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工程硕士英语

Graduate English for Engineering Students

上海交通大学出版社

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内 容 提 要

本书是参照研究生英语教学大纲编写的工程硕士英语教程，全书共14个单元，供两个学期的教学使用。本书以阅读为主线，配合课文设计了各类学习活动，以利于学生培养英语运用能力。

本书适合各专业工程硕士学生作为公共英语课程教材，也可供工程技术人士作为自学英语所用。

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前　　言

工程硕士研究生英语教学是我国研究生英语教学的一个重要组成部分。但多年来工程硕士研究生没有适合他们专业的英语教材，而是与其他专业的学生共用其他类英语教材，如文科英语教材，或商科英语教材。本书旨在为工程硕士英语研究生提供在内容和语言上都与工程专业相近的全新英语教材。

本书由14个单元组成，内容涉及电脑、公路、桥梁、基因工程、宇宙起源、激光、虚拟医院、黑客追踪等各类题材。文章内容新颖，语言生动，知识性和趣味性有机结合。每个单元都配有大量的练习，以供帮助学生消化和巩固课文中的语言点；练习中还提供了口语、阅读、翻译和作文等练习，以帮助学生进一步提高语言运用能力。

本书由沈炎副教授主编，夏莲莲副教授、李加宣副教授、李晓红讲师、陈多佳副教授、沈燕讲师、王为明副教授和叶晓辉副教授等编写，美籍专家Barbara Corbett审校。

本书编写时间仓促，疏漏与不妥之处在所难免，敬请读者批评指正。

编　者

2003年12月于上海

目　录

Unit 1

Activity 1 Predicting Content

Directions: *Work in small groups and discuss the following questions:*

1. Have you ever thought of the relationship between art and science?
2. Does any of your personal experience or knowledge or understanding of this world tell you or make you feel there exists a sort of connection between art and science? Please explain your answer.
3. What do you think of the following point made by the great French mathematician Jules Henri Poincare: a scientist studies nature not because it is useful; rather he studies it because it is a source of pleasure for him, because nature is beautiful. If nature were not beautiful, it would not be worthy of the effort that goes into knowing it, and life would be not worthy of the effort it takes to live it.

Activity 2 Listening for Ideas

Directions: *You are going to listen to a talk on gene technology. When you listen, please complete the following tasks:*

A. True or False Questions. Write T in front of a statement if it is true according to what you hear on the tape and write F if it is false.

1. ________ Unlike artists, scientists have defined beauty in science in terms of symmetries.
2. ________ The aesthetics in sciences is a well—studied subject.
3. ________ Like Einstein many scientists firmly believed that there is a strong relationship between art and science.
4. ________ According to the speaker, Tagore cannot be labelled as a scientist because he did not have a scientific mind.
5. ________ The speaker thinks that the aesthetically attractive theories are definitely correct.

B. Give brief answers to the following questions.

1. What does the basic science seek to do according to professor Chandrasekhar?

   ____

2. What are the three topics that professor Chandrasekhar deals with in his well-known book Truth and Beauty?

   ____

3. What are the major characteristics of the body of knowledge called science?

   ____

4. What is fundamental to the scientific method and to science?

____

5. What are the four steps taken in the application of scientific method?

____

Activity 3 Previewing

1. Do scientists understand beauty in science in the same way as artists appreciate beauty in art?
2. It is said one needs passion to be an artist, and rationality to be a scientist. Is it a valid statement?

The Scientific Aesthetic

K. C. Cole

1 Poets say science takes away from the beauty of the stars—mere globs of gas atoms. Nothing is 'mere'. I too can see the stars on a desert night, and feel them. But do I see less or more? The vastness of the heavens stretches my imagination—stuck on this carrousel, my little eye can catch one-million-year-old light... For far more marvelous is the truth than any artists of the past imagined Why do the poets of the present not speak of it? What men are poets who can speak of Jupiter if he were like a man, but if he is an immense spinning sphere of methane and ammonia must they be silent?

2 This poetic paragraph appears as a footnote in, of all places, a physics textbook: The Feynman Lectures on Physics by Nobel laureate Richard Feynman. Like so many others of his kind, Feynman scorns the suggestion that science strips nature of her beauty, leaving only a naked set of equations. Knowledge of nature, he thinks, deepens the awe, enhances the appreciation. But Feynman has also been known to remark that the only quality art and theoretical physics have in common is the joyful anticipation that artists and physicists alike feel when they contemplate a blank piece of paper.

