mathrm{O}}$. The formulas of $\mathcal{L}_{\mathrm{KD}}^{\mathrm{O_2O}}$ are:*

$$\varphi ::= p \mid \mathrm{O}_2 p \mid \mathrm{P}_2 p \mid \neg\varphi \mid (\varphi_1 \wedge \varphi_2).$$

Definition 23 *Let $Sub(\varphi)_{\left[\frac{c_1}{x_1}\cdots\frac{c_n}{x_n}\right]}$ denote the substitutional instance of $\varphi \in \mathcal{L}_{\mathrm{meta}}$ in which the constants $c_1,...,c_n$ are replaced by the variables $x_1,...,x_n$. Translation $\tau^2 : \mathcal{L}_{\mathrm{KD}}^{\mathrm{O_2O}} \rightarrow \mathcal{L}_{\mathrm{meta}}$ is defined as follows:*

$$\begin{aligned} \tau^2(\mathrm{O}_2 p) &= \forall i \forall w\, Sub(\tau^1(p))_{\left[\frac{\mathrm{a}}{i}\ \frac{\mathrm{v}}{w}\right]} \quad \textit{for } p \in \mathcal{L}_{\mathrm{KD}}^{\mathrm{O}} \\ \tau^2(\mathrm{P}_2 p) &= \exists i \exists w\, Sub(\tau^1(p))_{\left[\frac{\mathrm{a}}{i}\ \frac{\mathrm{v}}{w}\right]} \quad \textit{for } p \in \mathcal{L}_{\mathrm{KD}}^{\mathrm{O}} \\ \tau^2(\neg\varphi) &= \neg\tau^2(\varphi) \\ \tau^2(\varphi \wedge \psi) &= (\tau^2(\varphi) \wedge \tau^2(\psi)). \end{aligned}$$

Such an approach to iterated deontic modalities departs from von Wright's (1999) "second order descriptive interpretation" where e.g. O_2 would stand for the existence of "normative demands on normative systems" ("norms for the norm givers"). The "first order" translation τ^1 as well as the "second order" translation τ^2 give us statements in metanormative language $\mathcal{L}_{\mathrm{meta}}$, both of which may picture some type of normative system. The difference lies in the fact that τ^1 gives a local picture of a set of requirements (for a particular source, agent and world) while τ^2 gives a more global picture of a code function. In the second case, the properties depicted are the properties of a normative source.

Let us consider KD45 deontic logic! The τ^2 translations of the reinterpreted axioms 4, $\mathrm{O}_1 p \rightarrow \mathrm{O}_2\mathrm{O}_1 p$ and 5, $\mathrm{P}_1 p \rightarrow \mathrm{O}_2\mathrm{P}_1 p$ amount to stating that any s-obligation and any s-permission hold universally. So, the reinterpreted axioms will hold only if the s-code is absolute.

Following Broome's approach (2007b; 2008), a metanormative theory must take into consideration both normative sources and normative properties since the interaction between the normative and the real takes place on the level of agent properties. A straightforward definition of the "all-or-nothing" normative property has been proposed in (Broome, 2007b, 11) and its $\mathcal{L}_{\mathrm{meta}}$ reformulation is given below.

Definition 24 *An agent i at world w has an "all-or-nothing" normative property $\mathrm{K_s}$ that corresponds to the source s iff the set of requirements $\mathrm{k_s}(i,w)$ is satisfied in w, i.e. $\mathrm{K_s}(i,w) \leftrightarrow \mathrm{k_s}(i,w) \subseteq w$.*

If the only way to satisfy some relative code and some absolute code is to satisfy them simultaneously, then these codes define the same normative property. The question arises as to whether the (non)absoluteness of a code function introduces a difference with respect to normative properties. The next theorem provides a negative answer.

6. A Theorem on the Absolute and the Relative

There is a number of ways to define a conditionalized variant of a code. Definition 25, below, introduces one of the variants by using an infinite conjunction of quasi-literals to single out a world, and by assigning a conditional for each requirement.

