

## Exploring English for the Nuclear Industry in Biographical Films: *Oppenheimer* and *Silkwood*

*Exploration de l'anglais de l'industrie nucléaire dans les films biographiques:  
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**Exploring English for the Nuclear Industry in Biographical Films: *Oppenheimer* and *Silkwood***

**Keywords:** biographical pictures, ESP, scientific discourse, oral comprehension, teaching and learning, metaphor, mathematical probability

**Abstract:** There is an increased interest in using filmic texts, both fictional and documentary, in the ESP classroom. Medical and legal fields have seen considerable fictional representation, but the nuclear industry has not been wholly forgotten by the creators of popular drama. Film and television programs offer visually contextualized discourse in nuclear-related scientific settings. This study analyses the oral discourse features of the 1980 BBC series *Oppenheimer: The Father of the Atomic Bomb* and Mike Nichols' 1983 film *Silkwood*, based on the life and death of a plutonium plant worker and union member Karen Silkwood. The contrasting linguistic and thematic elements help to form distinctive representations of nuclear industry professionals, thereby offering rich sources of oral discourse, especially for learners requiring proficiency in English for Scientific Purposes (ESP).

**Exploration de l'anglais de l'industrie nucléaire dans les films biographiques : *Oppenheimer* et *Silkwood***

**Mots clés :** film biographique, anglais de spécialité, discours scientifique, compréhension de l'oral, didactique, métaphore, probabilité mathématique

**Résumé :** Dans l'enseignement de l'anglais de spécialité, il semble que l'utilisation de textes de films, qu'ils soient documentaires ou de fiction, présente un intérêt croissant. Les domaines de la médecine et du droit sont abondamment représentés dans les fictions, mais l'industrie nucléaire n'a pas été totalement oubliée par les créateurs de drames populaires. Le cinéma et la télévision offrent un contexte visuel au discours à caractère scientifique. La présente étude analyse les caractéristiques du discours oral dans la série télévisée de 1980, *Oppenheimer: The Father of the Atomic Bomb* diffusée par la BBC, et dans le film de Mike Nichols réalisé en 1983, *Silkwood*, qui raconte la vie et la mort de Karen Silkwood, salariée dans une usine de plutonium et syndicaliste. La complémentarité des éléments linguistiques et thématiques favorise la représentation des particularités concernant les professionnels de l'industrie nucléaire et, par là même, offre une richesse du discours oral particulièrement intéressante pour les apprenant-e-s ayant besoin de compétences en anglais à but scientifique.

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### **Exploring English for the Nuclear Industry in Biographical Films: *Oppenheimer and Silkwood***

The biographical picture genre—including both cinematographic and television productions—is an evolving one. It shares, among other aspects, a popularity similar to that of *Fiction à substrat professionnel* (FASP). Like FASP, it can capture the particularities of the language, discourse, and culture of a given professional community. While FASP is generally a thriller or mystery written by a professional of a specific domain, the biographical picture retraces the life, or certain parts of the life, of the chosen protagonist. Thus, the two genres may be considered as presenting contrasting claims to truth. Many biographical pictures portray the lexical and discursive practices characteristic of a given professional community, which may be of interest to the study, learning, and teaching of English for Specific Purposes. (For a more in-depth discussion of FASP, see Isani 2009, Petit 1999, Petit 2004.)

The professional community addressed in this paper is the nuclear industry. Two biographical pictures offer windows into the Anglophone field of nuclear science: the British Broadcasting Corporation (BBC) television series *Oppenheimer: The Father of the Atomic Bomb* (Davis 1984) and the US film *Silkwood* (Nichols 1983). Both works are from the eighties and are dramatized biographies of fascinating members of the nuclear industry. Both sources include essential aspects of English for Scientific Purposes including terminology related to probability and metaphor. They also offer contrasting views as the industry is seen from that of researchers and government agents in *Oppenheimer* and from the part of low-paid workers in the film *Silkwood*.