3 What is the kinship between these seemingly dissimilar species, science and art? Obviously there is some—if only because so often the same people are attracted to both. The image of Einstein playing his violin is only too familiar, or Leonardo with his inventions. It is a standing joke in some circles that all it takes to make a string quartet is four mathematicians sitting in the same room. Even Feynman plays the bongo drums. (He finds it curious that while he is almost always identified as the physicist who plays the bongo drums, the few times that he has been asked to play the drums "the introducer never seems to find it necessary to mention that I also do theoretical physics.")

4 One commonality is that art and science often cover the same territory. A tree is fertile ground for both the poet and the botanist. The relationship between mother and child, the symmetry of snowflakes, the effects of light and color, and the structure of the human form are studied equally by painters and psychologists, sculptors and physicians. The origins of the universe, the nature of life, and the meaning of death are the subjects of physicists, philosophers, and composers.

5 Yet when it comes to approach, the affinity breaks down completely. Artists approach nature with feeling; scientists rely on logic. Art elicits emotion; science makes sense. Artists are supposed to care; scientists are supposed to think.

6 At least one physicist I know rejects this distinction out of hand: "What a strange misconception has been taught to people," he says. "They have been taught that one cannot be disciplined enough to discover the truth unless one is indifferent to it. Actually, there is no point in looking for the truth unless what it is makes a difference."

7 The history of science bears him out. Darwin, while sorting out the clues he had gathered in the Galapagos Islands that eventually led to his theory of evolution, was hardly detached. "I am like a gambler and love a wild experiment," he wrote. "I am horribly afraid." "I trust to a sort of instinct and God knows can seldom give any reason for my remarks." "All nature is perverse and will not do as I wish it. I wish I had my old barnacles to work at, and nothing new."

8 The scientists who took various sides in the early days of the quantum debate were scarcely less passionate. Einstein said that if classical notions of cause and effect had to be renounced, he would rather be a cobbler or even work in a gambling casino than be a physicist. Niels Bohr called Einstein's attitude appalling, and accused him of high treason. Another major physicist, Erwin Schroedinger, said, "If one has to stick to this damned quantum jumping, then I regret having ever been involved in this thing." On a more positive note, Einstein spoke about the universe as a "great, eternal riddle" that "beckoned like a liberation." As the late Harvard professor George Sarton wrote in the preface to his History of Science, "There are blood and tears in geometry as well as in art."

9 Instinctively, however, most people do not like the idea that scientists can be passionate about their work, any more than they like the idea that poets can be calculating. But it would be a sloppy artist indeed who worked without tight creative control, and no scientist ever got very far by sticking exclusively to the scientific method. Deduction only takes you to the next step in a straight line of thought, which in science is often a dead end. "Each time we get into this log jam," says Feynman, "it is because the methods we are using are just like the ones we have used before... A new idea is extremely difficult to think of. It takes fantastic imagination."

10 The direction of the next great leap is as often as not guided by the scientist's vision of beauty. Einsteins highest praise for a theory was not that it was good but that it was beautiful. His strongest criticism was "Oh, how ugly!" He often spoke about the aesthetic appeal of ideas. "Pure logic could never lead us to anything but tautologies," wrote the French physicist Henri Poincare. "It could create nothing new; not from it alone can any science issue."

11 Poincare also described the role that aesthetics plays in science as "a delicate sieve," an arbiter between the telling and the misleading, the signals and the distractions. Science is not a book of lists. The facts need to be woven into theories like tapestries out of so many tenuous threads. Who knows when (and how) the right connections have been made? Sometimes, the most useful standard is aesthetic: Erwin Schroedinger refrained from publishing the first version of his now famous wave equations because they did not fit the

then-known facts. "I think there is a moral to this story," Paul Dirac commented later, "namely, that it is more important to have beauty in one's equations than to have them fit experiment... It seems that if one is working from the point of view of getting beauty in one's equations, and if one has really a sound insight, one is on a sure line of progress."

12 Sometimes the connection between art and science can be even more direct. Danish physicist Niels Bohr was known for his fascination with cubism—especially "that an object could be several things, could change, could be seen as a face, a limb, and a fruit bowl." He went on to develop his philosophy of complementarity, which showed how an electron could change, could be seen either as a particle or a wave. Like cubism, complementarity allowed contradictory views to coexist in the same natural frame.

