

Teaching Professional Engineering Ethics in Civil and Construction Engineering

Dr. Hossein Ataei P.E., Syracuse University

Dr. Ataei is an Assistant Professor of Civil & Infrastructure Engineering at Syracuse University in New York. As a registered Professional Engineer both in Canada and in the United States, he has the industry experience in the fields of structural design of civil infrastructure systems; business administration of heavy civil projects and project controls of large-scale civil infrastructure for global Engineering-Procurement and Construction firms. He has also been involved in project management consulting and risk advisory services for construction and infrastructure projects. Prior to joining Syracuse University, Dr. Ataei was teaching simultaneously at the California State University, Long Beach and the California State Polytechnic University, Pomona. He is a licensed Professional Engineer (P.E.) in Nevada, Ontario and Quebec. He has a Ph.D., Civil Engineering, from University of Southern California in Los Angeles, California; A Master of Business Administration (M.B.A.) from Concordia University in Montreal, Canada as well as a Master of Construction Management (M.C.M.) from University of Southern California in Los Angeles, California, USA.

Dr. Ossama M. Salem, University of Cincinnati

OProf. Ossama (Sam) Salem, Ph.D., P.E., CPC, LEED AP, is the Department Chair and Yabroudi Chair Professor in the Civil and Environmental Engineering Department, College of Engineering and Computer Science, 151M Link Hall, Syracuse University, Syracuse, NY 13244-1240; Phone: 1-315-443-3401; Fax: 1-315-443-1243; Email: omsalem@syr.edu

Teaching Professional Engineering Ethics in Civil and Construction Engineering

ABSTRACT:

Engineers are important contributors towards the economic prosperity and development of societies as they strive to improve the quality of life for all people. In their relations with the employers and clients, the Professional Engineers shall act in professional manners as faithful agents or trustees for each employer or client. However, in this practice, the engineers are expected to exhibit the highest standards of honesty, integrity, fairness and impartiality in protecting the public health and safety in delivering professional services. To that end, engineers must perform their professional duties in compliance with the highest principles of ethical conduct. The Civil Engineering graduates, through their careers, will be involved in working in teams or managing projects where decision making will often be an inevitable part of their responsibilities. Therefore, there is an emerging need within the engineering education curricula across the nation for developing ethical decision-making frameworks and to place an emphasis on theories and canons of professional ethics and the stakeholder models in conjunction or often beyond the technical teachings and competency development objectives. This paper presents further the three courses in the Construction Engineering and Management program at Syracuse University where the professional engineering ethics is pursued through their incorporation into the Civil Engineering curriculum: (1) “*CIE 401 – Construction Engineering*” – a senior/junior-level core course through which students are introduced to the ethical obligations and principles in professional engineering practice and learn about unethical issues particularly within the context of construction engineering profession; (2) “*CIE 475 – Senior Design Project*” – a core senior-level capstone course where different ethical frameworks and stake-holder model theories in professional decision-making are taught. In addition, the graduating students obtain more in-depth and practical insight of the ethical obligations in engineering practice through the case studies and in-class group discussions; and (3) “*CIE 400/600 – Construction Regulations and Organizational Management*” – an undergraduate/graduate-level elective course in which the theories of ethics are presented to the class and discussed further in terms of the existing different viewpoints towards ethics in managing an engineering enterprise.

INTRODUCTION:

The construction engineering sector is an important industry that is a major contributor to the national GDP for both developing and developed countries. According to the US Bureau of Economic Analysis (*BEA*), in 2007 alone, the construction industry was responsible for 4.1% of the United States GDP, down from a 4.8% contribution in 2006. *Engineering News Record (ENR)* and Oxford Economics in 2015 Global Construction Summit Report predicted a faster growth for the global construction market than world GDP over the next decade. This is mainly due to the fact that Asian economies continue to industrialize and the US recovers from the sharp downturn during the 2008 global financial crisis. The construction industry in Asia and other emerging economies will experience a continuous faster growth over the next decade (2015 – 2025) because of rising populations, rapid urbanization and strong economic growths.