Because of the need for spoken, domain-related English skills, the English for Specific Purposes (ESP) classroom is witnessing a growing attention to the use of oral documents, both documentary and fictional, especially in the context of improving oral comprehension (Fortanet-Gómez & Räisänen 2008; Villez 2004). Oral documents offer important sources of motivation (Lavinal *et al.* 2006), open windows into both target and source cultures (Isani 2006), and provide contextualized oral interaction (Sherman 2006). However, while the pairing of speech and images often facilitates comprehension, the cognitive attention required by multiple modes

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of transmission should not be underestimated (Hartwell 2009). Comprehending oral documents implies a series of active processes including detection and understanding of phonemes, terms, grammatical and morphological structures, and world knowledge (Flowerdew 1994; Rost 1990; Ur 1984; Vandergrift 2007). Subsequently, students must be guided and assisted if they are to benefit from the task of learning through viewing filmic texts (Mendelsohn 1995; Salehzadeh 2006).

This paper opens with an introduction to the biographical picture genre and its similarities and differences with *Fiction à substrat professionnel* (FASP). Next, it discusses certain linguistic features of two biographical pictures, especially notions of specific processes, probability, and metaphor in both practical and theoretical scientific contexts. Finally, considerations for teaching and learning from oral documents including issues of prediction, interactivity, and factual content are explored.

### 1. Biographical pictures

The biographical picture—often dubbed “biopic”—has evolved as a genre over the last eighty years, perhaps a refuted genre, but a genre nonetheless. The classical period of biographical films, dating back to the experimental period of the 1930s, often captured Europe’s “great” men, such as *The Adventures of Marco Polo* (Mayo & Ford 1938) or *The Life of Emile Zola* (Muni 1937). Post World War II, Hollywood’s classical biographical films have been dubbed “warts and all” as a more realist element was introduced, before disappearing in the 1960s. During this classical period, Hollywood’s major studios produced some 300 biographical films. In the 1970s, US television biographical movies became more popular. However, the 1980s, and the shift from producer films to author films in Hollywood, witnessed a revival of biographical pictures such as those by Martin Scorsese, Spike Lee, and Mary Harron. This often serious genre has also witnessed critical investigation as in *Citizen Kane* (Welles 1941), a widening of diversity in the 1990s to include people of color as in *Malcolm X* (Lee 1992), and even irony as in *I Shot Andy Warhol* (Harron 1996) (Bingham 2010; Custen 1992; Lupo & Anderson 2008; Moine 2010).

Altman (1984) underscores the general differences between semantic and syntactic definitions of film genre. The semantic definition encompasses a list of common traits or “building blocks” including attitudes, characters, shots, locations, and sets that encode the semantic elements of a given genre. The syntactic approach privileges how these “building blocks” are assembled or arranged. Bingham’s description of the biographical picture encompasses both its essential semantic trait, that is to say the life of a person as subject, but also the importance of assembly or arrangement in creating the finished work:

The biopic narrates, exhibits, and celebrates the life of a [real] subject in order to demonstrate, investigate, or question his or her importance in the world; to illuminate the fine points of a personality; and for both artist and spectator to discover what it

would be like to be this person, or to be a certain type of person [...] (Bingham 2010: 10).

Certain fields such as law or medicine are quite popular in contemporary fiction, while others, such as marketing, are not (Hardy 2005). Biographical pictures also favor certain professions. In his study on nearly 300 biographical pictures produced in Hollywood between 1927 and 1960, Custen (1992) found that 36 % of the professions of the main protagonists were in the arts or entertainment. Hence, Hollywood began with a reflection on its own profession. During this period, government or political elite (8.5 %), military figures (6.5 %), and outlaws (11 %) were also popular. Custen (1992: 230) also found that only 25.8 % of the biographical pictures studied had a woman as the single main character, compared to 65 % portraying a man as the single main character. Furthermore, women were most often members of the royalty or paramour, medical, education, and entertainment communities, while black Americans were limited to the professions of athlete and professional entertainer.

Today, biographical pictures about men vary from celebratory to parody, a richness and seriousness which has not been developed in pictures about women, who are more often portrayed in “lighter” subjects, despite the success of biographical films such as *An Angel at My Table* (Campion 1990) or *Erin Brockovich* (Soderbergh 1999) (Bingham 2010; Moine 2010). Through numerous examples, Bingham (2010) confirms that biographical films about women “are weighted down by myths of suffering, victimization, and failure perpetuated by a culture whose films reveal an acute fear of women in the public realm.” Custen (1992: 226) also notes in his study of the classical period that television biographical pictures more often portrayed women as victims (38 %) compared to only 20 % for men, figures which he esteems echo filmic tradition. This tendency is mirrored in the filmic texts discussed in this article. While Oppenheimer may be victimized by the US government for maintaining relations with members of the Communist Party, the spectator is shown both the hypocrisy of his trial and his merits as a scientist and leader. The fictionalized Karen Silkwood is not portrayed as having the scientific interests that in fact motivated the real-life person. She was most likely poisoned and then died, victim of a suspect automobile accident, without seeming to have made any impact on worker or environmental safety.