13 Some people wonder how art and science ever got so far separated in the first place. The definitions of both disciplines have narrowed considerably since the days when science was natural philosophy, and art included the work of artisans of the kind who build today's fantastic particle accelerators. Science acquired its present limited meaning barely before the nineteenth century, writes Sir Geoffrey Vickers in Judith Wechsler's collection of essays *On Aesthetics in Science*. "It came to apply to a method of testing hypotheses about the natural world by observations or experiments..." Surely, this has little to do with art. But Vickers suspects the difference is deeper. People want to believe that science is a rational process, that it is describable. Intuition is not describable, and should therefore be relegated to a place outside the realm of science. "Because our culture has somehow generated the unsupported and improbable belief that everything real must be fully describable, it is unwilling to acknowledge the existence of intuition."

14 There are, of course, substantial differences between art and science. Science is written in the universal language of mathematics; it is, far more than art, a shared perception of the world. Scientific insights can be tested by the good old scientific method. And scientists have to try to be dispassionate about the conduct of their work—at least enough so that their passions do not disrupt the outcome of experiments. Of course, sometimes they do: "Great thinkers are never passive before the facts," says Stephen Jay Gould. "They have hopes and hunches, and they try hard to construct the world in their light. Hence, great thinkers also make great errors."

15 But in the end, the connections between art and science may be closer than we think, and they may be rooted most of all in a person's motivations to do art, or science, in the first place. MIT metallurgist Cyril Stanley Smith became interested in the history of his field and was surprised to find that the earliest knowledge about metals and their properties was provided by objects in art museums. "Slowly, I came to see that this was not a coincidence but a consequence of the very nature of discovery, for discovery derives from aesthetically motivated curiosity and is rarely a result of practical purposefulness."

New Words

glob /glɔb/	*n.*	a small drop 一滴;large and rounded mass 一团
stretch /stretʃ/	*v.*	to extend or expand
carrousel /ˌkærəˈsel/	*n.*	a revolving slide projector 旋转式幻灯放映机

spin /spin/	*v.*	to revolve rapidly 旋转
methane /'mi:θein/	*n.*	甲烷,沼气
ammonia /ə'məunjə/	*n.*	a pungent colorless gaseous alkaline compound of nitrogen and hydrogen NH_3 that is very soluble in water 氨(水)
laureate /'lɔ:riit/	*n.*	the recipient of honor or recognition for achievement in art or science 获奖者
awe /ɔ:/	*n.*	reverential fear or wonder 畏怯,惊奇,惊叹
contemplate /'kɔntempleit/	*v.*	survey with the eyes or in the mind 注视,沉思
kinship /kinʃip/	*n.*	relationship 亲密关系
standing /'stændiŋ/	*a.*	continuing in existence 长期存在的,长期有效的
fertile /'ə:tail/	*a.*	producing or bearing fruit in great quantities, productive 肥沃的,富饶的
approach /ə'prəutʃ/	*n.*	a way of dealing with a person or thing
affinity /ə'finiti/	*n.*	relationship or kinship 密切关系,亲和
elicit /i'lisit/	*v.*	draw forth or bring out (something latent or potential) 引出,诱发
disciplined /'disiplind/	*a.*	showing a controlled form of behaviour or way of working
detached /di'tætʃt/	*a.*	an objective attitude achieved through absence of prejudice or self interest 公正的,超然的
perverse /pə'və:s/	*a.*	(of circumstances) contrary (to one's wishes) (指环境)与意愿相违的
barnacles /'bɑ:nəkl/	*n.*	黑雁,北极雁
renounce /ri'nəuns/	*v.*	give up, refuse or resign usually by formal declaration 声明放弃,抛弃
cobbler /'kɔblə/	*n.*	补鞋匠,制鞋匠
appalling /ə'pɔ:liŋ/	*a.*	inspiring horror, dismay or disgust 骇人的,可怕的
treason /'tri:zn/	*n.*	the betrayal of trust 背叛,背信
riddle /ridl/	*n.*	puzzling person, thing or situation, etc. 难以理解的人、事物、情况等
beckon /'bekən/	*v.*	appear inviting 吸引,引诱; summon or signal typically with a wave or nod 召唤,示意
calculating /'kælkjuleitiŋ/	*a.*	marked by prudent analysis or by shrewd consideration of self-interest 经过仔细分析的,审慎的
sloppy /'slɔpi/	*a.*	unsystematic, not done with care and thoroughness 草率的,马虎的
logjam /lɔgjæm/	*n.*	dead lock 僵局,停滞状态
tautology /tɔ:'tɔlədʒi/	*n.*	needless repetition 重复,赘言
issue /'isju:/	*v.*	emerge; come forth; appear 出现
sieve /siv/	*n.*	utensil with wire network for separating finer

