What Is Buddhist Transhumanism?

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Abstract The meeting of ancient Buddhism from Asia with modern orientation towards science and technology in the Western world has led to a burgeoning movement that combines these in new and innovative ways. Lacking much institutional structure, but with many shared goals among its adherents, this movement seeks to attain the traditional Buddhist goals of reducing suffering and realizing Awakening, but with the assistance of scientific knowledge and technological means.

Key words: Buddhism; Transhumanism; Meditation; Science; Technology; Pragmatic dharma

Reducing suffering and increasing happiness are goals common to Buddhism and to transhumanism. As always, the meaning of the preceding statement depends crucially on how the key terms are defined. There are several varieties, or schools, of Buddhism. There are also varieties of transhumanism. And there is, in contemporary thought, an ongoing discussion about the definition of happiness, and of its relationship to suffering. All of this could be discussed abstractly, as a philosophical matter. However, what distinguishes both Buddhism and transhumanism from philosophy as an intellectual discipline is that both of the former are concerned with the development and deployment of practical efforts aimed at reducing suffering and increasing happiness, by degrees and even ultimately, or in absolute terms. The central teaching of Buddhism is that suffering can be completely eliminated by means of correct spiritual practice resulting in final entry into Nirvana, the deathless state of perfect liberation. Among transhumanists who do not accept the teachings of Buddhism, some also claim that a perfect state is attainable, however they define it as physical (or virtual, "uploaded") existence of indefinitely long duration featuring an ongoing series of pleasant experiences. Buddhist transhumanists do not categorically reject the latter prospect, but they consider it to be a lesser attainment — not the ultimate one. Such an attainment would be, at best, a form of meliorism, featuring conditions that by their very nature can only bring temporary (albeit relatively long-lived) satisfactions. In some sense then, the latter, lesser attainment would be a form of satisficing, in which various alternatives are considered until an acceptability threshold is met.

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I am a self-identified Buddhist transhumanist. As such, my intention here is to inform you, the reader, about the intellectual landscape and social movements that comprise Buddhist transhumanism. In addition, my obligation and my joy as a Buddhist transhumanist is to inform you, as a person, of the opportunities for you to benefit from what Buddhist transhumanism has to offer. Based on all this, you would be justified in viewing me as an informant from within the community under discussion, and therefore not an unbiased source of information. So take what I say “with a grain of salt,” so to speak. However, also recognize that what I express here comes from deep conviction. Therefore, you may rightly view me as an example of what I am talking about. Judge accordingly.

The arc of this discussion begins with explanations of how Buddhism and transhumanism are defined, followed by a history of how they came together to form Buddhist transhumanism, and where Buddhist transhumanism may be headed, in the near future and the farthest future we can imagine.

**Bad boy Buddha**

He abandoned his wife and infant son. He left it to his father’s household to take care of them. He renounced his inheritance, as well as his duty as society defined it. He became homeless, begging or scrounging for food, and sleeping in the open air. He never held a job or paid his own way. And he encouraged others to follow his example.

Siddhartha Gautama, later to be known as the Buddha, did not live up to the social ideal of his society – or of ours! If everyone in society followed him into his chosen lifestyle, as a renunciate, no one would work for a living and no one would have children. Society would collapse and the species would go extinct.

What kind of a social example is that?

A special one. An exceptional one. One that could be accepted by society if, and only if, it were embraced by only a tiny minority. And yet, from that tiny minority, society could derive enormous cultural and spiritual benefits. The men and women who chose to follow the Buddha’s example became monks and nuns who created educational and religious institutions that served the larger society. They lived on donations; and in turn, they donated their services. This is not a market exchange, nor even a quid pro quo, but a gift economy. An economist might argue that there is an implicit expectation of payback in such a relationship – an invisible market, if you will. I would argue that this is not the case; for the mindset behind a gift economy makes all the difference. A gift is given, and a gift is received, voluntarily and in the mood of generosity and gratitude. That mood is a crucial part of the entire exercise. Cultivating the mood of gratitude is beneficial for the individuals involved, and for the society in which they live. Any society that embraces a religion in which a renunciate religious minority is supported by the non-renunciate majority will tend to function in this way, just so long as the conduct is completely voluntary.