Both the BBC series about Robert Oppenheimer and the film about Karen Silkwood belong to the biographical picture “revival” of the 1980s. The 8-hour *Oppenheimer* series has considerable factual information about his influential role in creating the atomic bomb at Los Alamos, his stand against the costly hydrogen bomb, the revocation of his security clearance, and his ensuing Senate investigations during the McCarthy era. In contrast, the film *Silkwood* noticeably lacks factual information concerning her likely murder shortly before she was to denounce the illegal practices of an influential plutonium production plant (Kohn 1975). The circumstances at the plant and her unresolved death affect the film such that “one

constantly feels that the filmmakers are running up against episodes they can't re-create, characters they can't represent, information they couldn't get access to, or could but cannot disclose" (Bingham 2010: 292).

The question of degrees of representation of truth is a recurrent one in biographical picture criticism. As Richter has pointed out:

There will inevitably be many different versions of a human life or a historical event, all of them providing different versions of the truth. But some constructions of the past will be more accurate than others, and with all due respect to the historiographical relativism, historical falsehood is not pleasant fiction but a species of lie (Richter 2007: 142).

Richter comments that biographical pictures about entertainers or sports stars during the classical period were often expected to be more entertaining than factual. Some biographical pictures, such as Charles Vidor's musical *Hans Christian Anderson* (1952) was announced not as historical, but as a fairytale (Richter 2007: 162). Written disclaimers or its opposite, claims to truth, are common aspects of the genre. A claim to truth is often highlighted through the use of written information about dates or other affirmations within the picture:

This convention of the biopic, the introductory assertion of the truth, serves as a reminder of a fact so obvious that we might overlook it: that most films made in Hollywood are not supposed to be taken as true. This use of the title sets up one on the genre's distinctive qualities, a claim to truth. (Custen 1992: 51)

A claim to truth is an inherent quality of the biographical picture. While discussing exceptions, Lupo and Anderson (2008) consider "trust and commitment" as a basic rule to biographical pictures. This aspect of veracity is discussed further in this paper, but first we turn to the scientific settings and discourse found in *Oppenheimer: The Father of the Atomic Bomb* (Davis 1984) and *Silkwood* (Nichols 1983).

## **2. Scientific settings and discourse**

As in FASP, setting, character roles, and language features are defining elements of biographical pictures. The settings, even within the domain of nuclear science, are varied and appropriately staged. In these biographical pictures, each setting is inhabited by a range of characters having differing knowledge, power, obligations, and interests. Their language is determined to a large degree by the setting and character roles. Speaking of video drama, Sherman remarks that the "appropriate choice of language depends on context, situation, roles and relationships, intention and feeling, which can only be appreciated—and only learnt well—in a whole and developing context" (2006: 14).

### **2.1. Scientific settings and discourse**

There are four broad categories of scientific settings found in the two screenplays: places of theoretical reflection, laboratories, workrooms, and medical structures.

Each setting is inhabited by corresponding scientists, students, government officials, technicians, trainees, and administrative staff. Hence, the oral discourse is firmly contextualized by the images on the screen.

The *Oppenheimer* series begins pre-World War II, when the physicist was still teaching at the University of Chicago where the first artificial, self-sustaining nuclear chain reaction took place in an “atomic pile”—now called a reactor—installed in a basement below a squash facility. The classroom is represented by a blackboard to which students are called to complete complex formulas. Although some seventy years have passed since this era, this setting and its corresponding didactic discourse are similar to today’s classroom. The linking of theoretical reflection to a blackboard is frequent in the series as it recurs in Oppenheimer’s office and in the meeting room at the Los Alamos laboratory.

This theoretical axis is complemented in the series with scenes of experimental physics in a control room where electro-magnetic separation is under study in the University of Chicago’s experimental nuclear physics facilities. In one particular scene, attentive physicists are seated before consoles and walls covered with dials, buttons, and needled meters. As today, these serve to modulate and monitor the workings of the equipment from a safer distance. Dr. Lawrence leads General Groves on a tour of the control room:

***Dialogue 1: Dr Lawrence describes electro-magnetic separation***

Dr. Ernest Lawrence: OK Jimmy, let’s switch her on.