		grains, etc from coarse grains, etc or solids from liquids 筛,漏勺,滤器
arbiter /'ɑːbitə/	n.	person with complete control 主宰者,裁决者
tapestry /'tæpistri/	n.	a heavy handwoven reversible textile characterized by complicated pictorial designs 织锦,挂毯
tenuous /'tenjuəs/	a.	not thick, thin, weak 稀,细,薄
moral /'mɔrəl/	n.	practical lesson drawn from a story 寓意,教训
cubism /'kjuːbizm/	n.	modern style of art in which objects are represented as if they are made up of geometrical shapes 立体派
coexist /'kəuig'zist/	v.	exist together or at the same time 共存,同时存在
artisan /ˌɑːti'zæn/	n.	craftsman 工匠,手艺人
acquire /ə'kwaiə/	v.	obtain; come into possession of
relegate /'religeit/	v.	assign to a place of insignificance or of oblivion, put out of sight or mind 把…置于次要的地位
hunch /hʌntʃ/	n.	a strong intuitive feeling concerning especially a future event or result 预感

Phrases and Expressions

take away from	lessen, weaken, diminish
strip... of...	deprive of
out of hand	at once, without hesitation
bear out	confirm
sort out	arrange in groups; separate things of one sort from things of other sorts
trust to	have reliance on
accuse... of...	say that (someone) has done wrong, broken the law, and is to be blamed
refrain from	hold oneself back
in the first place	firstly
in one's light	from one's perspective /knowledge/ understanding
derive from	get; take/have as a starting point, source, origin

Notes on the Text

1. string quartet: a quartet of performers on stringed instruments usually including a first and second violin, a viola and a cello 弦乐四重奏乐队
2. Richard Feynman: (1918～1988), American physicist, Nobel Prize laureate in 1965
3. Einstein: Albert Einstein (1879 ～ 1955), American (German-born) physicist, Nobel Prize laureate in 1921
4. Darwin: Charles Darwin (1809～1882), English naturalist, founder of the evolution theory, *Origins of Species*
5. Niels Bohr: (1885～1962), Danish physicist, Nobel Prize laureate in 1922

6. Erwin Schroedinger: (1887～1961), Australian physicist, Nobel Prize laureate in 1933
7. Leonardo da Vinci: (1452～1519), Italian painter, sculptor, architect and engineer
8. Henri Poincare: (1854～1912), French mathematician, physicist
9. Paul Dirac: (1902～1984), English physicist
10. cubism: style of art that stresses abstract structure at the expense of other pictorial elements, especially by displaying several aspects of the same object simultaneously

Comprehension

Answer the following questions according to the text.

1. What attitude does Feyuman assume towards poets' idea about science in relation to art?
2. What does Feynman have to say about the relationship between art and theoretical physics in the second paragraph?
3. Why does the author mention Einstein, Leonardo, some other famous mathematicians as well as Feynman?
4. What is the idea that the author wants to convey in paragraph 4?
5. What is the main idea in paragraph 5?
6. What does the author try to prove in paragraphs 6～8?
7. What are the words you can find in paragraphs 6～8 which indicate that scientists are hardly detached?
8. What are the classical images of artists and scientists in common people's mind? What does the author think of the images?
9. How did the French physicist Henri Poincare describe the role of beauty in science?
10. What can we learn from Erwin Shroedinger's story?
11. How did Cubism help Niels Bohr develop his ideas in physics?
12. When and why did art and science become so different as they appear to be today?
13. According to the author, what are some of the differences between art and science, despite of their close relationship?
14. According to the author, what is the driving force behind many discoveries in history?

Language Study

A. Match the words in Column A with their definitions in Column B.

Column A	Column B
1. stretch	a. bring about
2. tenuous	b. thin
3. laureate	c. extend
4. contemplate	d. look at
5. standing	e. showing a controlled form of behaviour or way of working
6. approach	f. manner or attitude

7. elicit
8. disciplined
9. logjam
10. hunch

g. prediction based on instinct
h. the person who is awarded a prize
i. permanent
j. dead end