In order to justify the negative resolution of the question posed above (i.e. is the normative property dependent on the relative-absolute character of the normative source that defines it?), several propositions will be needed. First, Lemma 1 will be established and used in the proof of Proposition 2 which shows that an adequately chosen set of quasi-literals is sufficient to determine a world. After that, the function that assigns to each code function its conditionalized variant will be introduced in Definition 25, and Theorem 1 on the existence of a realization equivalent absolute code for any relative code will be proved. The theorem is equivalent to the claim that relative and absolute codes do not generate different normative properties.

Lemma 1 *For all* $p \in \mathcal{L}_{n(\omega_1)}$, $\ulcorner p \urcorner \in \mathrm{Cn}(\mathrm{lt}(w))$ *or* $\ulcorner \neg p \urcorner \in \mathrm{Cn}(\mathrm{lt}(w))$.

Proof Transfinite induction on the pl-complexity of formulas will be used. Let the complexity of modal formulas and propositional letters be 0; the complexity of $\neg p$ — one greater than the complexity of p; the complexity of $(p \wedge q)$ — one greater than the maximum of that of p and q; the complexity of $\bigwedge x$ — ω. Let us consider only the cases of limit ordinals, 0 and ω. (0) The lemma holds for propositional letters and modal formulas in virtue of the pl-maximality of w. (ω) Suppose p is $\bigwedge x$. According to the definition, any $p_i \in x$ is a quasi-literal, and by inductive hypothesis the lemma holds for each p_i. Either all the quasi-literals in x are consequences of $\mathrm{lt}(w)$, and therefore $\ulcorner \bigwedge x \urcorner \in \mathrm{Cn}(\mathrm{lt}(w))$, or some of the quasi-literals are not consequences of $\mathrm{lt}(w)$, and therefore $\ulcorner \neg \bigwedge x \urcorner \in \mathrm{Cn}(\mathrm{lt}(w))$. □

Proposition 2 $\mathrm{Cn}(\mathrm{lt}(w)) = w$

Proof First, suppose $p \in \mathrm{Cn}(\mathrm{lt}(w))$. Then, $p \in w$ since w is deductively closed. Second, suppose $p \in w$. By Lemma 2, $\ulcorner p \urcorner \in \mathrm{Cn}(\mathrm{lt}(w)) \vee \ulcorner \neg p \urcorner \in \mathrm{Cn}(\mathrm{lt}(w))$, and so $\ulcorner p \urcorner \in \mathrm{Cn}(\mathrm{lt}(w))$ since w is consistent. □

Definition 25 *A code* $\mathrm{k}_{\mathsf{s}}^{cond}$ *is the conditionalized variant of a code* k_{s} *iff*

$$\forall p \forall w_1 \left(\begin{array}{l} p \in \mathrm{k}_{\mathsf{s}}^{cond}(i, w_1) \\ \leftrightarrow \\ \exists q \exists w_2 (q \in \mathrm{k}_{\mathsf{s}}(i, w_2) \wedge p = \ulcorner \bigwedge \mathrm{lt}(w_2) \rightarrow q \urcorner) \end{array} \right).$$

Lemma 2 *Any conditionalized code is absolute.*

Proof Let w_1 and w_2 be arbitrary worlds. Assume $p \in \mathrm{k}_{\mathsf{s}}^{cond}(i, w_1)$. By Definition 25, $\exists q \exists w_3 (q \in \mathrm{k}_{\mathsf{s}}(i, w_3) \wedge p = \ulcorner \bigwedge \mathrm{lt}(w_3) \rightarrow q \urcorner)$. Then, by universal instantiation of the same definition, $p \in \mathrm{k}_{\mathsf{s}}^{cond}(i, w_2)$. Obviously, the same holds in the opposite direction. □

Theorem 1 *For each world-relative code there is a realization equivalent world-absolute code.*