Engineering is a learned and respected profession that has an important impact on the well-being of the entire society and the quality of life for all people. According to the National Society of Professional Engineers (*NSPE*) Code of Ethics for Engineers, professional engineers shall honor the profession and must place service before profit and personal advantage while placing the public welfare above all other considerations. Moreover, in their professional relations with the employers and clients, the Professional Engineers shall act as faithful agents or trustees for each employer or client. However, it is imperative that the engineers place the safety and protection of the public as their first priority. For such, the engineers are expected to exhibit the highest standards of honesty, integrity, fairness and impartiality in delivering professional services in compliance with the highest principles of ethical conduct.

The American Society of Civil Engineers (*ASCE*) estimates that the cost of damages due to corruption in the global construction industry approach \$500 *billion* dollars annually (*ASCE* Website). It is a systematic issue that occurs in every country regardless of the form of government, the level of development, or geographic location and it requires a worldwide initiative for collective cooperation and action by governments, professional societies, engineering firms and members of the engineering profession worldwide.

The Civil Engineering graduates, through their careers, will be involved in working in teams or eventually will manage projects where decision making will often be an inevitable part of their responsibilities. Therefore, there is an emerging need within the education curricula in engineering schools and colleges across the nation for developing ethical decision-making frameworks for engineering students in order to place an emphasis on theories and canons of professional ethics and teaching the stakeholder models in conjunction or often beyond the technical competency development objectives.

This paper discusses the incorporation of Professionalism and Engineering Ethics education at Syracuse University in the Construction Engineering and Management curriculum through these three presented undergraduate courses: (1) “*CIE 401 – Construction Engineering*”; (2) “*CIE 475 – Senior Design Project*” and (3) “*CIE 400/600 – Construction Regulations and Organizational Management*”.

FIRST COURSE: CIE 401 – CONSTRUCTION ENGINEERING

The first course that is presented in this paper is “*CIE 401 – Construction Engineering*”. This is a three-credit mandatory senior/junior-level core course within the civil engineering undergraduate curriculum that serves as an introduction to the construction engineering and management subjects. In this course, students learn more about the importance of ethical obligations in civil engineering and the unethical practices within the context of the construction engineering profession.

This course introduces and discusses unethical practices in construction engineering to the students. The objective is to raise the students’ awareness of unethical practices that they might face during their careers as project engineers or construction managers. There will be few questions in the final exam about such conducts and their definitions to assess the student learning outcome on the subject. The most common unethical conducts in construction engineering industry, apart from the conflict of interest issues and document falsifications,

mainly occur in contract administration and project cost control areas. Some of the issues might be more severe than others with grave consequences. Examples of most common unethical conducts that are presented and discussed in this course are:

- (1) *Unbalancing Bids*: Unbalanced bidding is where a bidder places a high price on some items and a low price on other items in a unit price contract. One of the main reasons for a bidder to unbalance its prices is to conceal its pricing strategy from competitors or to receive large sums at the beginning of a contract that is commonly referred to as "*front-end loading*" in the industry. This is an unethical practice given that the contractors manipulate their bids for early cost line-items of work in an effort to recover the sums prior to the actual construction commencement.
- (2) *Bid Paddling*: This is an unethical conduct by the general contractor that does prior lower-bid shopping from the subcontractors in an effort to bring down the main bid estimate.
- (3) *Price Fixing*: This is an agreement either in writing or verbally-agreed-upon among contractors to raise or lower the bid prices or competitive terms. Price fixing relates not only to direct cost pricing (labor, equipment and material costs), but also, it applies to other contract terms and conditions that affect the final bid prices for the owner such as overhead fees, warranties, contingency or financing rates (US Federal Trade Commission).
- (4) *Bid Rigging*: The US Federal Trade Commission defines this unethical practice as an in-advance agreement of the competitors to let a certain firm win the bid by self-manipulation of estimates so they take turns in being the low-bidder or, being excluded of a bidding round, or provide unacceptable bids to cover up a bid-rigging scheme. Other bid-rigging agreements involve subcontracting part of the main contract to the other firms who self-excluded themselves from the bidding process, or forming a joint-venture to submit a single bid (US Federal Trade Commission).
- (5) *Cost Spreading*: This is a process of spreading total construction cost among different construction activities in an attempt to manipulate the construction cost curve and frontload the receivables.