B. Choose a word above to fill in each of the blanks in the following sentences. Change the word form where necessary.

1. Anyone can win if they ________ the rules like that. (paragraph 1)
2. She had nothing but ________ for those girls who worshipped football heroes. (paragraph 2)
3. Striking a balance between economic development and environmental protection is a ________ concern of the local governments in the underdeveloped areas. (paragraph 3)
4. His sober ________ to the crisis averted a catastrophe. (paragraph 5)
5. We have made persistent inquiries but we have been unable to ________ further information from any of the witnesses. (paragraph 5)
6. He listened quietly to the arguments with an air of aloof ________. (paragraph 7)
7. The country's obsession with the Western way of life has ________ its development. (paragraph 7)
8. The two officials working in the Department of Defense were charged with committing ________ against the state, for which the maximum penalty is death. (paragraph 8)
9. Employers are among those who are complaining about the ________ teaching of English in our schools. (paragraph 9)
10. I have never managed to make house keeping ________ to my daughter. (paragraph 10)
11. ________ necessitates the total noninterference by any power in the affairs of another. (paragraph 12)
12. The local football team was finally ________ to division B from division A after a battery of failures in the fierce competition. (paragraph 13)
13. It was no ________ that he organized the competition and his son won the first prize. (paragraph 15)

C. Choose the words or phrases that can best complete the following sentences. Change the word form where necessary.

take away from	strip... of...	make sense
out of hand	bear out	sort out
trust to something	accuse... of...	refrain from
in the first place	in one's light	derive from

1. The inexperienced detective failed to ________ the various clues the police had collected from the place where the murder took place.

2. The enemy's slanders do not in the least ________ our international prestige.
3. ________ all his titles, he suddenly realized that he was just as common as any other individuals around him.
4. She doesn't talk much, but what she says ________.
5. Most of the available evidence ________ the viewpoint that students learn better in small classes than in large ones.
6. The report from a local daily newspaper ________ the administration officials ________ hiding the facts and misleading the public.
7. Although there was a lot more to say, Jimmy ________ making further comments.
8. The laws that restrict working hours ________ the 19th century attempts to protect women and child workers.
9. It would not do to ________ memory for the preservation of the information.
10. These quotations, though independent of the context, are perfectly intelligible ________.

D. In the following passage, there are all together 10 mistakes, one in each boldfaced sentence. To correct them, you must add, cross out, or change a word. Mark out the mistakes and write the corrections in the blanks provided.

We can distinguish three different realms of matter, three levels on the quantum ladder. **The first is the atomic realm, which includes the world of atoms, their interactions, and the structures that formed by them , such as molecules, liquids and solids, and gases and plasmas.** (1. ________________) This realm includes all the phenomena of atomic physics, chemistry, and in a certain sense, biology. **The energy exchanges take place in this realm are of a relatively low order.** (2. ________________) If these exchanges are below one electron volt, such as in the collisions between molecules of the air in a room, then atoms and molecules can be regarded as elementary particles. **That is, they have "conditional elementarity" because they lose their identity and do not change in any collisions or in other processes at these low energy exchanges.** (3. ________________) If one goes to higher energy exchanges, say 10^4 electron volts, then atoms and molecules will decompose into nuclei and electrons ; at this level, the latter particles must be considered as elementary. **We find no examples of structures and processes of this first rung of the quantum ladder on Earth, on planets, and on the surfaces of stars.** (4. ________________)

The next rung is the nuclear realm. Here the energy exchanges are much higher, on the order of millions of electron volts. **As long as we are dealing with phenomena in the atomic realm, such amounts of energy are available and most nuclei are inert: they do not change.** (5. ________________) However, if one applies energies of millions of electron volts, nuclear reactions, fission and fusion, and the processes of radioactivity occur; our elementary particles then are protons, neutrons, and electrons. **In addition, nuclear process produce neutrinos, particles that have no detectable mass or charge.** (6. ________________) In the universe, energies at this level are available in the centers of stars and in star explosions. **Indeed, the energy radiate by the stars is produced by nuclear reactions.** (7. ________________) The natural radioactivity we find on Earth is the long-lived remnant of the time when now-earthly matter was expelled into space by a major stellar explosion.

The third rung of the quantum ladder is the sub—nuclear field. (8. ________________) Here we are dealing with energy exchanges of many billions of electron volts. **We encounter exciting nucleons, new types of particles such as mesons, heavy electron, quarks, and gluons, and also antimatter in large quantities.** (9. ________________) The gluons are the quanta, or smallest units, of the force (the strong force) that keeps the quarks together. **As long as we are dealing with the atomic or nuclear realm, these old types of particles do not occur and the nucleons remain inert.** (10. ________________) But at sub-nuclear energy levels, the nucleons and mesons appear to be composed of quarks, so that the quarks and gluons figure as elementary particles.