Proof We show that conditionalization generates a realization equivalent absolute code. By Lemma 2, each conditionalized code is absolute. It remains to prove that:

$$k_{\mathsf{s}}(i, w_1) \subseteq w_1 \leftrightarrow k_{\mathsf{s}}^{cond}(i, w_1) \subseteq w_1.$$

For the left to right direction, assume that $k_{\mathsf{s}}(i, w_1) \subseteq w_1$. Further, assume for an arbitrary p that $p \in k_{\mathsf{s}}^{cond}(i, w_1)$. Then, by Definition 25, there is some w_2 and some $q \in k_{\mathsf{s}}(i, w_2)$, such that $p = \ulcorner \bigwedge \mathrm{lt}(w_2) \rightarrow q \urcorner$. By *tertium non datur*, either $\mathrm{Cn}(\mathrm{lt}(w_2)) = w_1$ or $\mathrm{Cn}(\mathrm{lt}(w_2)) \neq w_1$. If $\mathrm{Cn}(\mathrm{lt}(w_2)) = w_1$, then by Proposition 2 $w_1 = w_2$. So, $q \in k_{\mathsf{s}}(i, w_1)$, and therefore $q \in w_1$ by the initial assumption. Since, w_1 is a deductively closed set, $\underbrace{\ulcorner \bigwedge \mathrm{lt}(w_2) \rightarrow q \urcorner}_{p} \in w_1$. If $\mathrm{Cn}(\mathrm{lt}(w_2)) \neq w_1$, then $\ulcorner \bigwedge \mathrm{lt}(w_2) \urcorner \notin w_1$. Therefore, by completeness of w_1, $\ulcorner \neg \bigwedge \mathrm{lt}(w_2) \urcorner \in w_1$. Then, $\underbrace{\ulcorner \bigwedge \mathrm{lt}(w_2) \rightarrow q \urcorner}_{p} \in w_1$ by deductive closure.

For the right to left direction, assume $k_{\mathsf{s}}^{cond}(i, w_1) \subseteq w_1$. Further, assume for an arbitrary p that $p \in k_{\mathsf{s}}(i, w_1)$. Then, by Definition 25, $\ulcorner \bigwedge \mathrm{lt}(w_1) \rightarrow p \urcorner \in k_{\mathsf{s}}^{cond}(i, w_1)$. By the initial assumption, $\ulcorner \bigwedge \mathrm{lt}(w_1) \rightarrow p \urcorner \in w_1$. Set w_1 is deductively closed, so, given the fact that $\ulcorner \bigwedge \mathrm{lt}(w_1) \urcorner \in w_1$, we get $p \in w_1$ as desired. □

Remark 4 *Theorem 1 can be easily generalized to the claim that for any relative code, either world or agent relative, there is a realization equivalent world and agent absolute code.*

7. Glimpses Beyond

It seems that a generalized set theoretic approach opens up a number of interesting topics of historical, social-theoretical, philosophical and ethical interest.

In historical terms (as the quotation below shows), Leibniz's way of understanding the connection between normative properties and normative requirements comes very close to the approach developed here, and differences and similarities should be more closely investigated:

> That is permitted what a good man possibly is. That is obligatory what a good man necessary is. (Leibniz, 2006, 280)[1]

The research presented in this paper should be extended towards the development of a typology of normative properties and a determination of the deontic logic that describes the structure of the property requirements. The typology of normative systems seems to need a supplementary typology of normative properties, most notably of those that are defined in terms of partial satisfaction.

The motivation for the AGM theory of belief revision came from a legal context. The AGM theory, inter alia, has described the logical ways in which the consistency of a theory should be maintained. The logical properties that define the state of equilibrium for the homeostatic dynamics of normative codes should be determined. Prima facie, a number of other properties, besides mere pl-consistency, should be taken into account for the determination of the equilibrium state of normative systems; in particular, properties such as code compatibility, social consistency, achievability, and logicality seem to be of theoretical importance.

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1 Leibniz's letter to Antoine Arnauld, November 1671: "Licitum enim est, quod viro bono possibile est. Debitum sit, quod viro bono necessarium est." [My translation]

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