Lewis Hyde quotes Thomas Merton, the Trappist (Cistercian) Catholic monk and author, that the begging bowl of the Buddha “represents the ultimate theological
root of the belief, not just in a right to beg, but in openness to the gifts of all beings as an expression of the interdependence of all beings. [...] Thus when a monk begs from the layman, it is not as a selfish person getting something from someone else. He is simply opening himself to this interdependence.”

Buddhism as inner science and technique

During the Buddha’s lifetime, around the sixth or fifth century B.C.E. (scholars disagree on these dates), the Indian subcontinent was already the ancient home of many spiritual philosophies and disciplines – including what we now refer to as meditation and yoga, and the multifaceted religion we now call Hinduism. According to the traditional stories that comprise the Buddha’s biography, he had been well educated in his father’s royal (perhaps a chieftain’s) household. During his subsequent spiritual quest, he learned and quickly mastered meditation and yoga techniques. After his Awakening (Bodhi; Enlightenment) he did not write down his teaching, but relied on his hearers to remember it and pass it down as an oral tradition. The written form of the Buddha’s teaching is believed by most scholars to have originated at least two centuries after the Buddha’s demise. So the possibility certainly exists that his teaching was reformulated, at first using mnemonic devices so that it could be more easily memorized, and later changed again to meet some other requirements that were believed by his followers to be appropriate for a written document. Nevertheless, in reading the oldest known texts translated from the Pali language that comprise the Theravada version of the Buddha dharma [teaching], one cannot help but be struck by their logic and elegance. The Buddha was a philosopher of the highest type. Indeed, Schopenhauer believed that Kant, Plato and the Buddha were the greatest philosophers in history up to his own time.

With the Buddha’s very first teaching, he made a realist argument in four parts, which has come to be known as the Four Noble Truths: (1) There is suffering; (2) There is a reason (cause) for suffering; (3) There can be an end of suffering; (4) The teachings of the Buddha (the Noble Eightfold Path) lead to the end of suffering. Each of those four were later expanded upon with detailed arguments. Of interest to us here are the aspects of the Eightfold Path that involve disciplines of mind.

The Buddha taught some 40 different types of meditation, many of them highly specialized for limited application (e.g., meditating in funeral grounds so as to better appreciate the reality of death). The Buddhist meditation techniques, as originally given and as extended over the millennia by Buddhist practitioners in different traditions, are based on a science of the mind designed for transforming the individual practitioner.

These transformational practices can be grouped in different ways. For our purposes, I shall divide them into two broad categories: moral transformation and transformation of awareness. This can be illustrated by considering the implications of the Noble Eightfold Path:

(1) Right view: acceptance of the basic Buddhist teachings, such as the Four Noble Truths.
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(2) Right resolve: having a positive outlook and a mind free from lust, ill will, and cruelty.
(3) Right speech: using speech in positive and productive ways.
(4) Right action: keeping the Precepts (moral rules that vary in number in different schools of Buddhism, but always include at least the following five: [1] not to kill or injure living creatures; [2] not to take what has not been given; [3] to avoid sexual misconduct; [4] not to speak untruthfully; [5] not to take intoxicants).
(5) Right livelihood: avoiding professions that harm others, such as arms manufacturing.
(6) Right effort: directing the mind toward religious goals and wholesome states of mind.
(7) Right mindfulness: being aware at all times of what one is doing, thinking and feeling.
(8) Right meditation: developing the focused attention required in order to enter the various states of meditation.²

The first five of these are clearly behavioral or moral disciplines. Their development benefits society as well as the individual. And they are, to a very large extent, foundational requirements for the development of the latter three disciplines, which relate to awareness, or consciousness. As we shall see shortly, Buddhist transhumanism also cleaves into these two divisions. Before discussing that, however, it is necessary to understand the nature and effects of these different aspects of Buddhist practice.

Buddhism, in common with other religions of India, asserts the doctrines of karma and rebirth. Your actions now will affect your present lifetime and your subsequent afterlife, just as your actions previous to this birth affected your current life circumstances and happenings. Leading a moral life (the first five parts of the Noble Eightfold Path) conduces to a better life now and to a better rebirth. However, the Buddha did not limit his teaching to that goal. A better rebirth is a relative improvement, a species of meliorism, but not the permanent end of suffering. To achieve the latter, one must put an end to rebirth entirely. The final three parts of the Noble Eightfold Path are the way to that end.