SECOND COURSE: CIE 475 – SENIOR DESIGN PROJECT

CIE 475 – Civil & Environmental Engineering Senior Design Project, or *capstone project*, is a four-credit senior-level capstone core course. Senior students of both civil engineering and environmental engineering majors must take this course in order to graduate. This is a Project-Based-Learning (*PBL*) course where students work on planning, designing, cost estimating, scheduling and preparing a comprehensive report and final presentation for a real-world industry project. This course is normally taken after the CIE 401. It encompasses almost all of the ABET learning outcomes (*a-k* or *1-6*) and, hence, engineering professionalism and ethics is covered in the course in order to better prepare the graduating civil and environmental engineering class. In accordance with the National Society of Professional Engineers' Code of Ethics, the engineering ethics education in this class is through the introduction of three main channels: (1) Fundamental Canons; (2) Rules of Practice and (3) Professional Obligations.

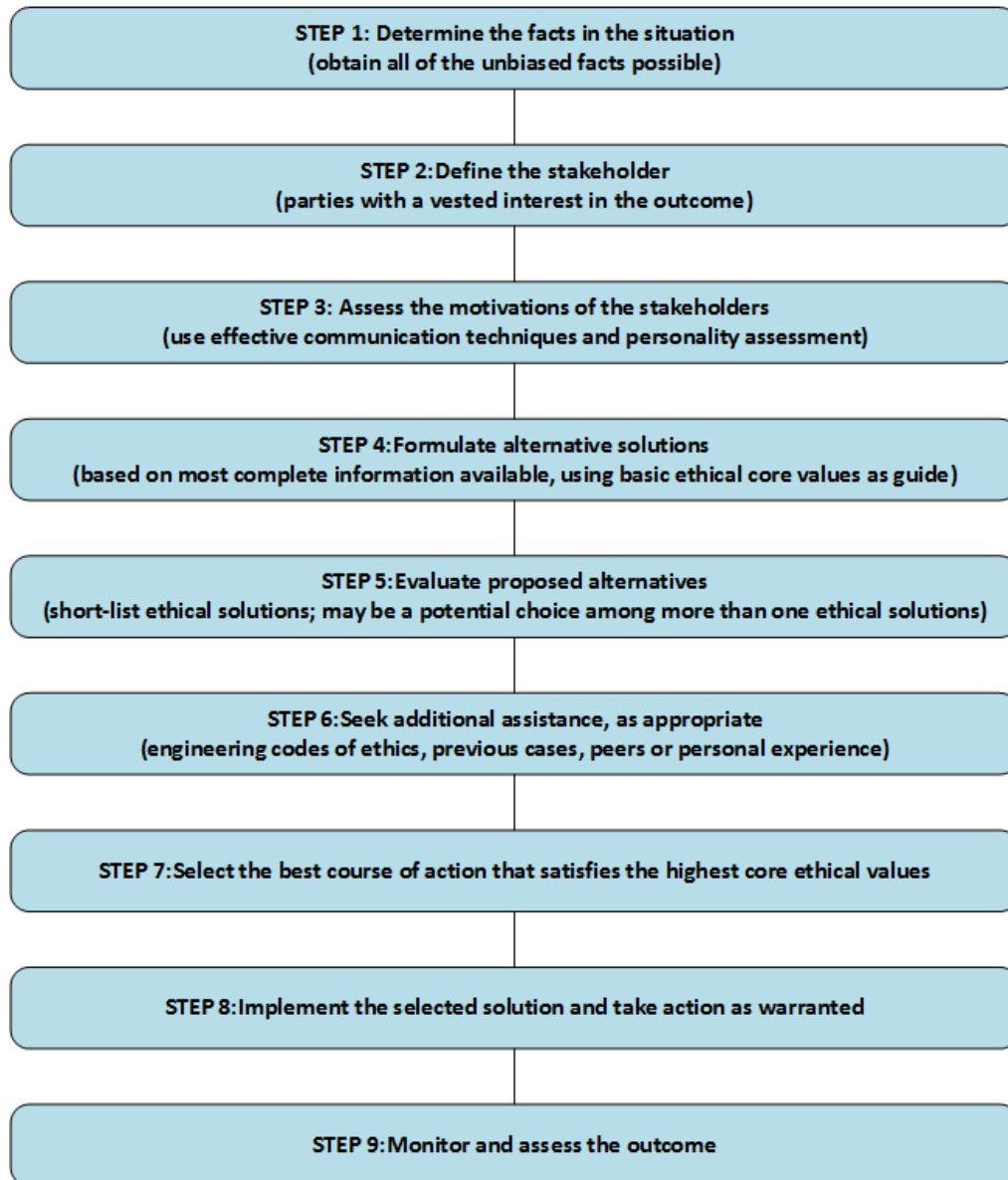


Figure 1: Step-by-Step Guidelines for Proposing Solutions to Ethical Dilemmas in Professional Engineering Practice [Adopted from NSPE & ASCE Code of Ethics]