Now then, by using high-electrical voltage the uranium atoms are accelerated through a vacuum tube at speeds at, ooh, many thousands of miles per second. Come on Jimmy, let’s goose her up. Now then, at these speeds, they enter an intensely strong magnetic field. The magnetic force pulls the atoms into circular paths. Now, uranium has two kinds of isotopes.

General Groves: 2 3 8... and 2 3 5

L: Right. And 235 is

G: lighter [...] (Davis 1984)

Their contextualized discourse related to physics (uranium atoms, circular paths, isotopes) intermingles with general expressions related to machines (high-electrical voltage, vacuum tube, magnetic field) and also familiar technical commands (switch her on, goose her up).

*Silkwood*, set in the 1970s, centers around lower-level technicians and laboratories with less multifaceted equipment. The predominant professional setting is the Kerr-McGee plutonium production plant of Oklahoma, notably the glove box room where dry processing takes place. One scene begins with the laughing workers blowing chewing gum bubbles. This bubble gum symbolizes their lack of knowledge concerning the dangers of manipulating plutonium and the lack of security measures despite the radiation detection alarm that sounds repeatedly. The setting is described to the spectators when a tour guide asks Karen Silkwood to explain dry processing to a group of trainees coiffed in hardhats:

**Dialogue 2: Dry processing**

Guide: Now, this is dry processing. The heart of the production process. Come in trainees. This brown powder you see here is mixed plutonium and uranium oxide. And these trained technicians are fabricating it into fuel pellets. Karen, could you explain the procedures in this glove box?

Karen Silkwood: Yeah. What we're doing is blending and mixing the plutonium and uranium oxide into correct ratios and then we sift it for impurity. Then it is fed into the slugging press which makes the pellets. (Nichols 1983)

The last type of setting is the medical facilities. First shown is the shower room where contaminated workers must undergo a scrub down in case of emergency. The scenes that take place here involve anxious and often weeping workers. More sobering are the medical offices and examination rooms of the Los Alamos site where Karen Silkwood and two other workers underwent a series of medical tests and are faced with the probability of serious health afflictions.

**2.2. Mathematical probability**

The notion of probability includes the mathematical process of evaluating the chance or risk that some event may occur. It is essential to the study of nuclear energy and is discussed in specific terms. For example, in one scene, Robert Oppenheimer, played by Sam Waterston, and General Groves, played by Manning Redwood, discuss the probability of setting fire to the Earth's atmosphere. General Groves, although not a scientist, was appointed by the US government to oversee the Manhattan Project during World War II in which scientists worked under pressure for months to create the first atomic bomb. He allotted funding and so was a key figure in determining the selection of the research sites, methods of isotope separation, and acquiring raw materials. The role has become more and more present, or perhaps more obvious, in the scientific sphere.

At one point, we see him examining mathematical formulas traced on a blackboard in Oppenheimer's office at the University of Chicago. He is searching for clear-cut, yes/no answers that are, on the contrary, not often the substance of scientific reflection where probability offers a more precise conclusion. They discuss the possible dangers linked to the enterprise of creating and deploying an atomic bomb:

**Dialogue 3: Exploding fission bomb**

Robert Oppenheimer: [Edward Teller] stopped us cold at one point with some calculations that indicated that the likely heat build-up in an exploding fission bomb would create a reaction between deuterium and nitrogen.

General Groves: Meaning...?

RO: Meaning we could set fire to the world's atmosphere.

GG: My God!

RO: It's all right. Hans Bethe checked the figures and it turned out Edward had been a little imprecise.

GG: There's no chance, huh?

RO: Oh, there's a chance, but not as great as Edward thought.



GG: There is a chance?

RO: Three in a million. (Davis 1984)

This passage includes expressions commonly found when discussing mathematical probability (calculations that indicated, likely, checked the figures, not as great, three in a million) and also nuclear physics (fission bomb, reaction between deuterium and nitrogen, world's atmosphere).