This is explained by Bhikkhu Bodhi, a New Jersey–born American who became a Theravadan monk and has dedicated many decades to the task of completing the translation of the entire corpus of Pali language Buddhist texts into English. Bhikkhu Bodhi writes the following (in which I have taken the liberty of including the more familiar Sanskrit terms in brackets for the Pali):

In Buddhist cosmology existence in every realm, being the product of a kamma [karma] with a finite potency, is necessarily impermanent. Beings take rebirth in accordance with their deeds, experience the good or bad results, and then, when the generative kamma has spent its force, they pass away to take rebirth elsewhere, as determined by still another kamma that has found the opportunity to ripen. Hence the torments of hell as well as the bliss of heaven, no matter how long they may last, are bound to pass. For this reason, the Buddha does not locate the final goal of his teaching anywhere in the conditioned world. He guides those who are still tender
to aspire for a heavenly rebirth and teaches them the lines of conduct that conduce to
the fulfillment of their aspirations. But for those whose faculties are mature and who
can grasp the unsatisfactory nature of everything conditioned, he urges determined
effort to put an end to wandering in samsara and to reach Nirvana [Nirvana], which
transcends all planes of being.3

Improvement versus perfect transcendence. A better rebirth versus liberation from
the burden of incarnation altogether.

At this point, I must help guard against the typical horrified reaction of many
Westerners to this vision, which seems to imply annihilation. The Buddha under-
stood this error of interpretation, and declared repeatedly (in the Pali Canon
suttas, such as the Alagaddupama Sutta and the Yamaka Sutta) that he did not
teach annihilation. He generally preferred to speak of the goal, the state of
Nirvana, in terms of what it was not: not mortal, not suffering, etc. The implication
of the Buddha’s teaching, therefore, is that once all negatives are removed, the
intrinsic positive would reveal itself. While this is logically consistent, many
people – especially Westerners – feel an emotional revulsion at the thought. Our
present society, and the three Abrahamic faiths originating in the Middle East,
teach us that our reward for a life well lived is pleasures, now or in Heaven. We
are taught by analogy that this wonderful afterlife is like a banquet, or a garden,
or some other earthly delights. Or, if those pale, then beholding the face of
God is upheld as the highest reward. Formless bliss does not feature in our
imaginings.

Transhumanism

The task of defining transhumanism is a bit more difficult than for defining Bud-
dhism. The acknowledged source of Buddhism is the historical Buddha, Sidd-
hartha Gautama. The source of the set of ideas generally known as
transhumanism is a somewhat contested question. According to the Oxford
English Dictionary (3rd edition), the term first appeared in print in 1957, when biol-
ogist Julian Huxley used it: "The human species can ... transcend itself ... in its
entirety, as humanity. We need a name for this belief. Perhaps transhumanism
will serve: man remaining man, but transcending himself, by realizing new possi-
bilities of and for his human nature."4 The term was used again in this sense in the
1990s, when Max More used it in Extropy magazine, the periodical of the Extropy
Institute, and on its Exf email listserv. In the same decade it was also used by Nick
Bostrom and David Pearce in their online writings that led to the creation of the
World Transhumanist Association. According to Bostrom, transhumanism
assumes that “we are about to transcend our biological limitations by means of
technology”; however, “Transhumanism is not a philosophy with a fixed set of
dogmas,” but rather “what distinguishes transhumanists, in addition to their
broadly technophilic values, is the sort of problems they explore.”5

Buddhism and transhumanism have many shared goals. Both seek to improve
the communal and individual circumstances of human life, to remove the causes
of suffering, and to raise humanity to a higher state of being. The chosen means by which these goals might be attained were given anciently by the historical Buddha approximately 2500 years ago, but only recently by our contemporary transhumanists. The ancient Buddhist means were entirely human and non-technological. The means now being used, or proposed, by transhumanists are mainly technological, or at least based on information derived from recent scientific research. Although Buddhist tradition does not draw on science (as defined in Western culture), or include technology in its practices, there is nothing in the teachings of the Buddha that forbids the inclusion of science and technology in Buddhist practice. Some Buddhist practitioners would argue that the Buddhist notion of “skillful means” (upāya) ought to include science and technology where and when these are deemed appropriate, based on practical testing and fruitful results. By the same reasoning, some transhumanists would argue that we have much to learn about human potential for living a happier, more balanced, more fulfilled life based on the techniques discovered and practiced to good effect by Buddhists over the millennia.