Figure 1 captures and summarizes the ethical decision making framework that is taught in the CIE 475 – Senior Design Project based on the ASCE and NSPE Code of Ethics, Fundamental Canons, Rules of Practice and Professional Obligations. After applying the aforementioned step-by-step guidelines for ethical decision making in Figure 1, the quality of the ethical decision is assessed through asking these three questions as elaborated in the below framework (Figure 2):

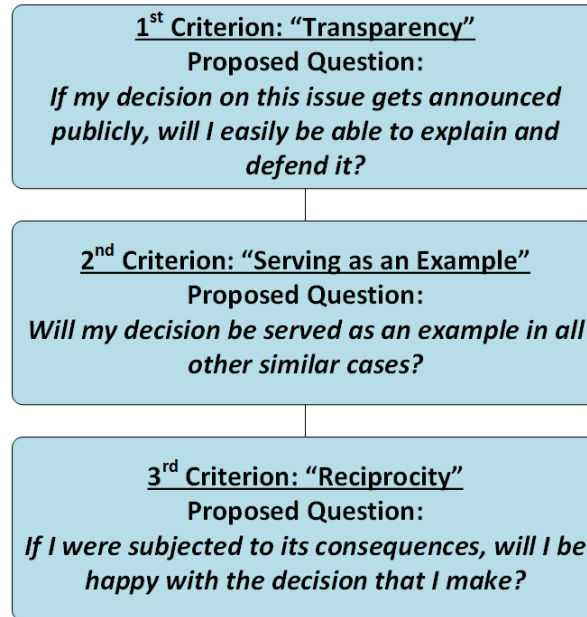


Figure 2: The Ethical Decision Making Test

[Adopted from *Quebec Order of Engineers, Professionalism, Ethics and Deontology*]

Different ethical frameworks and stakeholder model theories in professional decision-making are taught in this course. In addition, the graduating students obtain more in-depth and practical insight of the ethical obligations in engineering practice through the case studies and in-class group discussions. The instructors present case studies based on real professional experiences in dealing with ethical dilemmas in engineering practice. Other case studies are borrowed from the existing resources of the Ethics Cases at the *Texas Tech University's Murdough Center for Engineering Professionalism*. At the end of the semester, in order to assess the students learning outcome in engineering professionalism and ethics, they will be given a 40-question multiple choice exam on which the students shall score 90% or above to pass. The students who could not achieve 90% or higher, will need to repeat the test until they successfully pass. This practice is adopted in accordance with the ethics and professionalism examinations of the professional engineering boards across the nation.

According to the National Society of Professional Engineers' Code of Ethics, the Fundamental Canons and the Engineering Rules of Practice mandate the engineers to fulfill their professional duties by (1) placing highest priority on protection of the public safety, health and welfare; (2) rendering services only in areas of their competence; (3) issuing public statements only in an objective and truthful manner; (4) acting as faithful agents or trustees for each client or employee; (5) avoiding deceptive acts, conflicts of interest or document falsifications, and (6) conducting their professional duties with honor and high sense of responsibility and ethics as they represent the honor and reputation of the engineering profession. Furthermore, the Professional Obligations require the engineers to (1) demonstrate highest standards of honesty and integrity in their professional relations; (2) always strive to hold the interests of the public above all else; (3) never misrepresent facts or falsify any portion of the professional documents; (4) shall not disclose, without consent, any confidential business or technical information of the current or past clients; (5) avoid situations of conflicting interests; (6) shall not maliciously or falsely, directly or indirectly damage the reputation, employment or practice of other engineers;

(7) shall accept personal responsibility for their professional activities and shall give credit for engineering work to those to whom it is properly due (NSPE Website).