E. Choose one appropriate word from the following list to fill in each of the blanks in the passage below. Remember there are some extra items. Change the word form where necessary.

as	arise	aesthetic	coherent	deny
evil	end	extend	exploit	establish
different	free	goal	high	however
historical	among	misleading	rather	produce
original	masterpiece	while	no	reveal

Extraordinary creative activity has been characterized as revolutionary, flying in the face of what is established and producing not what is acceptable but what will become accepted. According to this formulation, __ 1 __ creative activity transcends the limits of an existing form and establishes a new principle of organization. __ 2 __, the idea that extraordinary creativity transcends established limit is __ 3 __ when it is applied to the arts, even though it may be valid for the sciences. Differences between highly creative art and highly creative science __ 4 __ in part from a difference in their goals. For the sciences, a new theory is the __ 5 __ and end result of the creative act. Innovative science produces new propositions in terms of which diverse phenomena can be related to one another in more __ 6 __ ways. Such phenomena as a brilliant diamond or a nesting bird are relegated to the role of data, serving __ 7 __ the means for formulating or testing a new theory. The goal of highly creative art is very __ 8 __ , the phenomenon itself becomes the direct product of the creative act. Shakespeare's Hamlet is not a tract about the behavior of indecisive princes or the uses of political power; nor is Picasso's painting Guernica primarily a prepositional statement about the Spanish Civil War or the __ 9 __ of fascism. What highly creative artistic activity __ 10 __ is not a new generalization that transcends established limits, but rather an aesthetic particular. Aesthetic particulars produced by the highly creative artist extend or exploit, in an innovative way, the limits of an existing form, __ 11 __ than transcend that form.

This is not to __ 12 __ that a highly creative artist sometimes establishes a new principle of organization in the history of an artistic field; the composer Monteverdi, who created music of the highest __ 13 __ value, comes to mind. More generally, however, whether or not a composition __ 14 __ a new principle in the history of music has little bearing on its aesthetic worth. Because they embody a new principle of organization, some musical works, such as the operas of the Florentine Camerata, are of signal __ 15 __ importance, but few listeners or musicologists would include these among the great works of music. On the other hand, Mozart's *The Marriage of Figaro* is surely among the __ 16 __ of music even though its modest innovations are confined to extending existing means. It has been said of Beethoven that he toppled the rules and __ 17 __ music from the stifling confines of convention. But a close study of his compositions __ 18 __ that Beethoven overturned __ 19 __ fundamental rules. Rather, he was an incomparable strategist who exploited limits — the rules, forms, and conventions that he inherited from predecessors such as Haydn and Mozart, Handel and Bach—in strikingly __ 20 __ ways.

Speaking

Read the following article and discuss in groups the questions listed below.

Arthur Miller addresses an important question: What was the connection, if any, between the simultaneous appearance of modern physics and modern art at the beginning of the 20th century? He has chosen to answer it by investigating in parallel biographies the pioneering works of the leaders of the two fields, Albert Einstein and Pablo Picasso. His brilliant book, *Einstein and Picasso*, offers the best explanation I have seen for the apparently independent discoveries of cubism and relativity as parts of a larger cultural transformation. He sees both as being focused on the nature of space and on the relation between perception and reality.

The suggestion that some connection exists between cubism and relativity, both of which appeared around 1905, is not new. But it has been made mostly by art critics who saw it as a simple causal connection: Einstein's theory influenced Picasso's painting. This idea failed for lack of plausible evidence. Miller sees the connection as being less direct: both Einstein and Picasso were influenced by the same European culture, in which speculations about four-dimensional geometry and practical problems of synchronizing clocks were widely discussed.

The French mathematician Henri Poincaré provided inspiration for both Einstein and Picasso. Einstein read Poincaré's *Science and Hypothesis* (French edition 1902, German translation 1904) and discussed it with his friends in Bern. He might also have read Poincaré's 1898 article on the measurement of time, in which the synchronization of clocks was discussed — a topic of professional interest to Einstein as a patent examiner. Picasso learned about *Science and Hypothesis* indirectly through Maurice Princet, an insurance actuary who explained the new geometry to Picasso and his friends in Paris. At that time there was considerable popular fascination with the idea of a fourth spatial dimension, thought by some to be the home of spirits, conceived by others as an "astral plane" where one can see all sides of an object at once. The British novelist H. G. Wells caused a sensation with his book *The Time Machine* (1895, French translation in a popular magazine 1898～99), where the fourth dimension was time, not space.

Picasso actually incorporated the fourth dimension into his creations before Einstein did. Miller discusses in great detail the history of a single painting, *Les Demoiselles dAvignon* —