Transhumanists and Buddhists generally propose using different functional means for achieving their goals of diminishing human suffering, or on the positive side, achieving human happiness. Transhumanists want to transform material conditions of human life and intervene directly into biological mechanisms, using science and technology. Buddhists want to change how human beings relate to their material conditions and to one another, using moral disciplines and transformative meditational and wisdom-inquiry practices. To put these differing views into perspective, consider the ancient Buddhist teaching aphorism (origin unknown) that says “To walk more comfortably, it is better to cover one’s feet than to try to cover the whole earth.” By contrast, many transhumanists would prefer to cover the earth in comfortable materials. And Buddhist transhumanists would use a combination of both, providing shoes for everyone while at the same time making large swaths of the earth into benign and comfortable regions where people could safely go barefoot.

One further distinction needs to be made with respect to each of these three communities: Buddhist, transhumanist, and Buddhist transhumanist. Each community has within it at least two subgroups. These groups could be defined quantitatively as “majority” and “minority.” Most often in this discussion, I will label them as “outer” (exoteric) and “inner” (esoteric, or hidden). The outer group is always the larger and more easily identified of the two, since it takes a more straightforward approach to the goals of the community as a whole. The inner group is always smaller and more difficult to identify, because its goals overlap with those of the exoteric group, yet differ in some particulars and include some goals and functions that the larger, exoteric group often ignores or disdains.

This distinction between outer and inner may even be found in the etymological roots of the terms “transhuman” and “transhumanism,” as I will show in the following section. Still earlier than the first recorded appearance of these terms in print, they were used in spiritual circles by an obscure American philosopher and spiritual practitioner who deserves to be better known.
Finding spirituality in transhumanism

Franklin Merrell-Wolff (1887–1985) independently invented the term “transhumanism” in the 1930s. Born with the given name Franklin Wolff, he was a native Californian who attended Stanford University in the early years of the twentieth century. Wolff majored in mathematics and minored in philosophy and psychology. Eventually, he won a scholarship to Harvard University for one year of study. After his year was up, Wolff returned to Stanford where he taught mathematics. He was drafted during World War I and served in a non-combat role as a conscientious objector. After the war, Wolff had some substantial involvement with Sufi and yoga groups during the 1920s. In 1928, Wolff co-founded his own organization, The Assembly of Man, with his wife, Sherifa Merrell. Up until that time, he had used his birth name of Franklin Wolff. But in order to show that he and his wife had co-equal roles in The Assembly of Man, they combined their surnames: Sherifa Merrell-Wolff and Franklin Merrell-Wolff.

In 1929, The Assembly of Man built a rural ashram on the eastern slope of the Sierra Nevada Mountains, near Mount Whitney. By this time, Franklin Merrell-Wolff had been on a serious spiritual quest for 20 years. Then, on August 7, 1936, as he later wrote in his journal, “the ineffable transition came.” Beginning on that day, and continuing over the month that followed, Merrell-Wolff underwent an ever-deepening spiritual transformation known in the Eastern traditions as Bodhi (Awakening; Enlightenment). His realization of Nirvana, or transcendental consciousness, changed his point of view and his life.

Merrell-Wolff used the term “transhumanism” in the late 1930s in discussions, and in print beginning with the first edition of his second book, which was composed in 1939 and privately circulated, but not published until 34 years later. Therefore, in this discussion of Buddhist transhumanism, I will claim that this man, about whom very few transhumanists, or Buddhists (or Buddhist transhumanists) have heard, is nevertheless the true intellectual and spiritual progenitor of a particular strain of Buddhist transhumanism that will be described in this paper. Merrell-Wolff wrote:

I am well aware that several philosophies affirm or imply that all consciousness is of necessity time conditioned. But since this is undeniable, it has only the value of arbitrary assertion, which is countered by simple denial. This affirmation or implication is incompatible with the basis realized or assumed here – whichever way it may be taken. At this point I simply deny the validity of the affirmation and assert that there is a Root Consciousness that is not time conditioned. It may be valid enough to assert that human consciousness qua human is always time conditioned, but that would amount merely to a partial definition of what is meant by human consciousness. In that case, the consciousness that is not time conditioned would be something that is transhuman or nonhuman. [Emphasis added.] I am entirely willing to accept this view, but would add that it is in the power of man to transcend the limits of human consciousness and thus come to a more or less complete understanding of the factors that limit the range of human consciousness qua human. The term “human” would thus define a certain range in the scale of consciousness – something like an octave in the scale of electromagnetic waves. In that case, the present system implies that it is, in principle, possible for a conscious being to
shift his field of consciousness up and down the scale. When such an entity is focused
within the human octave it might be agreed to call him human, but something other
than human when focused on other octaves. Logically, this is simply a matter of defi-
nition of terms, and I am more than willing to regard the human as merely a stage in
consciousness, provided it is not asserted dogmatically that it is impossible for con-
sciousness and self-identity to flow from stage to stage. On the basis of such a defi-
nition this philosophy would not be a contribution to Humanism but to
Transhumanism.8

This definition of transhumanism, while only partly overlapping with Bostrom’s
definition given above, is consonant with Buddhist transhumanism as I define it here.

Buddhist transhumanists

Identifying people as transhumanists depends on whether we admit only those
who self-identify as such, or whether we include those whose beliefs coincide
with those of transhumanist organizations even if the individuals themselves
eschew the transhumanist label. The world (or at least the Internet) is full of
many smaller groups (or even individuals who formed groups with a membership
of one) who proclaim themselves to be transhumanists. There are also quite a few
notable figures who agree with every one of the tenets of transhumanism, but
dislike the name and refuse to self-identify as transhumanists. Most notable
among the latter is Raymond Kurzweil, inventor, author, entrepreneur and futur-
ist, who was hired by Google in 2012 to head its research in natural language pro-
cessing. Kurzweil’s book The Singularity Is Near (2005) is, like the man himself,
transhumanist in orientation but not in name.9

Similarly, there are people who are functioning as Buddhist transhumanists who
do not self-identify as such. In the discussion below, I shall categorize such people
as Buddhist transhumanists because “By their works, ye shall know them”
(Matthew 7:16). The individuals described below include both those who are
openly Buddhist transhumanists, and those whose orientation to the issues
makes them effectively function as Buddhist transhumanists.

David Pearce is a philosopher who co-founded Humanity+ (originally named
the World Transhumanist Association) with philosopher Nick Bostrom in the
1990s. While Bostrom went on to an academic career, Pearce chose to work inde-
pendent of academic affiliation. Pearce aims for the long-term elimination of suf-
ferring among humans and animals using advanced technologies to change both
organisms and the environments in which they live. He organized an infor-
mation-sharing and advocacy group named the Hedonic Imperative that seeks
life extension, experiential enrichment, and the replacement of suffering with “gra-
dients of bliss.” Pearce refers to his goal as “paradise engineering” and the project
itself as The Hedonistic Imperative.10

James Hughes is a bioethicist with a doctorate in sociology from the University of
Chicago and a long-standing involvement with both formal Buddhism and insti-
tutional transhumanism.11 Hughes has given many talks at conferences and
appeared in interviews on television, but the most comprehensive explanation of his views to date is in his first book. While still a university student doing research in Sri Lanka, he ordained temporarily as a Buddhist monk (a common practice for many young men in South Asian Buddhist countries). In the early years of the twenty-first century, Hughes was elected to the Board of Directors of the World Transhumanist Association. Hughes later co-founded the Institute for Ethics and Emerging Technologies (IEET), an organization that researches and advocates for policies and programs that are transhumanist in all but name. At IEET, Hughes and interested others have created an umbrella group named the Cyborg Buddha Project. A cyborg is a biological organism that incorporates technological components. As such, it is hybrid between the natural and the artificial. In some sense, Buddhist transhumanism may be viewed as the same sort of animal/machine hybrid.

Mark Walker is an academic philosopher who has addressed more near-term, pragmatic issues of happiness and human flourishing. He has been working within the area of current psychological research known as “subjective well-being,” — or, more commonly, “happiness studies.” Walker has written about interventions that could substantially increase human happiness through currently available means. Such interventions include social, economic and other institutional modifications, as well as pharmaceutical treatments that would lead to immediate improvements in an individual’s mood and functional capacity. Walker is a member of the Cyborg Buddha Project.