THIRD COURSE: CIE 400/600 – CONSTRUCTION REGULATIONS AND ORGANIZATIONAL MANAGEMENT

A more in-depth discussion on theories of professional ethics is performed in the third course entitled “*CIE 400/600 – Construction Regulations and Organizational Management*” which is an elective undergraduate/graduate-level course. It further presents existing roots and sources of different viewpoints towards professional ethics and business decision making approaches.

The differences of professional ethics and moral values are presented and discussed in this course. Morality is a set of internal value system and/or social rules that govern and limit our conduct. It consists of forming moral judgements and developing moral standards especially the ultimate rules that concern the rights and wrongs. On the other hand, professional ethics provide an overarching structure that allows diverse, multidisciplinary and multicultural engineering and management teams to work together on a project regardless of their personal beliefs or internal moral values that, otherwise or under some circumstances, might have disrupted or impeded the team efforts. Through the application of the aforementioned overarching structure, professional engineers will share a commonly-held set of guidelines of expectations and course of action when working in a same or similar condition (UT Austin, Professional Responsibility).

There are basically two distinct approaches towards ethics and morality assessment in business decision making: (1) *consequentialism* (or *teleological* or *ontological*) which focuses on the “good” that comes out of the decisions made or the outcome of a professional action; (2) *deontological* that focuses on the professional duties and obligations. In consequentialism, since it is an outcome-focused approach, actions are evaluated by weighing the ratio of “good” outcome to the “bad” that the action produces. However, deontological approach is motive-focused and emphasizes on the moral importance of the employed means (duties and obligations) in reaching the outcome. In other words, all the steps in business decision making must be diligently examined and be morally correct. That said, not only are the consequences morally significant, but also, each action along the way is morally assessed and relevant to the final outcome. Deontological approach encompasses the responsibilities and regulations that are imposed on and expected from members of an Engineering society or association. These rules and regulations, similar to the rules of law, identically apply to all members of the profession. In other words, compliance with the deontological approach to professional ethics, does not require further reflection on personal or societal value systems. Professional engineering ethics is a deontological approach (Quebec Order of Engineers, Professionalism, Ethics and Deontology).

Moreover, on the other side of the engineering ethics, is the engineering social responsibility (*ESR*) which is an organizational matter. Society is best served by pursuing joint-interests of all the stakeholders involved in an engineering project or initiative and through an economic symbiosis that also considers legal obligations and ethical responsibilities. It is important for the students to realize that an ethical and sustainable engineering service is best achieved when various stakeholders and resource suppliers are properly identified and comprehensively considered and served, with the intention of increasing the common wealth.

This *Balanced Approach* and the Stakeholder Model Framework in ethical engineering and business decision making are further illustrated in Figure 3:

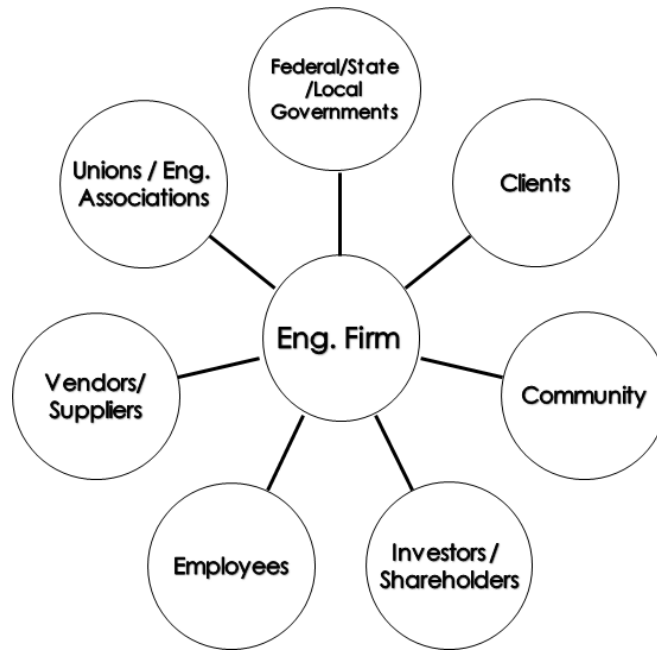


Figure 3: The Stakeholder Model for Engineering Ethics Analysis and Business Decision Making
[Adopted from *Business Ethics* course – John Molson School of Business, Concordia University]