In *Silkwood*, probability is also a factor when the doctors of the Los Alamos medical facility report their results of a battery of medical tests that three workers of the Kerr-McGee plant have just undergone. Once again, we find two contrasting discourse communities, the medical doctors of a well-equipped laboratory and the nuclear industry workers who assume the role of worried patients. One doctor has just explained to Karen Silkwood that she has an estimated internal contamination of 6 nanocuries of plutonium in her lungs, which is, according to the doctor, below the forty-nanocurie limit of permissible body burden for occupational exposure. He describes the accuracy of the results using mathematical expressions related to probability, such as “accuracy may be off plus or minus 300 percent”, “three times less”, “three times greater”:

**Dialogue 4: Medical examination**

Doctor: These are very sophisticated instruments we use to take these measurements, but their accuracy may be off by plus or minus 300 percent at this level.

Karen Silkwood: Plus or minus 300 percent.

Doctor: That's correct.

KS: Then what you're saying is that the amount of plutonium inside me could be three times less than you even think?

Doctor: Or three times greater. (Nichols 1983)

The actual analysis of Karen Silkwood's organs at the Los Alamos was instrumental in assessing plutonium lung and body burden measurement techniques (Los Alamos Laboratory 1995). While the precision of their diagnostics may vary depending on the capacity of measurement, scientific hypotheses may also vary or evolve. The research within the nuclear industry often moves quickly, and so one problem is that data can become out-dated and therefore imprecise. For example, in the film, the doctors evoke a permissible body burden of forty nanocuries. But in 1983, when the film was made, the maximum permissible deposit for occupational exposure was actually forty nanocuries for bones; however it was calculated at only sixteen nanocuries for the lungs of occupational workers. In the didactic context, hence, special attention should be paid to the factual content in this film, as in many fictional works.

### 2.3. Metaphor

Perhaps more intriguing than mathematical probability, metaphors have long been a topic of study in general English and in its literature; they also play a key role in scientific discourse. Lakoff and Johnson (1980) posit that a range of metaphors

exist, from structural to orientational to ontological, which govern, according to the authors, our everyday functioning, perception, and relating to others. In science, metaphors and analogies can be seen either as part of the “primary process” of scientific discovery or as simply a “secondary” process of communication, but in both cases they can help to understand what is yet “unknown” (Crease 2000: 17).

The “unknown” remains a historical tradition in nuclear physics and chemistry. While Oppenheimer and his team dealt with gaps of knowledge about fission or even how to create the detonator of the atomic bomb, today scientists search at great cost to control fusion reactions. As Boyd (1993) explains, in the “primary process” of scientific discovery, metaphors or analogies comparing two subjects help to understand the nature of the one under study:

Precisely because theory-constitutive metaphors are invitations to future research, and because that research is aimed at uncovering the theoretically important similarities between primary and secondary subjects of the metaphors, the explication of these similarities and analogies is the routine business of scientific researchers. (1993: 489)

In order to describe the process of electro-magnetic separation to General Groves, Dr. Lawrence uses the analogy of throwing stones having different weights to represent the isotopes Uranium 238 and Uranium 235:

***Dialogue 5: Electro-magnetic separation, part 2***

Dr. Ernest Lawrence: Now, how do we separate [Uranium 235] out? You see your lighter isotopes are bent into a different circuit from your heavier isotopes. I like to say it's kind of like throwing two stones of a different weight with the same force and one of 'ems gonna go further than the other, right?

General Groves: Sure.

EL: Right. Now, at the end of the electrical park, you'll find two separate containers, one to catch the heavier isotopes and one to catch the...

GG: lighter.

EL: Lighter and there you have it, sir. Electro-magnetic separation. OK, Jimmy, you can save the taxpayers' money now. (Davis 1984)

The analogy helps to understand the process of electro-magnetic separation by relating it to a visual image of stones being thrown. While General Groves has learned that there is a lighter and heavier form of uranium, he is not aware of the principle of weight and forces. With the information provided by Dr. Lawrence he is able to grasp the concept of separation. However, Black (1962) cautions against the filtering nature of metaphors that “organizes our view”. For example, he takes the common (or perhaps once common) examples of comparing a man to a “wolf” or a battle to a game of “chess.” In the case of the wolf, there must be a shared cultural perspective on the qualities of a wolf, which are then reconfirmed by the use of the metaphor. In the case of the chess metaphor, certain aspects of the battle are brought forward, but others, such as the “emotionally disturbing aspects of warfare” are excluded (1962: 42).

In the example of stone throwing, the structural metaphor is misleading in that

throwing stones is extremely simple, while electro-magnetic separation is not. Hence, General Groves, and perhaps the viewer, initially believe that the experiment is leading to greater understanding or practical implications than is actually the case.