George Dvorsky is a Canadian futurist, science writer, ethicist and secular Buddhist who is also a member of the Cyborg Buddha Project. He has focused on animal rights as a near-term means of reducing their suffering, and in the long term on their “uplift.” The term “uplift” was championed by scientist and science fiction author David Brin to indicate elevating the intelligence of certain species, such as dolphins and chimpanzees, into human-level sapience. Dvorsky also advocates for long-term human uplift into transhuman states of being, on earth and among the stars.

I categorize the aforementioned individuals as functioning Buddhist transhumanists, but in some cases they would probably say of themselves that they are more transhumanist than Buddhist. Among those individuals I will discuss next, the opposite would be true: many are explicitly Buddhist but only implicitly transhumanist.

Vincent Horn calls himself a mind hacker and is the co-founder of Buddhist Geeks, a website, podcast, and conference series. Horn was on Wired magazine’s “Smart List 2012: 50 People Who Will Change the World.” Horn has conducted many podcast interviews with prominent teachers of Buddhism and other spiritual disciplines with a focus on meditation. Along with his wife and Buddhist Geeks partner, Emily Horn, he has organized and run annual Buddhist Geeks Conferences for several years, beginning in 2011. They also conduct meditation retreats around the United States. Buddhist Geeks includes people of all ages, but this group or movement is especially attractive to young people who have grown into adulthood with the Internet and high technology, and have come to Buddhism (or at least meditation practice) with a technological mindset. They seek ways to
accelerate and improve their meditation practice and attainments via the application of modern technology. Many of them are entrepreneurs who would be delighted to create a “killer app” for meditation and get rich in the process of doing good.

Kenneth Folk and Daniel Ingram, MD are long-time meditators and friends who have realized significant Buddhist Awakening. Folk is a full-time meditation teacher of high attainment who works with students one-on-one in person and over the Internet. His skill at leading people from beginning meditation practice through the Theravada Vipassana stages of the Progress of Insight is legendary in the Buddhist community. Meanwhile, his friend Dr. Ingram, is a full-time physician who became an adept of meditation through years of practice, including extended meditation retreats in Asia. Ingram wrote a book that introduced a large audience to a practical, no-nonsense approach to meditation and the Progress of Insight. This is a handbook, or instruction manual, with a high degree of technical specificity.

Hokai Sobol is a Croatian Buddhist practitioner, teacher, and translator who aims to assist in “the emergence and propagation of a non-sectarian, real world, ‘post-east/west’ Dharma.” His approach is pragmatic and cosmopolitan, or universal. Sobol works internationally, having studied with Japanese Shingon (Vajrayana) masters for many years.

Gary Weber is an independent teacher with decades of experience and practice in yoga and Zen. His personal spiritual practice and transformation are in some respects reminiscent of what Franklin Merrell-Wolff described. Weber began a spiritual quest while still in college, and maintained it as a sort of parallel life while pursuing an otherwise conventional life as an officer in the US Navy, a graduate school researcher who attained a PhD in materials science, and a scientific administrator overseeing several laboratories. Despite the intense demands of his daily work life, and the personal relational demands of being a husband and father, Weber managed to find the time to study yoga and Zen meditation with some of the most prominent teachers of the day. He even earned certifications as a yoga teacher himself. And every day, Weber took time morning and night to practice both yoga and meditation. Then, one day, just as in the case of Merrell-Wolff, a transformation occurred in which the background of constant, non-necessary thought simply fell away, leaving a great space of silence and a tacit understanding of the nature of experience and self. In the years since this event, Weber has been a subject in several meditation studies at different universities, where fMRI (functional magnetic resonance imaging) was used to measure changes in brain activity. Weber’s brain functions in some remarkably different ways from that of other people, including other advanced meditators.

Conclusion

Buddhist transhumanism is the confluence of two streams, one ancient and one modern. The ancient stream of teachings now known as Buddhism has flowed for ages from a timeless source located high in the mountains of Asian spirituality. The modern stream descends from a peak in Western culture that represents the
improvement of human life by reason and material means. Buddhist transhumanism results from the meeting of these two streams and the formation of a common river flowing to the single sea, the *sumnum bonum*. Today we stand far up river, closer to the point of confluence than to the sea. What lies between us and the sea is as yet unknown. There could be rapids and waterfalls along the way. The journey of Buddhist transhumanism has barely begun.

**Endnotes**


**Biographical Notes**

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