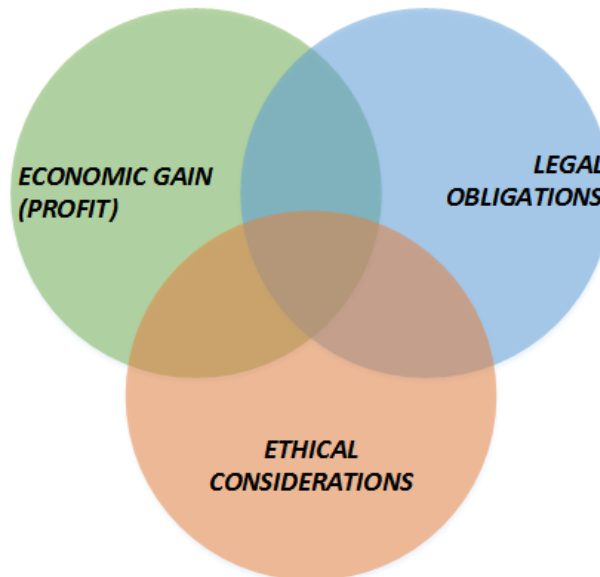


Figure 4: The Balanced Approach to Ethical Decision Making in Professional Engineering Practice
[Adopted from *Business Ethics* course – John Molson School of Business, Concordia University]

Therefore, an ethically-sustainable engineering decision is best-achieved not only on the grounds of technical competency but also through finding and maintaining a *balance* between economic

consequences (economic gain), legal obligations and ethical considerations as demonstrated in Figure 4.

SUMMARY

Engineering is a learned profession that is an important contributor to the economic prosperity and development of societies. It is a respected profession whose main objective is to improve the quality of life for all people while protecting the safety, health and well-being of the public. In this practice, the engineers are expected to exhibit the highest standards of honesty, integrity, fairness and impartiality and must perform their professional duties in compliance with the highest principles of ethical conduct. The Civil Engineering graduates, through their careers, will be involved in working in teams or managing projects where decision making will often be an inevitable part of their responsibilities. Therefore, engineering professionalism and ethics education should be further regarded and included within the engineering education curricula across the nation. This paper discusses and presents three courses that introduce and teach the theories and methodologies of engineering ethics to the civil and construction undergraduate and graduate students. The ethical decision-making frameworks are presented and an emphasis is put on theories and canons of professional ethics and the stakeholder models in conjunction or often beyond the technical teachings and competency development objectives to better prepare the students for business decision making in professional context and in their workplace.

REFERENCES:

1. American Society of Civil Engineers (ASCE), Code of Ethics, The Engineers Charter (<http://www.asce.org/engineer-s-charter/>)
2. Business Ethics (MBA 691) Resources, John Molson School of Business (JMSB), Concordia University, Montreal, Canada
3. Ethics Cases, Educational Products and Services, Murdough Center for Engineering Professionalism, Texas Tech University (<http://www.depts.ttu.edu/murdoughcenter/products/cases.php>)
4. Global Construction Summit Report, Engineering News Records and Oxford Economics, New York City, September 2015
5. Morals versus Professional Ethics, Professional Responsibility, The University of Texas at Austin, Cockrell School of Engineering
6. National Society of Professional Engineers (NSPE), Code of Ethics for Engineers (<http://www.nspe.org/resources/ethics/code-ethics>)
7. Ordre des ingénieurs du Québec, Code de déontologie des ingénieurs, December 2015 (<http://www2.publicationsduquebec.gouv.qc.ca>)
8. Ordre des ingénieurs du Québec, Test d'une décision éthique, November 2013 (http://gpp.oiq.qc.ca/test_d_une_decision_ethique.htm)
9. Ordre des ingénieurs du Québec, Professionnalisme, éthique et déontologie, May 2011 (http://gpp.oiq.qc.ca/1_ethique.htm)
10. United States Federal Trade Commission, Guidelines to Antitrust Laws, Dealing with Competitors, Bid Rigging (<https://www.ftc.gov/tips-advice/competition-guidance/guide-antitrust-laws/dealings-competitors/bid-rigging>)
11. United States Federal Trade Commission, Guidelines to Antitrust Laws, Dealing with Competitors, Price Fixing (<https://www.ftc.gov/tips-advice/competition-guidance/guide-antitrust-laws/dealings-competitors/price-fixing>)