Dr. Lawrence also uses general English metaphors and metonymy. “There you have it” refers to understanding as if it could actually be grasped and is commonly found in general English discourse (Black 1962: 54). His instruction to Jimmy, “you can save the taxpayers’ money now”, means “turn off the machine.” However, this metonymy offers insight into the cost of the experimentation that the more direct command would not.

Spoken English for Scientific Purposes combines expressions of mathematical probability and metaphor stemming from both general English and ESP. We see in these passages that the role, interlocutor, and personality of the speaker modify discourse. Within the ESP classroom, metaphors also help learners and teachers to understand the general idea without being bogged down in “theoretical paraphernalia”; however, they may also lead to misunderstandings, especially if cultural models impinge on the conceptualization of models (cf. Fries 2006).

### **3. Teaching and learning**

Misunderstandings are often common when learners listen to oral documents in the ESP classroom. Understanding through listening is a broader activity than simply comprehending spoken words. As is found in numerous textbooks and classrooms, lists of true/false or fill-in-the-blank comprehension questions may be prepared for students to complete while listening. However, these types of activity lack authenticity for in the real world few people, besides those administering a survey, must read and answer questions while listening to a speaker. Question answering is more passive as the key facts or ideas are often identified by the content of the questions, leaving little room for the listener to establish personal points of interest based on previous world knowledge. Note-taking, skits, and debate help create a more dynamic approach to practicing authentic oral language skills.

The previously mentioned passages related to guided tours (Dialogues 1 and 2) offer context-specific vocabulary, which is at the core of basic comprehension. Taking notes from oral sources such as these resembles an authentic task as a visitor or trainee might actually take notes in a similar real-life situation. Taking notes while listening also eliminates the distraction of reading written materials while listening (Hartwell 2007).

The notion of prediction has received considerable attention as a reading strategy, but it can also be used when listening. Real world knowledge, for example, about electro-magnetic separation will have considerable impact on understanding an oral text on the subject. Dialogues, especially those with questions, offer rich sources for creating explicit prediction activities. After playing a sufficient amount of the

oral document for students to understand the general context, it can be stopped just after characters have posed questions in order to give time to students to think about and predict the answer. Prediction requires cognitive processing of the gleaned information.

The scene in which Dr. Lawrence explains electromagnetic separation contains a dialogue that could easily be split up into question and answer sections:

***Dialogue 6: Electro-magnetic separation, part 3***

General Groves: So, how long do you have to keep this thing running to get any appreciable separation?

Dr. Ernest Lawrence: Well, it takes a long time to make a vacuum in the machine itself. Fourteen to twenty-four hours.

GG: And how long do you run it?

EL: Never more than ten to fifteen minutes.

GG: So how much separation do you have so far? How much have you got in that basket?

EL: Well Sir, as yet we don't have any sizeable separation at all. You see, all of this is still completely experimental. (Davis 1984)

During this passage, the filmic document could be stopped after “So, how long do you have to keep this thing running to get any appreciable separation?” Having the “correct” answer is not the point—General Groves speaks and understands English perfectly well and does not have the scientific knowledge necessary to answer the question. The objective of asking this question of the students is to process the information and provide a catalyst for language production. In turn, aiding students to process the information will help them to understand the meaning of “any sizeable separation” in the last sentence of the passage. The technique of asking students to integrate the role of a character may be used on numerable occasions. For example, a teacher might stop a law film or television show at the moment a lawyer cries “Objection, your honor” in a court of law. The task for students would be to determine if the judge will answer “Objection overruled” or “Objection sustained”. The decision must be based on factual information from both the story line and the law, but also from the character of the judge. By playing the judge, students play an active role in the dialogue.

Organizing student skits in class is another engaging way for students to explore oral language. By using audio or audiovisual sources, students may base their oral production on oral sources, instead of written texts. Using oral sources means that students have access not only to specific terminology, expressions, microstructures or macrostructures, but also to such qualities as intonation or timing that accompany these elements and add to the expression of meaning.

***Dialogue 7: Woolly-minded speculation***

RO: You can't keep scientists from speculating, General.

GG: Woolly-minded speculation and talk. That's what I aim to stop. I tell you, Professor, I've just had a bellyful of fancy-thinking experts. Can't pin 'em down on any-

thing.

RO: Of course, there aren't really any experts in this field.

GG: What?

RO: Not really. It's too new. (Davis 1984)

In this passage, Robert Oppenheimer's calm and convincing affirmations punctuate the energetic and surprised contributions of the exasperated General. In imitating the actors the students can experience how language also conveys emotions, feeling, or ways of thinking through voice. Through imitation, students avoid having to search for appropriate words or correct conjugations and hence, may concentrate on how they sound compared to the voice of the source document.

A third possible class activity following the viewing of a filmic text is the organization of a debate around a subject of importance to students and for which there is not universal agreement. For example, I have found that the question of worker contamination can give forth to much heart-felt discussion. One of the troubling current debates within the nuclear industry is precisely the bodily effects of radiation (Dialogue 4). The current international standard is that the effect of radiation on the possibility of inducing cancer in the human body is linear. Other researchers, including the European Committee on Radiation Risk, suggest that the effect of small amounts of radiation may have greater effects than those predicted by the linear hypothesis (Busby & Yablokov 2006); while still other members of the nuclear industry suggest that small doses may have an effect of protection, dubbed *hormesis*.

Although often used with varying meanings, the term *hormesis* is now found in the literature of toxicology, biology, and physics, especially in the fields of health. *Hormesis* is defined by Calabrese and Baldwin (2002: 97) as "an adaptive response with distinguishing dose-response characteristics induced by either direct acting or overcompensation-induced stimulatory processes at low doses". Although now found in scientific literature, this neologism is not yet found in, for example, the *Encyclopedia Britannica* (Carr 2010).

However, there is an entry for *radiation hormesis* in the online encyclopedia Wikipedia (Wikipedia 2010). Wikipedia is not an authoritative source of reference, but a popular collective source of information, just as biographical pictures serve as popular, but non authoritative sources of reference. The entry contains a numberless graph representing four possible types of effects of low-dose radiation exposure on cancer risk. A straight red line represents the currently accepted notion of a linear effect. A slightly upwardly-curved pink line—a color linked to sweets or little girls—is used to represent an increased effect of cancer risk due to exposure. A slightly dipped blue line represents a beneficial effect of low-dose radiation exposure. Finally, a heavily, downwardly-curved green line—a color linked to organic food and the "go" of a street light—is used to represent the supposedly more beneficial effects of *radiation hormesis*, that is to say exposure to low-doses of radiation. The graph's curves contain over-emphasized differences unrelated to any

numeric references. The graph is obviously visually weighted toward promoting *hormesis* instead of reflecting actual scientific research. Thus, precaution should be taken when examining the factual data of biographical pictures, just as when probing information presented in common “factual” sources such as Wikipedia.

Although fictional sources do not always provide accurate factual data, they can be a prelude to discussions of difficult subjects to which students have already been exposed. Furthermore, data presented as non-fiction, such as the current introduction of the concept of *hormesis*, are also of highly dubious factual accuracy. While questioning the accuracy of fictional sources is commonplace, it is essential that scientists question the veracity of postulates, especially those that are of high political and health importance, such as the effect of radiation fallout on health. FASP and biographical pictures such as those cited in this paper offer such occasions.

### **Conclusion**

Discussing the assessment of listening comprehension, Buck (2006: 252) concludes that the most pressing practical issue is “the problem of providing texts that have the characteristics of real-world, spoken texts.” Biographical pictures offer distinctive discursive representations of nuclear industry professionals: theoreticians, experimentalists, medical technicians, and financiers. Their discourse includes common elements of scientific reflection including metaphor, procedures, tools, probability, measurement, and what General Groves might label “woolly-minded speculation and talk”.

Hence, film and television programs offer rich sources for the learning of English for Specific Purposes. One of the most positive advantages is that students can hear both pronunciation and intonation, which are not found in written texts.

In discussing lawyer films, Elkins (2006) relates his reasons for presenting them: “[W]e need vivid, compelling representation of lawyers in action, by way of stories that prompt us to explore and re-imagine the on-going, relentless, sometimes heart-breaking, fateful struggle to give professional life meaning” (2006: 23). Biographical pictures are produced to engage us while raising important issues related to professional life. Hence, they can play a vital role in both learning a second language and in examining one’s professional path. van Naerssen (2010) remarks that the three principles of the ESP classroom are specificity, relevance, and needs-driven language objectives. When appropriate filmic texts are found, these principles can be met.

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